EST 120	BASICS OF CIVIL & MECHANICAL ENGINEERING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		ESC	4	0	0	4	2019

Preamble:

Objective of this course is to provide an insight and inculcate the essentials of Civil Engineering discipline to the students of all branches of Engineering and to provide the students an illustration of the significance of the Civil Engineering Profession in satisfying the societal needs.

To introduce the students to the basic principles of mechanical engineering

Prerequisite: NIL

Course Outcomes: After completion of the course, the student will be able to

CO 1	Recall the role of civil engineer in society and to relate the various disciplines of Civil Engineering.
CO 2	Explain different types of buildings, building components, building materials and building construction
CO 3	Describe the importance, objectives and principles of surveying.
CO 4	Summarise the basic infrastructure services MEP, HVAC, elevators, escalators and ramps
CO 5	Discuss the Materials, energy systems, water management and environment for green buildings.
CO 6	Analyse thermodynamic cycles and calculate its efficiency
CO 7	Illustrate the working and features of IC Engines
CO 8	Explain the basic principles of Refrigeration and Air Conditioning
CO 9	Describe the working of hydraulic machines
CO 10	Explain the working of power transmission elements
CO 11	Describe the basic manufacturing, metal joining and machining processes

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	-	-	-	-	3	2	2	-	-	-	-
CO2	3	2	-	1	3	-	-	3	-	-	-	-
CO3	3	2	-	-	3	-	-	-	2	-	-	-

CO4	3	2	-	-	3	-	-	-	2	-	-	-
CO5	3	2	-	-	3	2	3	-	2	-	-	-
CO6	3	2										
CO7	3	1										
CO8	3	1										
CO9	3	2										
CO10	3	1										
CO11	3											

Assessment Pattern

	Basic Civil Engineering			**Basic Mechanical Engineering**		
Bloom's Category	**Continuous Assessment**		**End Semester Examination (marks)**	**Continuous Assessment**		**End Semester Examination (marks)**
	Test 1 marks	**Test 2 marks**		**Test 1 marks**	**Test 2 marks**	
Remember	5	5	10	7.5	7.5	15
Understand	20	20	40	12.5	12.5	25
Apply				5	5	10
Analyse						
Evaluate						
Create						

Mark distribution

Total Marks	**CIE (Marks)**	**ESE (Marks)**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern:

There will be two parts; Part I – Basic Civil Engineering and Part II – Basic Mechanical Engineering. Part I and PART II carries 50 marks each. For the end semester examination, part I contain 2 parts -

Part A and Part B. Part A contain 5 questions carrying 4 marks each (not exceeding 2 questions from each module). Part B contains 2 questions from each module out of which one to be answered. Each question carries 10 mark and can have maximum 2 sub-divisions. The pattern for end semester examination for part II is same as that of part I. **However, student should answer both part I and part 2 in separate answer booklets.**

Course Level Assessment Questions:

Course Outcome CO1: *To recall the role of civil engineer in society and to relate the various disciplines of Civil Engineering.*

1.Explain relevance of Civil engineering in the overall infrastructural development of the country.
Course outcome 2 (CO2) (One question from each module and not more than two)

Explain different types of buildings, building components, building materials and building construction
1. Discuss the difference between plinth area and carpet area.

Course outcome 3 (CO3) (One question from each module and not more than two)

Describe the importance, objectives and principles of surveying.

1. Explain the importance of surveying in Civil Engineering

Course outcome 4 (CO4) (One question from each module and not more than two)

Summarise the basic infrastructure services MEP, HVAC, elevators, escalators and ramps

1. Explain the civil engineering aspects of elevators, escalators and ramps in buildings

Course outcome 5 (CO5) (One question from each module and not more than two)

Discuss the Materials, energy systems, water management and environment for green buildings.

1. Discuss the relevance of Green building in society

Section II *Answer any 1 full question from each module. Each full question carries 10 marks*

Course Outcome 1 (CO1) (Two full question from each module and each question can have maximum 2 sub-divisions)

To recall the role of civil engineer in society and to relate the various disciplines of Civil Engineering
CO Questions

1. a List out the types of building as per occupancy. Explain any two, each in about five sentences.
   b. Discuss the components of a building with a neat figure.

2. a. What are the major disciplines of civil engineering and explain their role in the infrastructural framework.

b. Explain the role of NBC, KBR & CRZ norms in building rules and regulations prevailing in our country.

Course Outcome 2 (CO2) & Course Outcome 3 (CO3) (Two full question from each module and each question can have maximum 2 sub-divisions)

Explain different types of buildings, building components, building materials and building construction & Describe the importance, objectives and principles of surveying.

CO Questions

1. **a.** What are the different kinds of cement available and what is their use.
   b. List the properties of good building bricks. Explain any five.
2. a. List and explain any five modern construction materials used for construction.
   b. Explain the objectives and principles of surveying

Course outcome 4 (CO4) & Course outcome 5 (CO5) (Two full question from each module and each question can have maximum 2 sub-divisions)

Summarise the basic infrastructure services MEP, HVAC, elevators, escalators and ramps & Discuss the Materials, energy systems, water management and environment for green buildings.

CO Questions

1. **a**. Draw the elevation and plan of one brick thick wall with English bond
   b. Explain the energy systems and water management in Green buildings

2. **a.** Draw neat sketch of the following foundations: (i) Isolated stepped footing; (ii) Cantilever footing; and (iii) Continuous footing.

   b. Discuss the civil engineering aspect of MEP and HVAC in a commercial building

Course Outcome 6 (CO6):

1. In an air standard Otto cycle the compression ratio is 7 and compression begins at 35°C, 0.1 MPa. The maximum temperature of the cycle is 1100°C. Find
   i) Heat supplied per kg of air,
   ii) Work done per kg of air,
   iii) Cycle efficiency
   Take Cp = 1.005 kJ/kgK and Cv=0.718 kJ/kgK
2. A Carnot cycle works with adiabatic compression ratio of 5 and isothermal expansion ratio of 2. The volume of air at the beginning of isothermal expansion is 0.3 m^3. If the maximum temperature and pressure is limited to 550K and 21 bar, determine the minimum temperature in the cycle and efficiency of the cycle.
3. In an ideal diesel cycle, the temperature at the beginning and end of compression is 65°C and 620°C respectively. The temperature at the beginning and end of the expansion is 1850°C and 850 °C. Determine the ideal efficiency of the cycle.

4. Explain the concepts of CRDI and MPFI in IC Engines.

Course Outcome 7 (CO7)

1. With the help of a neat sketch explain the working of a 4 stroke SI engine
2. Compare the working of 2 stroke and 4 stroke IC engines
3. Explain the classification of IC Engines.

Course Outcome 8(CO8):

1. Explain the working of vapour compression refrigeration system.
2. With the help of suitable sketch explain the working of a split air conditioner.
3. Define: COP, specific humidity, relative humidity and dew point temperature.

Course Outcome 9 (CO9):

1. Explain the working of a single stage centrifugal pump with sketches.
2. With the help of a neat sketch, explain the working of a reciprocating pump.
3. A turbine is to operate under a head of 25 m at 200 rpm. The discharge is 9 m^3/s. If the overall efficiency of the turbine is 90%. Determine the power developed by the turbine.

Course Outcome 10 (CO10):

1. Explain the working of belt drive and gear drive with the help of neat sketches
2. Explain a single plate clutch.
3. Sketch different types of gear trains and explain.

Course Outcome 11 (CO11):

1. Describe the operations which can be performed using drilling machine.
2. Explain the functions of runners and risers used in casting.
3. With a neat sketch, explain the working and parts of a lathe.

Model Question Paper

QP CODE: **EST120** page:3

Reg No:___________________

Name:______________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EST 120

Course Name: BASICS OF CIVIL AND MECHANICAL ENGINEERING

Max. Marks: 100 Duration: 3 hours

Answer both part I and part 2 in separate answer booklets

PART I: BASIC CIVIL ENGINEERING

PART A

(Answer all questions. Each question carries 4 marks)

1. Explain relevance of Civil engineering in the overall infrastructural development of the country.
2. Discuss the difference between plinth area and carpet area.
3. Explain different types of steel with their properties.
4. What are the different kinds of cement available and what is their use?
5. Define bearing capacity of soil.

(5 x 4 = 20)

Part B

Answer one full question from each module.

MODULE I

6a. List out the types of building as per occupancy. Explain any two, each in about five sentences. (5)

b. Discuss the components of a building with a neat figure. (5)

OR

7a. What are the major disciplines of civil engineering and explain their role in the infrastructural framework. (5)

b. Explain the role of NBC, KBR & CRZ norms in building rules and regulations prevailing in our country. (5)

MODULE II

8a. What are the different kinds of cement available and what is their use. (5)

b. List the properties of good building bricks. Explain any five. (5)

OR

9a. List and explain any five modern construction materials used for construction. (5)

b. Explain the objectives and principles of surveying (5)

MODULE III

10a. Draw the elevation and plan of one brick thick wall with English bond (5)

b. Explain the energy systems and water management in Green buildings (5)

OR

11a. Draw neat sketch of the following foundations: (i) Isolated stepped footing;
(ii) Cantilever footing; and (iii) Continuous footing. (5)

b. Discuss the civil engineering aspect of MEP and HVAC in a commercial building (5)

[10 x 3 = 30]

PART II: BASIC MECHANICAL ENGINEERING

PART A

Answer all questions. Each question carries 4 marks

1. Sketch the P-v and T-s diagram of a Carnot cycle and List the processes.
2. Illustrate the working of an epicyclic gear train.
3. Explain cooling and dehumidification processes.
4. Differentiate between soldering and brazing.
5. Explain the principle of Additive manufacturing.

4 x 5 = 20 marks

Part B

Answer one full question from each module.

MODULE I

6. In an air standard Otto cycle the compression ratio is 7 and compression begins at 35^{o}C, 0.1MPa. The maximum temperature of the cycle is 1100^{o}C. Find
   i) Heat supplied per kg of air,
   ii) Work done per kg of air,
   iii)Cycle efficiency

   Take C_p = 1.005 kJ/kgK and C_v=0.718 kJ/kgK 10 marks

OR

7. a) Explain the working of a 4 stroke SI engine with neat sketches. 7 marks
   b) Explain the fuel system of a petrol engine. 3 marks

MODULE II

8. a) Explain the working of a vapour compression system with help of a block diagram. 7 marks
   b) Define: Specific humidity, relative humidity and dew point temperature. 3 marks

OR

9. With the help of a neat sketch, explain the working of a centrifugal pump. 10 marks

MODULE III

10. Explain the two high, three high, four high and cluster rolling mills with neat sketches. 10 marks

OR

11. a) Describe the arc welding process with a neat sketch. 6 marks
    b) Differentiate between up-milling and down-milling operations. 4 marks

SYLLABUS

Module 1

General Introduction to Civil Engineering: Relevance of Civil Engineering in the overall infrastructural development of the country. Responsibility of an engineer in ensuring the safety of built environment. Brief introduction to major disciplines of Civil Engineering like Transportation Engineering, Structural Engineering, Geo-technical Engineering, Water Resources Engineering and Environmental Engineering.

Introduction to buildings: Types of buildings, selection of site for buildings, components of a residential building and their functions.

Building rules and regulations: Relevance of NBC, KBR & CRZ norms (brief discussion only).

Building area: Plinth area, built up area, floor area, carpet area and floor area ratio for a building as per KBR.

Module 2

Surveying: Importance, objectives and principles.

Construction materials, Conventional construction materials**:** types, properties and uses of building materials: bricks, stones, cement, sand and timber

Cement concrete: Constituent materials, properties and types.

Steel: Steel sections and steel reinforcements, types and uses.

Modern construction materials:- Architectural glass, ceramics, Plastics, composite materials, thermal and acoustic insulating materials, decorative panels, waterproofing materials. Modern uses of gypsum, pre-fabricated building components (brief discussion only).

Module 3

Building Construction: Foundations: Bearing capacity of soil (definition only), functions of foundations, types – shallow and deep (brief discussion only). Load bearing and framed structures (concept only).

Brick masonry: - Header and stretcher bond, English bond & Flemish bond random rubble masonry.

Roofs and floors: - Functions, types; flooring materials (brief discussion only).

Basic infrastructure services: MEP, HVAC, elevators, escalators and ramps (Civil Engineering aspects only), fire safety for buildings.

Green buildings:- Materials, energy systems, water management and environment for green buildings. (brief discussion only).

Module 4

Analysis of thermodynamic cycles: Carnot, Otto, Diesel cycles, Derivation of efficiency of these cycles, Problems to calculate heat added, heat rejected, net work and efficiency. IC Engines: CI, SI, 2-Stroke, 4-Stroke engines. Listing the parts of different types of IC Engines. Efficiencies of IC Engines(Definitions only), Air, Fuel, cooling and lubricating systems in SI and CI Engines, CRDI, MPFI. Concept of hybrid engines.

Module 5

Refrigeration: Unit of refrigeration, reversed Carnot cycle,COP, vapour compression cycle (only description and no problems); Definitions of dry, wet & dew point temperatures, specific humidity and relative humidity, Cooling and dehumidification, Layout of unit and central air conditioners.

Description about working with sketches of: Reciprocating pump, Centrifugal pump, Pelton turbine, Francis turbine and Kaplan turbine. Overall efficiency, Problems on calculation of input and output power of pumps and turbines (No velocity triangles)

Description about working with sketches of: Belt and Chain drives, Gear and Gear trains, Single plate clutches.

Module 6

Manufacturing Process: Basic description of the manufacturing processes – Sand Casting, Forging, Rolling, Extrusion and their applications.

Metal Joining Processes: List types of welding, Description with sketches of Arc Welding, Soldering and Brazing and their applications

Basic Machining operations: Turning, Drilling, Milling and Grinding.

Description about working with block diagram of: Lathe, Drilling machine, Milling machine, CNC Machine. Principle of CAD/CAM, Rapid and Additive manufacturing.

Text Books:

1. Rangwala, S. C., Essentials of Civil Engineering, Charotar Publishing House
2. Mckay, W.B. and Mckay, J. K., Building Construction, Volumes 1 to 4, Pearson India Education Services

References Books:

1. Chen W.F and Liew J Y R (Eds), The Civil Engineering Handbook. II Edition CRC Press (Taylor and Francis)
2. Chudley, R and Greeno R, Building construction handbook, Addison Wesley, Longman group, England
3. Chudley, R, Construction Technology, Vol. I to IV, Longman group, England Course Plan
4. Kandya A A, Elements of Civil Engineering, Charotar Publishing house
5. Mamlouk, M. S., and Zaniewski, J. P., Materials for Civil and Construction Engineering, Pearson Publishers
6. Rangwala S.C and Dalal K B Building Construction Charotar Publishing house
7. Clifford, M., Simmons, K. and Shipway, P., An Introduction to Mechanical Engineering Part I - CRC Press
8. Roy and Choudhary, Elements of Mechanical Engineering, Media Promoters &Publishers Pvt. Ltd., Mumbai.
9. Sawhney, G. S., Fundamentals of Mechanical Engineering, PHI
10. G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill Education; First edition, 2018
11. Benjamin,J.,Basic Mechanical Engineering,Pentex Books,9th Edition,2018
12. Balachandran, P.Basic Mechanical Engineering,Owl Books

Course Contents and Lecture Schedule:

No	Topic	Course outcomes addressed	No. of Lectures
1	**Module I**		**Total: 7**
1.1	*General Introduction to Civil Engineering*: Relevance of Civil Engineering in the overall infrastructural development of the country. Responsibility of an engineer in ensuring the safety of built environment.	CO1	1
1.2	Brief introduction to major disciplines of Civil Engineering like Transportation Engineering, Structural Engineering, Geo-technical Engineering, Water Resources Engineering and Environmental Engineering.	CO1	2
1.3	*Introduction to buildings:* Types of buildings, selection of site for buildings, components of a residential building and their functions.	CO2	2
1.4	*Building rules and regulations:* Relevance of NBC, KBR & CRZ norms (brief discussion only)	CO2	1
1.5	*Building area:* Plinth area, built up area, floor area, carpet area and floor area ratio for a building as per KBR.	CO2	1
2	**Module 2**		**Total: 7**
2.1	*Surveying:* Importance, objectives and principles.	CO3	1
2.2	Bricks: - Classification, properties of good bricks, and tests on bricks	CO2	1
2.3	Stones: - *Qualities* of good stones, types of stones and their uses. Cement: - Good qualities of cement, types of cement and their uses.	CO2	1
2.4	Sand: - Classification, qualities of good sand and sieve analysis (basics only). Timber: - Characteristics, properties and uses.	CO2	1
2.5	Cement concrete: - Constituent materials, properties and types, Steel: - Steel sections and steel reinforcements, types and uses.	CO2	1

2.6	Modern construction materials: - Architectural glass, ceramics, plastics, composite materials, thermal and acoustic insulating materials, decorative panels, waterproofing materials, modern uses of gypsum, pre-fabricated building components (brief discussion only)	CO2	2
3	**Module 3**		**Total: 7**
3.1	Foundations: - Bearing capacity of soil (definition only), functions of foundations, types – shallow and deep (brief discussion only). Brick masonry: - Header and stretcher bond, English bond & Flemish bond– elevation and plan (one & one and a half brick wall only). Random rubble masonry.	CO2	2
3.2	Roofs: Functions, types; roofing materials (brief discussion only) Floors: Functions, types; flooring materials (brief discussion only)	CO2	2
3.3	*Basic infrastructure services:* MEP, HVAC, Elevators, escalators and ramps (Civil Engineering aspects only) fire safety for buildings	CO4	2
3.4	*Green buildings:*- Materials, energy systems, water management and environment for green buildings. (brief discussion only)	CO5	1
4	**MODULE 4**		
4.1	Analysis of thermodynamic cycles: Carnot, Otto, and Diesel cycle- Derivation of efficiency of these cycles, Problems to calculate heat added, heat rejected, net work and efficiency	4	
4.2	IC Engines: CI, SI, 2-Stroke, 4-Stroke engines. Listing the parts of different types of IC Engines, efficiencies of IC Engines(Description only)	2	
4.3	Air, Fuel, cooling and lubricating systems in SI and CI Engines, CRDI, MPFI. Concept of hybrid engines	2	
5	**MODULE 5**		
5.1	Refrigeration: Unit of refrigeration, reversed Carnot cycle, COP, vapour compression cycle (only description and no problems)	1	
5.2	Definitions of dry, wet & dew point temperatures, specific humidity and relative humidity, Cooling and dehumidification, Layout of unit and central air conditioners.	1	

5.3	Description about working with sketches : Reciprocating pump, Centrifugal pump, Pelton turbine, Francis turbine and Kaplan turbine. Overall efficiency, Problems on calculation of input and output power of pumps and turbines (No velocity triangles)	4
5.4	Description about working with sketches of: Belt and Chain drives, Gear and Gear trains, Single plate clutches	3
6	**MODULE 6**	
6.1	Manufacturing Process: Basic description of the manufacturing processes – Sand Casting, Forging, Rolling, Extrusion and their applications.	2
6.2	Metal Joining Processes :List types of welding, Description with sketches of Arc Welding, Soldering and Brazing, and their applications	1
6.3	Basic Machining operations: Turning, Drilling, Milling and Grinding Description about working with block diagrams of: Lathe, Drilling machine, Milling machine, CNC Machine	3
6.4	Principle of CAD/CAM, Rapid and Additive manufacturing	1

EST 130	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		ESC	4	0	0	4	2019

Preamble:

This course aims to (1) equip the students with an understanding of the fundamental principles of electrical engineering(2) provide an overview of evolution of electronics, and introduce the working principle and examples of fundamental electronic devices and circuits (3) provide an overview of evolution of communication systems, and introduce the basic concepts in radio communication.

Prerequisite: Physics and Mathematics (Pre-university level)

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply fundamental concepts and circuit laws to solve simple DC electric circuits
CO 2	Develop and solve models of magnetic circuits
CO 3	Apply the fundamental laws of electrical engineering to solve simple ac circuits in steady state
CO 4	Describe working of a voltage amplifier
CO 5	Outline the principle of an electronic instrumentation system
CO 6	Explain the principle of radio and cellular communication

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1	-	-	-	-	-	-	-	-	-	2
CO 2	3	1	-	-	-	-	-	-	-	-	-	2
CO 3	3	1	-	-	-	-	-	-	-	-	-	2
CO 4	2	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	-	-	-	-	-	-	-	-	-	-	2
CO 6	2	-	-	-	-	-	-	-	-	-	-	2

Assessment Pattern

	Basic Electrical Engineering			**Basic Electronics Engineering**		
Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination (Marks)**	**Continuous Assessment Tests**		**End Semester Examination (Marks)**
	Test 1 (Marks)	**Test 2 (Marks)**		**Test 1 (Marks)**	**Test 2 (Marks)**	
Remember	0	0	10	10	10	20
Understand	12.5	12.5	20	15	15	30
Apply	12.5	12.5	20			
Analyse						
Evaluate						
Create						

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part I – Basic Electrical Engineering and Part II – Basic Electronics Engineering. Part I and PART II carries 50 marks each. For the end semester examination, part I contain 2 parts - Part A and Part B. Part A contain 5 questions carrying 4 marks each (not exceeding 2 questions from each module). Part B contains 2 questions from each module out of which one to be answered. Each question carries 10 mark and can have maximum 2 sub-divisions. The pattern for end semester examination for part II is same as that of part I. **However, student should answer both part I and part 2 in separate answer booklets.**

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Solve problems based on current division rule.

2. Solve problems with Mesh/node analysis.

3. Solve problems on Wye-Delta Transformation.

Course Outcome 2 (CO2):

1. Problems on series magnetic circuits

2. Problems on parallel magnetic circuits

3. Problems on composite magnetic ciruits

4. **Course Outcome 3 (CO3):**

1. problems on self inductance, mutual inductance and coefficient of coupling

2. problems on rms and average values of periodic waveforms

3. problems on series ac circuits

4. Compare star and Delta connected 3 phase AC systems.

Course Outcome 4 (CO4): Describe working of a voltage amplifier

1.What is the need of voltage divider biasing in an RC coupled amplifier?

2. Define operating point in the context of a BJT amplifier.

3. Why is it required to have a voltage amplifier in a public address system?

Course Outcome 5 (CO5): Outline the principle of an electronic instrumentation system

1. Draw the block diagram of an electronic instrumentation system.

2. What is a transducer?

3. Explain the working principle of operation of digital multimeter.

Course Outcome 6 (CO6): Explain the principle of radio and cellular communication

1. What is the working principle of an antenna when used in a radio transmitter?

2. What is the need of two separate sections RF section and IF section in a super heterodyne receiver?

3. What is meant by a cell in a cellular communication?

Model Question Paper

QP CODE: Pages: 3

Reg No.:________________

Name:__________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EST 130

Course Name: BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING

Max. Marks: 100 Duration: 3 hours

Answer both part I and part 2 in separate answer booklets

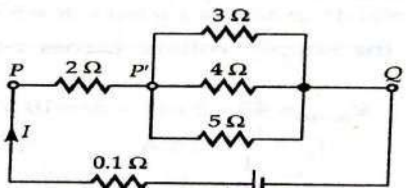
PART I

BASIC ELECTRICAL ENGINEERING

PART A

Answer all questions; each question carries 4 marks.

1. Calculate the current through the 4Ω resistor in the circuit shown, applying current division rule:



2. Calculate the RMS and average values of a purely sinusoidal current having peak value 15A.

3. An alternating voltage of (80+j60)V is applied to an RX circuit and the current flowing through the circuit is (-4+j10)A. Calculate the impedance of the circuit in rectangular and polar forms. Also determine if X is inductive or capacitive.

4. Derive the relation between line and phase values of voltage in a three phase star connected system.

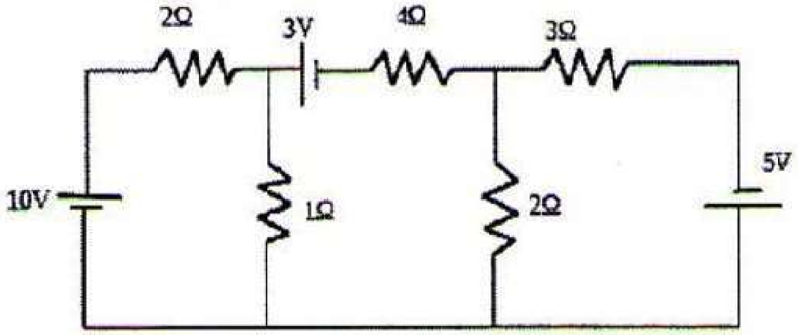
5. Compare electric and magnetic circuits. *(5x4=20)*

PART B

Answer one question from each module; each question carries 10 marks.

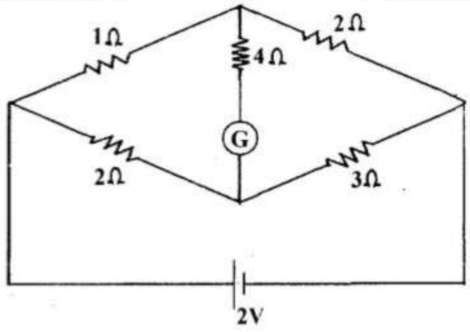
Module 1

6. . Calculate the node voltages in the circuit shown, applying node analysis:



7. (a) State and explain Kirchhoff's laws. (4 marks)

(b) Calculate the current through the galvanometer (G) in the circuit shown:



(6 marks)

Module 2

8. (a) State and explain Faraday's laws of electromagnetic induction with examples. (4 marks)

(b) Differentiate between statically and dynamically induced emf. A conductor of length 0.5m moves in a uniform magnetic field of flux density 1.1T at a velocity of 30m/s. Calculate the emf induced in the conductor if the direction of motion of the conductor is inclined at 60^0 to the direction of field. (6 marks)

9. (a) Derive the amplitude factor and form factor of a purely sinusoidal waveform. (5 marks)

(b) A current wave is made up of two components-a 5A dc component and a 50Hz ac component, which is a sinusoidal wave with a peak value of 5A. Sketch the resultant waveform and determine its RMS and average values. (5 marks)

Module 3

10. Draw the power triangle and define active, reactive and apparent powers in ac circuits. Two coils A and B are connected in series across a 240V, 50Hz supply. The resistance of A is 5Ω and the inductance of B is 0.015H. If the input from the supply is 3kW and 2kVAR, find the inductance of A and the resistance of B. Also calculate the voltage across each coil.

11. A balanced three phase load consists of three coils each having resistance of 4Ω and inductance 0.02H. It is connected to a 415V, 50Hz, 3-phase ac supply. Determine the phase voltage, phase current, power factor and active power when the loads are connected in (i) star (ii) delta.

(3x10=30)

PART II

BASIC ELECTRONICS ENGINEERING

PART A

Answer all questions; each question carries 4 marks.

1. Give the specifications of a resistor. The colour bands marked on a resistor are Blue, Grey, Yellow and Gold. What are the minimum and maximum resistance values expected from that resistance?
2. What is meant by avalanche breakdown?
3. Explain the working of a full-wave bridge rectifier.
4. Discuss the role of coupling and bypass capacitors in a single stage RC coupled amplifier.
5. Differentiate AM and FM communication systems.

(5x4=20)

PART B

Answer one question from each module; each question carries 10 marks.

Module 4

6. a) Explain with diagram the principle of operation of an NPN transistor. (5)
   b) Sketch and explain the typical input-output characteristics of a BJT when connected in common emitter configuration. (5)

OR

7. a) Explain the formation of a potential barrier in a P-N junction diode. (5)
   b) What do you understand by Avalanche breakdown? Draw and explain the V-I characteristics of a P-N junction and Zener diode. (5)

Module 5

8. a) With a neat circuit diagram, explain the working of an RC coupled amplifier. (6)
   b) Draw the frequency response characteristics of an RC coupled amplifier and state the reasons for the reduction of gain at lower and higher frequencies. (4)

OR

9. a) With the help of block diagram, explain how an electronic instrumentation system. (6)
   b) Explain the principle of an antenna. (4)

Module 6

10. a) With the help of a block diagram, explain the working of Super hetrodyne receiver. (6)
    b) Explain the importance of antenna in a communication system. (4)

OR

11. a) With neat sketches explain a cellular communication system. (5)
    b) Explain GSM communication with the help of a block diagram. (5)

(3x10=30)

SYLLABUS

MODULE 1: Elementary Concepts of Electric Circuits

Elementary concepts of DC electric circuits: Basic Terminology including voltage, current, power, resistance, emf; Resistances in series and parallel; Current and Voltage Division Rules; Capacitors & Inductors: V-I relations and energy stored. Ohms Law and Kirchhoff's laws-Problems; Star-delta conversion (resistive networks only-derivation not required)-problems.

Analysis of DC electric circuits: Mesh current method - Matrix representation - Solution of network equations. Node voltage methods-matrix representation-solution of network equations by matrix methods. Numerical problems.

MODULE 2: Elementary Concepts of Magnetic circuits, Electromagnetic Induction and AC fundamentals

Magnetic Circuits: Basic Terminology: MMF, field strength, flux density, reluctance - comparison between electric and magnetic circuits- Series and parallel magnetic circuits with composite materials, numerical problems.

Electromagnetic Induction: Faraday's laws, problems, Lenz's law- statically induced and dynamically induced emfs - Self-inductance and mutual inductance, coefficient of coupling

Alternating Current fundamentals: Generation of alternating voltages-Representation of sinusoidal waveforms: frequency, period, Average, RMS values and form factor of waveforms-Numerical Problems.

MODULE 3: AC Circuits

AC Circuits: Phasor representation of sinusoidal quantities. Trignometric, Rectangular, Polar and complex forms. Analysis of simple AC circuits: Purely resistive, inductive & capacitive circuits; Inductive and capacitive reactance, concept of impedance. Average Power Power factor. Analysis of RL, RC and RLC series circuits-active, reactive and apparent power. Simple numerical problems.

Three phase AC systems: Generation of three phase voltages; advantages of three phase systems, star and delta connections (balanced only), relation between line and phase voltages, line and phase currents- Numerical problems

MODULE 4

Introduction to Semiconductor devices: Evolution of electronics – Vacuum tubes to nano electronics. Resistors, Capacitors and Inductors (constructional features not required): types, specifications. Standard values, color coding. PN Junction diode: Principle of operation, V-I characteristics, principle of avalanche breakdown. Bipolar Junction Transistors: PNP and NPN structures, Principle of operation, relation between current gains in CE, CB and CC, input and output characteristics of common emitter configuration.

MODULE 5

Basic electronic circuits and instrumentation: Rectifiers and power supplies: Block diagram description of a dc power supply, Working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple zener voltage regulator. Amplifiers: Block diagram of Public Address system, Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response, Concept of voltage divider biasing. Electronic Instrumentation: Block diagram of an electronic instrumentation system.

MODULE 6

Introduction to Communication Systems: Evolution of communication systems – Telegraphy to 5G. Radio communication: principle of AM & FM, frequency bands used for various communication systems, block diagram of super heterodyne receiver, Principle of antenna – radiation from accelerated charge. Mobile communication: basic principles of cellular communications, principle and block diagram of GSM.

Text Books

1. D P Kothari and I J Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. D C Kulshreshtha, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
3. ChinmoySaha, Arindham Halder and Debarati Ganguly, Basic Electronics - Principles and Applications, Cambridge University Press, 2018.
4. M.S.Sukhija and T.K.Nagsarkar, Basic Electrical and Electronics Engineering, Oxford University Press, 2012.
5. Wayne Tomasi and Neil Storey, A Textbook On Basic Communication and Information Engineering, Pearson, 2010.

Reference Books

1. Del Toro V, “Electrical Engineering Fundamentals”, Pearson Education.
2. T. K. Nagsarkar, M. S. Sukhija, “Basic Electrical Engineering”, Oxford Higher Education.
3. Hayt W H, Kemmerly J E, and Durbin S M, “Engineering Circuit Analysis”, Tata McGraw-Hill
4. Hughes, “Electrical and Electronic Technology”, Pearson Education.
5. V. N. Mittle and Arvind Mittal, “Basic Electrical Engineering,” Second Edition, McGraw Hill.
6. Parker and Smith, “Problems in Electrical Engineering”, CBS Publishers and Distributors.
7. S. B. Lal Seksena and Kaustuv Dasgupta, “Fundamentals of Electrical Engineering”, Cambridge University Press.
8. Anant Agarwal, Jeffrey Lang, Foundations of Analog and Digital Electronic Circuits, Morgan Kaufmann Publishers, 2005.
9. Bernard Grob, Ba sic Electronics, McGraw Hill.
10. A. Bruce Carlson, Paul B. Crilly, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, Tata McGraw Hill, 5th Edition.

COURSE CONTENTS AND LECTURE SCHEDULE

No	**Topic**	**No. of Lectures**
1	***Elementary Concepts of Electric Circuits***	
1.1	**Elementary concepts of DC electric circuits:** Basic Terminology including voltage, current, power, resistance, emf; Resistances in series and parallel; Current and Voltage Division Rules; Capacitors & Inductors: V-I relations and energy stored. Ohms Law and Kirchhoff's laws-Problems; Star-delta conversion (resistive networks only-derivation not required)-problems.	1 2 1
1.2	**Analysis of DC electric circuits:** Mesh current method - Matrix representation - Solution of network equations. Node voltage methods-matrix representation-solution of network equations by matrix methods. Numerical problems.	1 1 2
2	**Elementary Concepts of Magnetic circuits, Electromagnetic Induction and AC fundamentals**	
2.1	**Magnetic Circuits:** Basic Terminology: MMF, field strength, flux density, reluctance - comparison between electric and magnetic circuits- Series and parallel magnetic circuits with composite materials, numerical problems.	1 2
2.2	**Electromagnetic Induction:** Faraday's laws, problems, Lenz's law- statically induced and dynamically induced emfs - Self-inductance and mutual inductance, coefficient of coupling	1 2
2.3	**Alternating Current fundamentals:** Generation of alternating voltages-Representation of sinusoidal waveforms: frequency, period, Average, RMS values and form factor of waveforms-Numerical Problems.	2
3	**AC Circuits**	

3.1	**AC Circuits:** Phasor representation of sinusoidal quantities. Trigonometric, Rectangular, Polar and complex forms. Analysis of simple AC circuits: Purely resistive, inductive & capacitive circuits; Inductive and capacitive reactance, concept of impedance. Average Power, Power factor. Analysis of RL, RC and RLC series circuits-active, reactive and apparent power. Simple numerical problems.	1 2 1 2
3.2	**Three phase AC systems:** Generation of three phase voltages; advantages of three phase systems, star and delta connections (balanced only), relation between line and phase voltages, line and phase currents- Numerical problems.	2
4	**Introduction to Semiconductor devices**	
4.1	Evolution of electronics – Vacuum tubes to nano electronics (In evolutional perspective only)	1
4.2	Resistors, Capacitors and Inductors: types, specifications. Standard values, color coding (No constructional features)	2
4.3	**PN Junction diode**: Principle of operation, V-I characteristics, principle of avalanche breakdown	2
4.4	**Bipolar Junction Transistors:** PNP and NPN structures, Principle of operation, relation between current gains in CE, CB and CC, input and output characteristics of common emitter configuration	3
5	**Basic electronic circuits and instrumentation**	
5.1	**Rectifiers and power supplies:** Block diagram description of a dc power supply, Working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple zener voltage regulator	3
5.2	**Amplifiers:** Block diagram of Public Address system, Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response, Concept of voltage divider biasing	4
5.3	**Electronic Instrumentation:** Block diagram of an electronic instrumentation system	2
6	**Introduction to Communication Systems**	
6.1	Evolution of communication systems – Telegraphy to 5G	1

6.2	**Radio communication:** principle of AM & FM, frequency bands used for various communication systems, block diagram of super heterodyne receiver, Principle of antenna – radiation from accelerated charge	4
6.3	**Mobile communication:** basic principles of cellular communications, principle and block diagram of GSM.	2

Suggested Simulation Assignments for Basic Electronics Engineering

1. Plot V-I characteristics of Si and Ge diodes on a simulator
2. Plot Input and Output characteristics of BJT on a simulator
3. Implementation of half wave and full wave rectifiers
4. Simulation of RC coupled amplifier with the design supplied
5. Generation of AM signal

Note: The simulations can be done on open tools such as QUCS, KiCad, GNURadio or similar software to augment the understanding.

EST 102	PROGRAMING IN C	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		ESC	2	1	2	4	2019

Preamble: The syllabus is prepared with the view of preparing the Engineering Graduates capable of writing readable C programs to solve computational problems that they may have to solve in their professional life. The course content is decided to cover the essential programming fundamentals which can be taught within the given slots in the curriculum. This course has got 2 Hours per week for practicing programming in C. A list showing 24 mandatory programming problems are given at the end. The instructor is supposed to give homework/assignments to write the listed programs in the rough record as and when the required theory part is covered in the class. The students are expected to come prepared with the required program written in the rough record for the lab classes.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Analyze a computational problem and develop an algorithm/flowchart to find its solution
CO 2	Develop readable* C programs with branching and looping statements, which uses Arithmetic, Logical, Relational or Bitwise operators.
CO 3	Write readable C programs with arrays, structure or union for storing the data to be processed
CO 4	Divide a given computational problem into a number of modules and develop a readable multi-function C program by using recursion if required, to find the solution to the computational problem
CO 5	Write readable C programs which use pointers for array processing and parameter passing
CO 6	Develop readable C programs with files for reading input and storing output

readable* - readability of a program means the following:

1. Logic used is easy to follow
2. Standards to be followed for indentation and formatting
3. Meaningful names are given to variables
4. Concise comments are provided wherever needed

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓				✓	✓	✓
CO2	✓	✓	✓	✓	✓					✓		✓
CO3	✓	✓	✓	✓	✓					✓		✓
CO4	✓	✓	✓	✓	✓					✓	✓	✓
CO5	✓	✓			✓					✓		✓
CO6	✓	✓			✓					✓		✓

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	15	10	25
Understand	10	15	25
Apply	20	20	40
Analyse	5	5	10
Evaluate			
Create			

Mark distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test 1 (for theory, for 2 hrs)	: 20 marks
Continuous Assessment Test 2 (for lab, internal examination, for 2 hrs)	: 20 marks

Internal Examination Pattern: There will be two parts; Part A and Part B. Part A contains 5 questions with 2 questions from each module (2.5 modules x 2 = 5), having 3 marks for each question. Students should answer all questions. Part B also contains 5 questions with 2 questions from each module (2.5 modules x 2 = 5), of which a student should answer any one. The questions should not have sub-divisions and each one carries 7 marks.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1): Write an algorithm to check whether largest of 3 natural numbers is prime or not. Also, draw a flowchart for solving the same problem.

Course Outcome 2 (CO2): Write an easy to read C program to process a set of n natural numbers and to find the largest even number and smallest odd number from the given set of numbers. The program should not use division and modulus operators.

Course Outcome 3(CO3): Write an easy to read C program to process the marks obtained by n students of a class and prepare their rank list based on the sum of the marks obtained. There are 3 subjects for which examinations are conducted and the third subject is an elective where a student is allowed to take any one of the two courses offered.

Course Outcome 4 (CO4): Write an easy to read C program to find the value of a mathematical function f which is defined as follows. f(n) = n! / (sum of factors of n), if n is not prime and f(n) = n! / (sum of digits of n), if n is prime.

Course Outcome 5 (CO5): Write an easy to read C program to sort a set of n integers and to find the number of unique numbers and the number of repeated numbers in the given set of numbers. Use a function which takes an integer array of n elements, sorts the array using the Bubble Sorting Technique and returns the number of unique numbers and the number of repeated numbers in the given array.

Course Outcome 6 (CO6): Write an easy to read C program to process a text file and to print the Palindrome words into an output file.

Model Question paper

QP CODE: PAGES:3

Reg No:______________

Name :______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: **EST 102**

Course Name: Programming in C (Common to all programs)

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Write short note on processor and memory in a computer.
2. What are the differences between compiled and interpreted languages? Give example for each.
3. Write a C program to read a Natural Number through keyboard and to display the reverse of the given number. For example, if "3214567" is given as input, the output to be shown is "7654123".
4. Is it advisable to use *goto* statements in a C program? Justify your answer.
5. Explain the different ways in which you can *declare & initialize* a single dimensional array.
6. Write a C program to read a sentence through keyboard and to display the count of white spaces in the given sentence.
7. What are the advantages of using functions in a program?
8. With a simple example program, explain *scope* and *life time* of variables in C.
9. Write a function in C which takes the address of a single dimensional array (containing a finite sequence of numbers) and the number of numbers stored in the array as arguments and stores the numbers in the same array in reverse order. Use pointers to access the elements of the array.
10. With an example, explain the different modes of opening a file. (10x3=30)

Part B

Answer any one Question from each module. Each question carries 14 Marks

11. (a) Draw a flow chart to find the position of an element in a given sequence, using linear searching technique. With an example explain how the flowchart finds the position of a given element. **(10)**

    (b) Write a pseudo code representing the flowchart for linear searching. **(4)**

OR

12. (a) With the help of a flow chart, explain the bubble sort operation. Illustrate with an example. **(10)**
    (b) Write an algorithm representing the flowchart for bubble sort. **(4)**

13. (a) Write a C program to read an English Alphabet through keyboard and display whether the given Alphabet is in upper case or lower case. **(6)**
    (b) Explain how one can use the builtin function in C, *scanf*to read values of different data types. Also explain using examples how one can use the builtin function in C, *printf*for text formatting. **(8)**

OR

14. (a) With suitable examples, explain various operators in C. (10)
    (b) Explain how characters are stored and processed in C. **(4)**

15. (a) Write a function in C which takes a 2-Dimensional array storing a matrix of numbers and the order of the matrix (number of rows and columns) as arguments and displays the sum of the elements stored in each row. **(6)**
    (b) Write a C program to check whether a given matrix is a diagonal matrix. **(8)**

OR

16. (a) Without using any builtin string processing function like *strlen*, *strcat* etc., write a program to concatenate two strings. **(8)**
    (b) Write a C program to perform bubble sort. **(6)**

17. (a) Write a function namely *myFact* in C to find the factorial of a given number. Also, write another function in C namely*nCr* which accepts two positive integer parameters *n* and *r* and returns the value of the mathematical function*C(n,r)*(n! / (r! x (n - r)!)). The function *nCr* is expected to make use of the factorial function *myFact.* *(10)*
    (b) What is recursion? Give an example. **(4)**

OR

18. (a) With a suitable example, explain the differences between a structure and a union in C. **(6)**
    (b) Declare a structure namely *Student* to store the details (*roll number, name, mark_for_C*) of a student. Then, write a program in C to find the average mark obtained by the students in a class for the subject *Programming in C* (using the field *mark_for_C*). Use array of structures to store the required data **(8)**

19. (a) With a suitable example, explain the concept of pass by reference. **(6)**
    (b) With a suitable example, explain how pointers can help in changing the content of a single dimensionally array passed as an argument to a function in C. **(8)**

OR

20. (a) Differentiate between sequential files and random access files? **(4)**

(b) Using the prototypes explain the functionality provided by the following functions. (10)

rewind()

- *i. fseek()*
- *ii. ftell()*
- *iii. fread()*
- ***iv.** fwrite()*

(14X5=70)

SYLLABUS

Programming in C (Common to all disciplines)

Module 1

Basics of Computer Hardware and Software

Basics of Computer Architecture: processor, Memory, Input& Output devices

Application Software & System software: Compilers, interpreters, High level and low level languages

Introduction to structured approach to programming, Flow chart Algorithms, Pseudo code (*bubble sort, linear search - algorithms and pseudocode*)

Module 2

Program Basics

Basic structure of C program: Character set, Tokens, Identifiers in C, Variables and Data Types , Constants, Console IO Operations, printf and scanf

Operators and Expressions: Expressions and Arithmetic Operators, Relational and Logical Operators, Conditional operator, size of operator, Assignment operators and Bitwise Operators. Operators Precedence

Control Flow Statements: If Statement, Switch Statement, Unconditional Branching using goto statement, While Loop, Do While Loop, For Loop, Break and Continue statements.(Simple programs covering control flow)

Module 3

Arrays and strings

Arrays Declaration and Initialization, 1-Dimensional Array, 2-Dimensional Array

String processing: In built String handling functions (strlen, strcpy, strcat and strcmp, puts, gets) Linear search program, bubble sort program, simple programs covering arrays and strings

Module 4

Working with functions

Introduction to modular programming, writing functions, formal parameters, actual parameters Pass by Value, Recursion, Arrays as Function Parameters structure, union, Storage Classes, Scope and life time of variables, *simple programs using functions*

Module 5

Pointers and Files

Basics of Pointer: declaring pointers, accessing data though pointers, NULL pointer,array access using pointers, pass by reference effect

File Operations: open, close, read, write, append

Sequential access and random access to files: In built file handlingfunctions (*rewind() ,fseek(), ftell(), feof(), fread(), fwrite()*), *simple programs covering pointers and files.*

Text Books

1. Schaum Series, Gottfried B.S.,Tata McGraw Hill,Programming with C
2. E. Balagurusamy, Mcgraw Hill,Programming in ANSI C
3. Asok N Kamthane, Pearson,Programming in C
4. Anita Goel, Pearson, Computer Fundamentals

Reference Books

1. Anita Goel and Ajay Mittal, Pearson, Computer fundamentals and Programming in C
2. Brian W. Kernighan and Dennis M. Ritchie, Pearson, C Programming Language
3. Rajaraman V, PHI, Computer Basics and Programming in C
4. Yashavant P, Kanetkar, BPB Publications, Let us C

Course Contents and Lecture Schedule

Module 1: Basics of Computer Hardware and Software		**(7 hours)**
1.1	**Basics of Computer Architecture:** Processor, Memory, Input& Output devices	**2 hours**
1.2	**Application Software & System software:** Compilers, interpreters, High level and low level languages	**2 hours**
1.3	Introduction to structured approach to programming, Flow chart	**1 hours**
1.4	Algorithms, Pseudo code (*bubble sort, linear search - algorithms and pseudocode*)	**2 hours**
Module 2: Program Basics		**(8 hours)**
2.1	**Basic structure of C program:** Character set, Tokens, Identifiers in C, Variables and Data Types , Constants, Console IO Operations, printf and scanf	**2 hours**
2.2	**Operators and Expressions:** Expressions and Arithmetic Operators, Relational and Logical Operators, Conditional operator, sizeof operator, Assignment operators and Bitwise Operators. Operators Precedence	**2 hours**

2.3	**Control Flow Statements:** If Statement, Switch Statement, Unconditional Branching using goto statement, While Loop, Do While Loop, For Loop, Break and Continue statements.*(Simple programs covering control flow)*	**4 hours**
Module 3: Arrays and strings:		**(6 hours)**
3.1	Arrays Declaration and Initialization, 1-Dimensional Array, 2-Dimensional Array	**2 hours**
3.2	**String processing:** In built String handling functions(*strlen, strcpy, strcat and strcmp, puts, gets*)	**2 hours**
3.3	Linear search program, bubble sort program, *simple programs covering arrays and strings*	**3 hours**
Module 4: Working with functions		**(7 hours)**
4.1	Introduction to modular programming, writing functions, formal parameters, actual parameters	**2 hours**
4.2	Pass by Value, Recursion, Arrays as Function Parameters	**2 hours**
4.3	structure, union, Storage Classes,Scope and life time of variables, *simple programs using functions*	**3 hours**
Module 5: Pointers and Files		**(7 hours)**
5.1	**Basics of Pointer**: declaring pointers, accessing data though pointers, NULL pointer,array access using pointers, pass by reference effect	**3 hours**
5.2	**File Operations**: open, close, read, write, append	1 **hours**
5.3	**Sequential access and random access to files:** In built file handlingfunctions (*rewind() ,fseek(), ftell(), feof(), fread(), fwrite()*)**,** *simple programs covering pointers and files.*	**2 hours**

C PROGRAMMING LAB (Practical part of EST 102, Programming in C)

Assessment Method: The Academic Assessment for the Programming lab should be done internally by the College. The assessment shall be made on 50 marks and the mark is divided as follows: Practical Records/Outputs - 20 marks (internal by the College), Regular Lab Viva - 5 marks (internal by the College), Final Practical Exam – 25 marks (internal by the College).

The mark obtained out of 50 will be converted into equivalent proportion out of 20 for CIE computation.

LIST OF LAB EXPERIMENTS

1. Familiarization of Hardware Components of a Computer

2. Familiarization of Linux environment – How to do Programming in C with Linux

3. Familiarization of console I/O and operators in C

  i) Display "Hello World"

  ii) Read two numbers, add them and display theirsum

  iii) Read the radius of a circle, calculate its area and display it

  iv)Evaluate the arithmetic expression ((a -b / c * d + e) * (f +g)) and display its solution.Read the values of the variables from the user through console.

4. Read 3 integer values and find the largest amoung them.

5. Read a Natural Number and check whether the number is prime or not

6. Read a Natural Number and check whether the number is Armstrong or not

7. Read n integers, store them in an array and find their sum and average

8. Read n integers, store them in an array and search for an element in the array using an algorithm for Linear Search

9. Read n integers, store them in an array and sort the elements in the array using Bubble Sort algorithm

10**.** Read a string (word), store it in an array and check whether it is a palindrome word or not.

11. Read two strings (each one ending with a $ symbol), store them in arrays and concatenate them without using library functions.

12. Read a string (ending with a $ symbol), store it in an array and count the number of vowels, consonants and spaces in it.

13. Read two input each representing the distances between two points in the Euclidean space, store these in structure variables and add the two distance values.

14. Using structure, read and print data of n employees (*Name, Employee Id and Salary*)

15. Declare a union containing 5 string variables (*Name, House Name, City Name, State and Pin code*) each with a length of C_SIZE (user defined constant). Then, read and display the address of a person using a variable of the union.

16. Find the factorial of a given Natural Number n usingrecursive and non recursive functions

17. Read a string (word), store it in an array and obtain its reverse by using a user defined function.

18. Write a menu driven program for performing matrix addition, multiplication and finding the transpose. Use functions to (i) read a matrix, (ii) find the sum of two matrices, (iii) find the product of two matrices, (i) find the transpose of a matrix and (v) display a matrix.

19. Do the following using pointers

  i) add two numbers

  ii) swap two numbers using a user defined function

20. Input and Print the elements of an array using pointers

21. Compute sum of the elements stored in an array using pointers and user defined function.

22. Create a file and perform the following

  iii) Write data to the file

  iv) Read the data in a given file & display the file content on console

  v) append new data and display on console

23. Open a text input file and count number of characters, words and lines in it; and store the results in an output file.

ESL 120	CIVIL & MECHANICAL WORKSHOP	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
			0	0	2	1	2019

Preamble: The course is designed to train the students to identify and manage the tools, materials and methods required to execute an engineering project. Students will be introduced to a team working environment where they develop the necessary skills for planning, preparing and executing an engineering project.

To enable the student to familiarize various tools, measuring devices, practices and different methods of manufacturing processes employed in industry for fabricating components.

Prerequisite: None

Course Outcomes: After the completion of the course the student will be able to:

Course Outcome	Course Outcome Description
CO 1	Name different devices and tools used for civil engineering measurements
CO 2	Explain the use of various tools and devices for various field measurements
CO 3	Demonstrate the steps involved in basic civil engineering activities like plot measurement, setting out operation, evaluating the natural profile of land, plumbing and undertaking simple construction work.
CO 4	Choose materials and methods required for basic civil engineering activities like field measurements, masonry work and plumbing.
CO 5	Compare different techniques and devices used in civil engineering measurements
CO 6	Identify Basic Mechanical workshop operations in accordance with the material and objects
CO 7	Apply appropriate Tools and Instruments with respect to the mechanical workshop trades
CO 8	Apply appropriate safety measures with respect to the mechanical workshop trades

Mapping of course outcomes with program outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	-	-	-	1	1	-	-	2	2	-	-
CO 2	1	-	-	-	1	1	-	-	2	2	-	-
CO 3	1	-	-	-	1	1	-	2	2	2	1	-
CO 4	1	-	-	-	1	1	-	2	2	2	1	1
CO 5	1	-	-	-	1	1	-	-	2	2		1
CO 6	2											

CO 7	2											
CO 8	2											

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
100	70	30	1 hour

Assessment Procedure: Total marks allotted for the course is 100 marks. CIE shall be conducted for 70 marks and ESE for 30 marks. CIE should be done for the work done by the student and also viva voce based on the work done on each practical session. ESE shall be evaluated by written examination of one hour duration conducted internally by the institute.

Continuous Internal Evaluation Pattern:

Attendance	: 20 marks
Class work/ Assessment /Viva-voce	: 50 marks
End semester examination (Internally by college)	: 30 marks

End Semester Examination Pattern: Written Objective Examination of one hour

SYLLABUS

PART 1

CIVIL WORKSHOP

Exercise 1. Calculate the area of a built-up space and a small parcel of land- Use standard measuring tape and digital distance measuring devices

Exercise 2. (a) Use screw gauge and vernier calliper to measure the diameter of a steel rod and thickness of a flat bar

(b) Transfer the level from one point to another using a water level

(c) Set out a one room building with a given plan and measuring tape

Exercise 3. Find the level difference between any two points using dumpy level

Exercise 4. (a) Construct a $1\frac{1}{2}$ thick brick wall of 50 cm height and 60 cm length using English bond. Use spirit level to assess the tilt of walls.

(b) Estimate the number of different types of building blocks to construct this wall.

Exercise 5. (a) Introduce the students to plumbing tools, different types of pipes, type of connections, traps, valves ,fixtures and sanitary fittings.

(b) Install a small rainwater harvesting installation in the campus

Reference Books:

1. Khanna P.N, “Indian Practical Civil Engineering Handbook”, Engineers Publishers.
2. Bhavikatti. S, "Surveying and Levelling (Volume 1)", I.K. International Publishing House
3. Arora S.P and Bindra S.P, " Building Construction", Dhanpat Rai Publications
4. S. C. Rangwala, “Engineering Materials,” Charotar Publishing House.

PART II

MECHANICAL WORKSHOP

LIST OF EXERCISES

(Minimum EIGHT units mandatory and FIVE models from Units 2 to 8 mandatory)

UNIT 1:- General : Introduction to workshop practice, Safety precautions, Shop floor ethics, Basic First Aid knowledge.

Study of mechanical tools, components and their applications: (a) Tools: screw drivers, spanners, Allen keys, cutting pliers etc and accessories (b) bearings, seals, O-rings, circlips, keys etc.

UNIT 2:- Carpentry : Understanding of carpentry tools

Minimum any one model

1. T –Lap joint 2. Cross lap joint 3. Dovetail joint 4. Mortise joints

UNIT 3:- Foundry : Understanding of foundry tools

Minimum any one model

1.Bench Molding 2. Floor Molding 3. Core making 4. Pattern making

UNIT 4: - Sheet Metal : Understanding of sheet metal working tools

Minimum any one model

1. Cylindrical shape
2. Conical shape
3. Prismatic shaped job from sheet metal

UNIT 5: - Fitting : Understanding of tools used for fitting

Minimum any one model

1. Square Joint
2. V- Joint
3. Male and female fitting

UNIT 6: - Plumbing : Understanding of plumbing tools, pipe joints

Any one exercise on joining of pipes making use of minimum three types of pipe joints

UNIT 7: - Smithy: Understanding of tools used for smithy.

Demonstrating the forge-ability of different materials (MS, Al, alloy steel and cast steels) in cold and hot states.

Observing the qualitative difference in the hardness of these materials

Minimum any one exercise on smithy

1. Square prism
2. Hexagonal headed bolt
3. Hexagonal prism
4. Octagonal prism

UNIT 8: -Welding: Understanding of welding equipments

Minimum any one welding practice

Making Joints using electric arc welding. bead formation in horizontal, vertical and over head positions

UNIT 9: - Assembly: Demonstration only

Dissembling and assembling of

1. Cylinder and piston assembly
2. Tail stock assembly
3. Bicycle
4. Pump or any other machine

UNIT 10: - Machines: Demonstration and applications of the following machines

Shaping and slotting machine; Milling machine; Grinding Machine; Lathe; Drilling Machine.

UNIT 11: - Modern manufacturing methods: Power tools, CNC machine tools, 3D printing, Glass cutting.

Course Contents and Lecture Schedule:

No	Topic	No of Sessions
1	**INTRODUCTION**	
1.1	Workshop practice, shop floor precautions, ethics and First Aid knowledge. Studies of mechanical tools, components and their applications: (a) Tools: screw drivers, spanners, Allen keys, cutting pliers etc and accessories (b) bearings, seals, O-rings, circlips, keys etc	1
2	**CARPENTRY**	
2.1	Understanding of carpentry tools and making minimum one model	2

3	**FOUNDRY**	
3.1	Understanding of foundry tools and making minimum one model	2
4	**SHEET METAL**	
4.1	Understanding of sheet metal working tools and making minimum one model	2
5	**FITTING**	
5.1	Understanding of fitting tools and making minimum one model	2
6	**PLUMBING**	
6.1	Understanding of pipe joints and plumbing tools and making minimum one model	2
7	**SMITHY**	
7.1	Understanding of smithy tools and making minimum one model	2
8	**WELDING**	
8.1	Understanding of welding equipments and making minimum one model	2
9	**ASSEMBLY**	
9.1	Demonstration of assembly and dissembling of multiple parts components	1
10	**MACHINES**	
10.1	Demonstration of various machines	1
11	**MODERN MANUFACTURING METHODS**	
11.1	Demonstrations of: power tools, CNC Machine tools, 3D printing, Glass cutting	1

MAT 102	**VECTOR CALCULUS, DIFFERENTIAL EQUATIONS AND TRANSFORMS**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**	**Year of Introduction**
		BSC	**3**	**1**	**0**	**4**	**2019**

Preamble: This course introduces the concepts and applications of differentiation and integration of vector valued functions, differential equations, Laplace and Fourier Transforms. The objective of this course is to familiarize the prospective engineers with some advanced concepts and methods in Mathematics which include the Calculus of vector valued functions, ordinary differential equations and basic transforms such as Laplace and Fourier Transforms which are invaluable for any engineer's mathematical tool box. The topics treated in this course have applications in all branches of engineering.

Prerequisite: Calculus of single and multi variable functions.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Compute the derivatives and line integrals of vector functions and learn their applications
CO 2	Evaluate surface and volume integrals and learn their inter-relations and applications.
CO 3	Solve homogeneous and non-homogeneous linear differential equation with constant coefficients
CO 4	Compute Laplace transform and apply them to solve ODEs arising in engineering
CO 5	Determine the Fourier transforms of functions and apply them to solve problems arising in engineering

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	2	1			1	2		2
CO 2	3	3	3	3	2	1			1	2		2
CO 3	3	3	3	3	2	1			1	2		2
CO 4	3	3	3	3	2	1			1	2		2
CO 5	3	3	3	3	2	1			1	2		2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks	Test 2 (Marks)	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			

Create			

Mark distribution

Total Marks	**CIE** (Marks)	**ESE** (Marks)	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

Assignments: Assignment should include specific problems highlighting the applications of the methods introduced in this course in science and engineering.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Compute the derivatives and line integrals of vector functions and learn their applications

1. How would you calculate the speed, velocity and acceleration at any instant of a particle moving in space whose position vector at time $t$is $\boldsymbol{r}(t)$?

2. Find the work done by the force field $F = (e^x - y^3)\boldsymbol{i} + (\cos y + x^3)$on a particle that travels once around the unit circle centred at origin having radius 1.

3. When do you say that a vector field is conservative? What are the implications if a vector field is conservative?

Course Outcome 2 (CO2): Evaluate surface and volume integrals and learn their inter-relations and applications

1. Write any one application each of line integral, double integral and surface integral.

2. Use the divergence theorem to find the outward flux of the vector field $F(x, y\ , z) = z\boldsymbol{k}$across the

$$x^2 + y^2 + z^2 = a^2$$

3. State Greens theorem. Use Green’s theorem to express the area of a plane region bounded by a curve as a line integral.

Course Outcome 3 (CO3): Solve homogeneous and non-homogeneous linear differential equation with constant coefficients

1. If $y_1(x)$ and $y_2(x)$ are solutions of$y'' + py' + qy = 0$, where p, q are constants, show that

   $y_1(x) + y_2(x)$ is also a solution.

2. Solve the differential equation $y'' + y = 0.001x^2$ using method of undetermined coefficient.

3. Solve the differential equation of$y''' - 3y'' + 3y' - y = e^x - x - 1$.

Course Outcome 4 (CO4): Compute Laplace transform and apply them to solve ODEs arising in engineering

1. What is the inverse Laplace Transformof $(s) = \frac{3s-137}{s^2+2s+4}$?

2. Find Laplace Transform of Unit step function.

3. Solve the differential equation of $y'' + 9y = \delta\left(t - \frac{\pi}{2}\right)$? Given $y(0) = 2,\ y'(0) = 0$

Course Outcome 5(CO5): Determine the Fourier transforms of functions and apply them to solve problems arising in engineering

1. Find the Fourier integral representation of function defined by $f(x) = e^{-x}$for$x > 0$ and $f(x) = 0$for$x < 0$.

2. What are the conditions for the existence of Fourier Transform of a function $f(x)$?

3. Find the Fourier transform of $f(x) = 1$ for $|x| < 1$ and $f(x) = 0$ otherwise.

Model Question paper

QP CODE: PAGES:3

Reg No:_______________

Name :_______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MAT 102

Max. Marks: 100 **Duration: 3 Hours**

VECTOR CALCULUS, DIFFERENTIAL EQUATIONS AND TRANSFORMS

(2019-Scheme)

(Common to all branches)

PART A

(Answer all questions. Each question carries 3 marks)

1. Is the vector $\boldsymbol{r}$ **where** $\boldsymbol{r} = x\boldsymbol{i} + y\boldsymbol{j} + z\boldsymbol{k}$ conservative. Justify your answer.
2. State Greens theorem including all the required hypotheses
3. What is the outward flux of $\boldsymbol{F}(\boldsymbol{x}, \boldsymbol{y}, \boldsymbol{z}) = x\boldsymbol{i} + y\boldsymbol{j} + z\boldsymbol{k}$ across any unit cube**.**
4. What is the relationship between Green's theorem and Stokes theorem?
5. Solve $y^{''} + 4y^{'} + 2.5y = 0$
6. Does the function $y = C_1 \cos x + C_2\, sinx$form a solution of$y^{''} + y = 0$?. Is it the general solution? Justify your answer.
7. Find the Laplace transform of $e^{-t} \sinh 4t$
8. Find the Laplace inverse transform of $\frac{1}{s\,(s^2+\omega^2)}$.
9. Given the Fourier transform $\frac{1}{\sqrt{2}}e^{-\frac{\omega^2}{4}}$ of $f(x) = e^{-x^2}$, find the Fourier transform of xe^{-x^2}
10. State the convolution theorem for Fourier transform

PART B

(Answer one full question from each module. Each full question carries 14 marks)

MODULE 1

11a) Prove that the force field $\boldsymbol{F} = e^y\boldsymbol{i} + xe^y\boldsymbol{j}$is conservative in the entire xy-plane

b**)** Use Greens theorem to find the area enclosed by the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

12 a) Find the divergence of the vector field$\boldsymbol{F} = \frac{c}{(\boldsymbol{x^2+y^2+z^2})^{3/2}}(x\boldsymbol{i} + y\boldsymbol{j} + z\boldsymbol{k})$

b) Find the work done by the force field$\boldsymbol{F}(x, y, z) = xy\boldsymbol{i} + yz\boldsymbol{j} + xz\boldsymbol{k}$along C where

C is the curve$\boldsymbol{r}(t) = \boldsymbol{t}\boldsymbol{i} + t^2\boldsymbol{j} + t^3\boldsymbol{k}$

MODULE II

13 a) Use divergence theorem to find the outward flux of the vector field

$\boldsymbol{F} = 2x\boldsymbol{i} + 3y\boldsymbol{j} + z^3\boldsymbol{k}$acrossthe unit cube bounded by or $x = 0$, $y = 0$,$z = 0$,$x = 1$,$y = 1$,$z = 1$

b) Find the circulation of $\boldsymbol{F} = (x - z)\boldsymbol{i} + (y - x)\boldsymbol{j} + (\boldsymbol{z} - \boldsymbol{xy})\boldsymbol{k}$ using Stokes theorem around the triangle with vertices $A(1,0,0)$, $B(0,2,0)$and $C(0,0,1)$

14 a**)** Use divergence theorem to find the volume of the cylindrical solid bounded by $x^2 + 4x + y^2 = 7$, $z = -1$, $z = 4$, given the vector field $\boldsymbol{F} = \boldsymbol{x}i + \boldsymbol{y}j + \boldsymbol{z}k$ across surfaceof the cylinder

b) Use Stokes theorem to evaluate$\int_C \boldsymbol{F}.\boldsymbol{dr}$where$\boldsymbol{F} = x^2\boldsymbol{i} + 3x\boldsymbol{j} - y^3\boldsymbol{k}$where Cis the circle $x^2 + y^2 = 1$ in the xy- plane with counterclockwise orientation looking down the positive z-axis

MODULE III

15 a) Solve $y'' + 4y' + 4y = x^2 + e^{-x}\cos x$

b) Solve $y''' - 3y'' + 3y' - y = e^x - x - 1$

16 a) Solve$\boldsymbol{y}''' + \mathbf{3}y'' + 3y' + y = 30e^{-x}$given$y(0) = 3, y'(0) = -3\,\mathbf{,}\quad y''(0) = -47$

b) Using method of variation of parameters, solve$y'' + y = sec\ x$

MODULE IV

17 a) Find the inverse Laplace transform of $F(s) = \frac{2(e^{-s} - e^{-3s})}{s^2 - 4}$

b) Solve the differential equation$y'' + 16y = 4\delta(t - 3\pi);\ y(0) = 2, y'(0) = 0$ using Laplace transform

18 a) Solve$y'' + 3y' + 2y = f(t)$ where $f(t) = 1$ for $0 < t < 1$ and $f(t) = 1$for $t > 1$ using Laplace transform

b) Apply convolution theorem to find the Laplace inverse transform of $\frac{1}{s^2(s^2 + \omega^2)}$

MODULE V

19 a) Find the Fourier cosine integral representation for $f(x) = e^{-kx}$for $x > 0$and $k > 0$ and hence evaluate $\int_0^\infty \frac{\cos wx}{k^2 + w^2}$the function

b) Does the Fourier sine transform $f(x) = x^{-1}\sin x$for $0 < x < \infty$ exist? Justify your answer

20 a) Find the Fourier transform of $f(x) = |x|$for $|x| < 1$ and $f(x) = 0$ otherwise

b) Find the Fourier cosine transform of $f(x) = e^{-ax}$for a> 0

Syllabus

Module 1 (Calculus of vector functions)

(Text 1: Relevant topics from sections 12.1, 12.2, 12.6, 13.6, 15.1, 15.2, 15.3)

Vector valued function of single variable, derivative of vector function and geometrical interpretation, motion along a curve-velocity, speed and acceleration. Concept of scalar and vector fields , Gradient and its properties, directional derivative , divergence and curl, Line integrals of vector fields, work as line integral, Conservative vector fields , independence of path and potential function(results without proof).

Module 2 (Vector integral theorems)

(Text 1: Relevant topics from sections 15.4, 15.5, 15.6, 15.7, 15.8)

Green's theorem (for simply connected domains, without proof) and applications to evaluating line integrals and finding areas. Surface integrals over surfaces of the form z = g(x, y), y = g(x, z) or x = g(y, z) , Flux integrals over surfaces of the form z = g(x, y), y = g(x, z) or x = g(y, z), divergence theorem (without proof) and its applications to finding flux integrals, Stokes' theorem (without proof) and its applications to finding line integrals of vector fields and work done.

Module- 3 (Ordinary differential equations)

(Text 2: Relevant topics from sections 2.1, 2.2, 2.5, 2.6, 2.7, 2.10, 3.1, 3.2, 3.3)

Homogenous linear differential equation of second order, superposition principle,general solution, homogenous linear ODEs with constant coefficients-general solution. Solution of Euler-Cauchy equations (second order only).Existence and uniqueness (without proof). Non homogenous linear ODEs-general solution, solution by the method of undetermined coefficients (for the right hand side of the form x^n,e^{kx},$sinax$,$cosax$,$e^{kx}sinaxe^{kx}cosax$and their linear combinations), methods of variation of parameters. Solution of higher order equations-homogeneous and non-homogeneous with constant coefficient using method of undetermined coefficient.

Module- 4 (Laplace transforms)

(Text 2: Relevant topics from sections 6.1,6.2,6.3,6.4,6.5)

Laplace Transform and its inverse ,Existence theorem (without proof) , linearity,Laplace transform of basic functions, first shifting theorem, Laplace transform of derivatives and integrals, solution of differential equations using Laplace transform, Unit step function, Second shifting theorems. Dirac delta function and its Laplace transform, Solution of ordinary differential equation involving unit step function and Dirac delta functions. Convolution theorem(without proof)and its application to finding inverse Laplace transform of products of functions.

Module-5 (Fourier Tranforms)

(Text 2: Relevant topics from sections 11.7,11.8, 11.9)

Fourier integral representation, Fourier sine and cosine integrals. Fourier sine and cosine transforms, inverse sine and cosine transform. Fourier transform and inverse Fourier transform, basic properties. The Fourier transform of derivatives. Convolution theorem (without proof)

Text Books

1. H. Anton, I. Biven S.Davis, "Calculus", Wiley, 10th edition, 2015.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley, 10th edition, 2015.

Reference Books

1. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9 th Edition, Pearson,Reprint, 2002.
3. Peter O Neil, Advanced Engineering Mathematics, 7th Edition, Thomson, 2007.
4. Louis C Barret, C Ray Wylie, "Advanced Engineering Mathematics", Tata McGraw Hill, 6th edition, 2003.
5. VeerarajanT."Engineering Mathematics for first year", Tata McGraw - Hill, 2008.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th edition , 2010.
7. Srimanta Pal, Subodh C. Bhunia, "Engineering Mathematics", Oxford University Press, 2015.
8. Ronald N. Bracewell, "The Fourier Transform and its Applications", McGraw – Hill International Editions, 2000.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Calculus of vector functions (9 hours)**	
1.1	Vector valued function of a scalar variable - derivative of vector valued function of scalar variable t-geometrical meaning	2
1.2	Motion along a curve-speed , velocity, acceleration	1
1.3	Gradient and its properties, directional derivative , divergent and curl	3
1.4	Line integrals with respect to arc length, line integrals of vector fields. Work done as line integral	2
1.5	Conservative vector field, independence of path, potential function	1

2	**Vector integral theorems**(**9 hours**)	
2.1	Green's theorem and it's applications	2
2.2	Surface integrals , flux integral and their evaluation	3
2.3	Divergence theorem and applications	2
2.4	Stokes theorem and applications	2
3	**Ordinary Differential Equations** (**9 hours**)	
3.1	Homogenous linear equation of second order, Superposition principle, general solution	1
3.2	Homogenous linear ODEs of second order with constant coefficients	2
3.3	Second order Euler-Cauchy equation	1
3.4	Non homogenous linear differential equations of second order with constant coefficient-solution by undetermined coefficients, variation of parameters.	3
3.5	Higher order equations with constant coefficients	2
4	**Laplace Transform** (**10 hours**)	
4.1	Laplace Transform , inverse Transform, Linearity, First shifting theorem, transform of basic functions	2
4.2	Transform of derivatives and integrals	1
4.3	Solution of Differential equations, Initial value problems by Laplace transform method.	2
4.4	Unit step function --- Second shifting theorem	2
4.5	Dirac Delta function and solution of ODE involving Dirac delta function	2
4.6	Convolution and related problems.	1
5	**Fourier Transform** (**8 hours**)	
5.1	Fourier integral representation	1
5.2	Fourier Cosine and Sine integrals and transforms	2
5.3	Complex Fourier integral representation, Fourier transform and its inverse transforms, basic properties	3
5.4	Fourier transform of derivatives, Convolution theorem	2

EST 110	ENGINEERING GRAPHICS	CATEGORY	L	T	P	CREDIT	Year of Introduction
		ESC	2	0	2	3	2019

Preamble: To enable the student to effectively perform technical communication through graphical representation as per global standards.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Draw the projection of points and lines located in different quadrants
CO 2	Prepare multiview orthographic projections of objects by visualizing them in different positions
CO 3	Draw sectional views and develop surfaces of a given object
CO 4	Prepare pictorial drawings using the principles of isometric and perspective projections to visualize objects in three dimensions.
CO 5	Convert 3D views to orthographic views
CO 6	Obtain multiview projections and solid models of objects using CAD tools

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3											
CO 2	3											
CO 3	3	1										
CO 4	3									1		
CO 5	3									2		
CO 6	3				3					3		

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination (100 Marks)**
	Test 1 (15 Marks)	**Test 2 (15 Marks)**	
Remember			
Understand	5		20
Apply	10	10	80
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE (Marks)	ESE (Marks)	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
CIA for section A carries 25 marks (15 marks for 1 test and Class work 10 marks)
CIA for section B carries 15 marks (10 marks for 1 test and Class work 5 marks)

End Semester Examination Pattern:

ESE will be of 3 hour duration on A4 size answer booklet and will be for 100 marks. The question paper shall contain two questions from each module of Section A only. Student has to answer any one question from each module. Each question carries 20 marks.

Course Level Assessment Questions

(Questions may be framed based on the outline given under each course outcome)

Course Outcome 1 (CO1):

1. Locate points in different quadrants as per given conditions.
2. Problems on lines inclined to both planes .
3. Find True length, Inclinations and Traces of lines.

Course Outcome 2 (CO2)

1. Draw orthographic views of solids and combination solids
2. Draw views of solids inclined to any one reference plane.
3. Draw views of solids inclined to both reference planes.

Course Outcome 3 (CO3):

1. Draw views of solids sectioned by a cutting plane
2. Find location and inclination of cutting plane given true shape of the section
3. Draw development of lateral surface of solids and also its sectioned views

Course Outcome 4 (CO4):

1. Draw Isometric views/projections of soilds
2. Draw Isometric views/projections of combination of soilds
3. Draw Perspective views of Soilds

Course Outcome 5 (CO5):

1. Draw Orthographic views of solids from given three dimensional view

Course Outcome 6 (CO6):

1. Draw the given figure including dimensions using 2D software
2. Create 3D model using modelling software from the given orthographic views or 3D figure or from real 3D objects

Model Question paper

QP CODE: PAGES:3

Reg No:______________

Name :______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EST 110

ENGINEERING GRAPHICS

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

Instructions: Retain necessary Construction lines
Show necessary dimensions
Answer any ONE question from each module
Each question carries 20 marks

MODULE I

1. The end point A of a line is 20mm above HP and 10mm in front of VP. The other end of the line is 50mm above HP and 15mm behind VP. The distance between the end projectors is 70mm. Draw the projections of the line. Find the true length and true inclinations of the line with the principal planes. Also locate the traces of the line.
2. One end of a line is 20mm from both the principal planes of projection. The other end of the line is 50mm above HP and 40mm in front of VP. The true length of the line is 70mm. Draw the projections of the line. Find its apparent inclinations, elevation length and plan length. Also locate its traces.

MODULE II

3. A pentagonal pyramid of base side 25mm and height 40mm, is resting on the ground on one of its triangular faces. The base edge of that face is inclined 30° to VP. Draw the projections of the solid.

4. A hexagonal prism has side 25mm and height 50mm has a corner of its base on the ground and the long edge containing that corner inclined at 30^{o} to HP and 45^{o} to VP. Draw the projections of the solid.

MODULE III

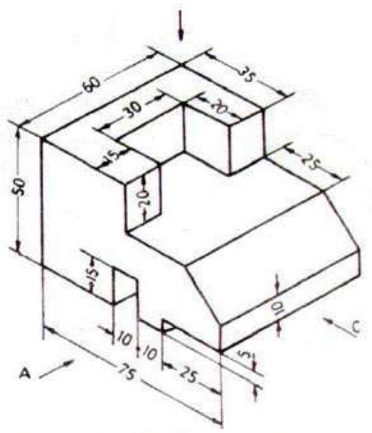
5. A triangular prism of base side 40mm and height 70mm is resting with its base on the ground and having an edge of the base perpendicular to VP. Section the solid such that the true shape of the section is a trapezium of parallel sides 30mm and 10mm. Draw the projections showing the true shape. Find the inclination of the cutting plane with the ground plane.
6. Draw the development of a pentagonal pyramid of base side 30mm and height 50mm. A string is wound from a corner of the base round the pyramid and back to the same point through the shortest distance. Show the position of the string in the elevation and plan.

MODULE IV

7. The frustum of a cone has base diameter 50mm and top diameter 40mm has a height of 60mm. It is paced centrally on top of a rectangular slab of size 80x60mm and of thickness 20mm. Draw the isometric view of the combination.
8. A hexagonal prism has base side 35mm and height 60mm. A sphere of diameter 40mm is placed centrally on top of it. Draw the isometric projection of the combination.

MODULE V

9. Draw the perspective view of a pentagonal prism, 20mm side and 45mm long lying on one of its rectangular faces on the ground and having its axis perpendicular to picture plane. One of its pentagonal faces touches the picture plane and the station point is 50mm in front of PP, 25mm above the ground plane and lies in a central plane, which is 70mm to the left of the center of the prism.
10. Draw three orthographic views with dimensions of the object shown in figure below.



(20X5=100)

Time : 3 hours **EST110 ENGINEERING GRAPHICS** **Max. Marks: 100**

SCHEME OF VALUATION

1. Locating the points and drawing the projections of the line – 4 marks
   Finding true length by any one method – 6 marks
   Finding true inclination with VP – 2 marks
   Finding true inclination with HP – 2 marks
   Locating horizontal trace – 2 marks
   Locating vertical trace – 2 marks
   Dimensioning and neatness – 2 marks
   Total = 20 marks
2. Locating the points and drawing true length of the line – 4 marks
   Finding projections by any method – 6 marks
   Finding length of elevation and plan – 2 marks
   Finding apparent inclinations – 2 marks
   Locating horizontal trace – 2 marks
   Locating vertical trace – 2 marks
   Dimensioning and neatness – 2 marks
   Total = 20 marks
3. Drawing initial position plan and elevation – 4 marks
   First inclination views – 4 marks
   Second inclination views -8 marks
   Marking invisible edges – 2 marks
   Dimensioning and neatness – 2 marks
   Total = 20 marks
   (Any one method or combination of methods for solving can be used.
   If initial position is wrong then maximum 50% marks may be allotted for the answer)
4. Drawing initial position plan and elevation – 4 marks
   First inclination views – 4 marks
   Second inclination views -8 marks
   Marking invisible edges – 2 marks
   Dimensioning and neatness – 2 marks
   Total = 20 marks
   (Any one method or combination of methods for solving can be used
   If initial position is wrong then maximum 50% marks may be allotted for the answer)
5. Drawing initial position plan and elevation – 4 marks
   Locating section plane as per given condition – 5 marks
   Drawing true shape -5 marks
   Finding inclination of cutting plane – 2 marks
   Dimensioning and neatness – 2 marks
   Total = 20 marks
6. Drawing initial position plan and elevation – 4 marks
   Development of the pyramid – 6 marks

Locating string in development -2 marks
Locating string in elevation – 3 marks
Locating string in plan – 3 marks
Dimensioning and neatness – 2 marks

Total = 20 marks

7. Drawing initial positions – 4 marks
   Isometric View of Slab -6 marks
   Isometric View of Frustum – 10 marks
   Dimensioning and neatness – 2 marks

   Total = 20 marks

   (Initial position is optional, hence redistribute if needed.
   Reduce 4 marks if Isometric scale is taken)

8. Drawing initial positions – 4 marks
   Isometric scale – 4 marks
   Isometric projection of prism -5 marks
   Isometric projection of sphere – 5 marks
   Dimensioning and neatness – 2 marks

   Total = 20 marks

   (Initial position is optional, hence redistribute if needed.

9. Drawing the planes and locating the station point – 4 marks
   Locating elevation points – 2 marks
   Locating plan points – 2 marks
   Drawing the perspective view – 10 marks
   Dimensioning and neatness – 2 marks

   Total = 20 marks

10. Drawing the elevation – 8marks
    Drawing the plan – 4 marks
    Drawing the side view – 4 marks
    Marking invisible edges – 2 marks
    Dimensioning and neatness – 2 marks

    Total = 20 marks

SYLLABUS

General Instructions:

- First angle projection to be followed
- Section A practice problems to be performed on A4 size sheets
- Section B classes to be conducted on CAD lab

SECTION A

Module 1

Introduction : Relevance of technical drawing in engineering field. Types of lines, Dimensioning, BIS code of practice for technical drawing.

Orthographic projection of Points and Lines: Projection of points in different quadrants, Projection of straight lines inclined to one plane and inclined to both planes. Trace of line. Inclination of lines with reference planes True length of line inclined to both the reference planes.

Module 2

Orthographic projection of Solids: Projection of Simple solids such as Triangular, Rectangle, Square, Pentagonal and Hexagonal Prisms, Pyramids, Cone and Cylinder. Projection of solids in simple position including profile view. Projection of solids with axis inclined to one of the reference planes and with axis inclined to both reference planes.

Module 3

Sections of Solids: Sections of Prisms, Pyramids, Cone, Cylinder with axis in vertical position and cut by different section planes. True shape of the sections. Also locating the section plane when the true shape of the section is given.

Development of Surfaces: Development of surfaces of the above solids and solids cut by different section planes. Also finding the shortest distance between two points on the surface.

Module 4

Isometric Projection: Isometric View and Projections of Prisms, Pyramids, Cone , Cylinder, Frustum of Pyramid, Frustum of Cone, Sphere, Hemisphere and their combinations.

Module 5

Perspective Projection: Perspective projection of Prisms and Pyramids with axis perpendicular to the ground plane, axis perpendicular to picture plane.

Conversion of Pictorial Views: Conversion of pictorial views into orthographic views.

SECTION B

(To be conducted in CAD Lab)

Introduction to Computer Aided Drawing: Role of CAD in design and development of new products, Advantages of CAD. Creating two dimensional drawing with dimensions using suitable software. (Minimum 2 exercises mandatory)

Introduction to Solid Modelling: Creating 3D models of various components using suitable modelling software. (Minimum 2 exercises mandatory)

Text Books

1. Bhatt, N.D., Engineering Drawing, Charotar Publishing House Pvt. Ltd.
2. John, K.C. Engineering Graphics, Prentice Hall India Publishers.

Reference Books

1. Anilkumar, K.N., Engineering Graphics, Adhyuth narayan Publishers
2. Agrawal, B. And Agrawal, C.M., Engineering Darwing, Tata McGraw Hill Publishers.
3. Benjamin, J., Engineering Graphics, Pentex Publishers- 3rd Edition, 2017
4. Duff, J.M. and Ross, W.A., Engineering Design and Visualisation, Cengage Learning.
5. Kulkarni, D.M., Rastogi, A.P. and Sarkar, A.K., Engineering Graphics with AutoCAD, PHI.
6. Luzaddff, W.J. and Duff, J.M., Fundamentals of Engineering Drawing, PHI.
7. Varghese, P.I., Engineering Graphics, V I P Publishers
8. Venugopal, K., Engineering Drawing and Graphics, New Age International Publishers.

Course Contents and Lecture Schedule

No	**SECTION A**	No. of Hours
1	**MODULE I**	
1.1	Introduction to graphics, types of lines, Dimensioning	1
1.2	Concept of principle planes of projection, different quadrants, locating points on different quadrants	2
1.3	Projection of lines, inclined to one plane. Lines inclined to both planes, trapezoid method of solving problems on lines.	2
1.4	Problems on lines using trapezoid method	2
1.5	Line rotation method of solving, problems on line rotation method	2
2	**MODULE II**	
2.1	Introduction of different solids, Simple position plan and elevation of solids	2
2.2	Problems on views of solids inclined to one plane	2
2.3	Problems on views of solids inclined to both planes	2
2.4	Practice problems on solids inclined to both planes	2

3	**MODULE III**	
3.1	Introduction to section planes. AIP and AVP. Principle of locating cutting points and finding true shape	2
3.2	Problems on sections of different solids	2
3.3	Problems when the true shape is given	2
3.4	Principle of development of solids, sectioned solids	2
4	**MODULE IV**	
4.1	Principle of Isometric View and Projection, Isometric Scale. Problems on simple solids	2
4.2	Isometric problems on Frustum of solids, Sphere and Hemisphere	2
4.3	Problems on combination of different solids	2
5	**MODULE V**	
5.1	Introduction to perspective projection, different planes, station point etc. Perspective problems on pyramids	2
5.2	Perspective problems on prisms	2
5.3	Practice on conversion of pictorial views into orthographic views	2
	SECTION B *(To be conducted in CAD lab)*	
1	Introduction to CAD and software. Familiarising features of 2D software. Practice on making 2D drawings	2
2	Practice session on 2D drafting	2
3	Introduction to solid modelling and software	2
4	Practice session on 3D modelling	2

EST 100	ENGINEERING MECHANICS	CATEGORY	L	T	P	CREDIT	Year of Introduction
		ESC	2	1	0	3	2019

Preamble: Goal of this course is to expose the students to the fundamental concepts of mechanics and enhance their problem-solving skills. It introduces students to the influence of applied force system and the geometrical properties of the rigid bodies while stationary or in motion. After this course students will be able to recognize similar problems in real-world situations and respond accordingly.

Prerequisite: Nil

Course Outcomes: After completion of the course the student will be able to:

CO 1	Recall principles and theorems related to rigid body mechanics
CO 2	Identify and describe the components of system of forces acting on the rigid body
CO 3	Apply the conditions of equilibrium to various practical problems involving different force system.
CO 4	Choose appropriate theorems, principles or formulae to solve problems of mechanics.
CO 5	Solve problems involving rigid bodies, applying the properties of distributed areas and masses

Mapping of course outcomes with program outcomes (Minimum requirement)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	-	-	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	-	-	-	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	10	10	15
Understand	10	10	15
Apply	30	30	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions:

Part A

Course Outcome 1 (CO1): (One question from each module to meet the course objective 1: *To recall principles and theorems related to rigid body mechanics***)**

1. Explain D'Alembert's principle

2. Distinguish static and dynamic friction

3. State and explain perpendicular axis theorem

Course Outcome 2 (CO2) (One question from each module to meet the course objective 2: *To identify and describe the components of system of forces acting on the rigid body***)**

1. A simply supported beam AB of span 5 m is carrying point loads 5 kN, 3 kN and 2 kN at 1m, 3m and 4m respectively from support A. Calculate the support reaction at B.

2. A gymnast holding onto a bar, is suspended motionless in mid-air. The bar is supported by two ropes that attach to the ceiling. Diagram the forces acting on the combination of gymnast and bar

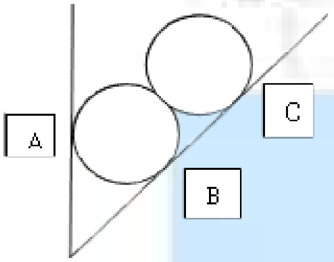
3. While you are riding your bike, you turn a corner following a circular arc. Illustrate the forces that act on your bike to keep you along the circular path ?

Part B

All the questions under this section shall assess the learning levels corresponding to the course outcomes listed below.

CO 3	To apply the conditions of equilibrium to various practical problems involving different force system.
CO 4	To choose appropriate theorems, principles or formulae to solve problems of mechanics.
CO 5	To solve problems involving rigid bodies, applying the properties of distributed areas and masses

1. Two rollers each of weight 100 N are supported by an inclined plane and a vertical wall. Find the reaction at the points of contact A, B, C. Assume all the surfaces to be smooth.

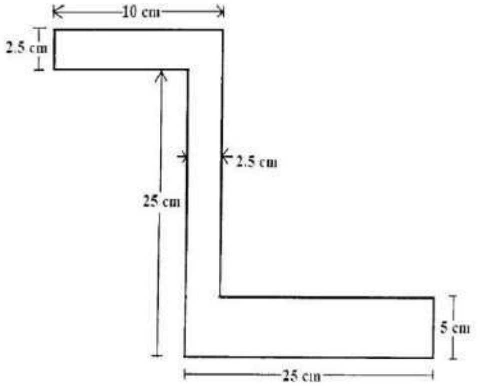


Course outcome identifier	**Description of course outcome**	**Learning level assessed**	**Marks allocated**
CO 3	To apply the conditions of equilibrium to various practical problems involving different force system.	Applying – (Sketch the free body diagram that represent equilibrium state of the body)	4
CO 4	To choose appropriate theorems, principles or formulae to solve problems of mechanics.	Applying (Choose the equations and formulae required for calculation)	4
CO 5	To solve problems involving rigid bodies, applying the properties of distributed areas and masses	Applying (Solve the problem based on the descriptions given in CO3 and CO4)	6
Total			14

2. A cylindrical disc, 50 cm diameter and cm thickness, is in contact with a horizontal conveyor belts running at uniform speeds of 5 m/s. Assuming there is no slip at points of contact determine (i) angular velocity of disc (ii) Angular acceleration of disc if velocity of conveyor changes to 8 m/s. Also compute the moment acting about the axis of the disc in both cases.

Course outcome identifier	Description of course outcome	Learning level assessed	Marks allocated
CO 3	To apply the conditions of equilibrium to various practical problems involving different force system.	Applying – (Sketch the free body diagram that represent state of the body)	4
CO 4	To choose appropriate theorems, principles or formulae to solve problems of mechanics.	Applying (Choose the equations and formulae required for calculation)	4
CO 5	To solve problems involving rigid bodies, applying the properties of distributed areas and masses	Applying (Solve the problem based on the descriptions given in CO3 and CO4)	6
Total			14

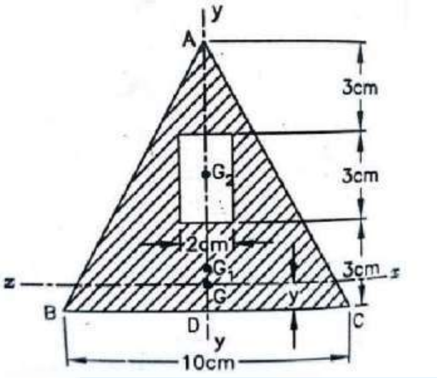
3. Determine the centroid of the given section



Course outcome identifier	Description of course outcome	Learning level assessed	Marks allocated
CO 3	To apply the conditions of equilibrium to various practical problems involving different force system.	Applying – (Illustrate the computation of centroid for the given geometrical shape)	4
CO 4	To choose appropriate theorems, principles or formulae to solve problems of mechanics.	Applying (Choose the equations and formulae required for calculation)	4
CO 5	To solve problems involving rigid bodies, applying the properties of distributed	Applying (Solve the problem based on the descriptions	6

	areas and masses	given in CO3 and CO4)	
Total			14

4. A rectangular hole is made in a triangular section as shown. Find moment of inertia about the section x-x passing through the CG of the section and parallel to BC.



Course outcome identifier	Description of course outcome	Learning level assessed	Marks allocated
CO 3	To apply the conditions of equilibrium to various practical problems involving different force system.	Applying – (Illustrate the computation of moment of inertia for the given geometrical shape)	4
CO 4	To choose appropriate theorems, principles or formulae to solve problems of mechanics.	Applying (Choose the equations and formulae required for calculation)	4
CO 5	To solve problems involving rigid bodies, applying the properties of distributed areas and masses	Applying (Solve the problem based on the descriptions given in CO3 and CO4)	6
Total			14

Model Question Paper

QP CODE:

Reg No.:_______________

Name:___________________________ ___

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EST 100

ENGINEERING MECHANICS

Max. Marks: 100 Duration: 3 hours

Part A

(Answer all questions; each question carries 3 marks)

1. Explain D'Alembert's principle

2. Distinguish static and dynamic frictioni.

3. State and explain perpendicular axis theorem.

4. A simply supported beam AB of span 5 m is carrying point loads 5 kN, 3 kN and 2 kN at 1m, 3m and 4m respectively from support A. Calculate the support reaction at B.

5. A gymnast holding onto a bar, is suspended motionless in mid-air. The bar is supported by two ropes that attach to the ceiling. Diagram the forces acting on the combination of gymnast and bar

6. While you are riding your bike, you turn a corner following a circular arc. Illustrate the forces that act on your bike to keep you along the circular path ?

7. Compare damped and undamped free vibrations.

8. State the equation of motion of a rotating rigid body, rotating about its fixed axis.

9. Illustrate the significance of instantaneous centre in the analysis of rigid body undergoing rotational motion.

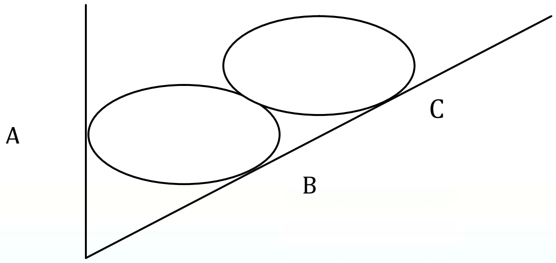
10. Highlight the principles of mechanics applied in the evaluation of elastic collusion of rigid bodies.

PART B

(Answer **one full** question from each module, each question carries **14** marks)

Module -I

11. Two identical rollers each of weight 100 N are supported by an inclined plane, making an angle of 30^o with the vertical, and a vertical wall. Find the reaction at the points of contact A, B, C. Assume all the surfaces to be smooth. (14 marks)

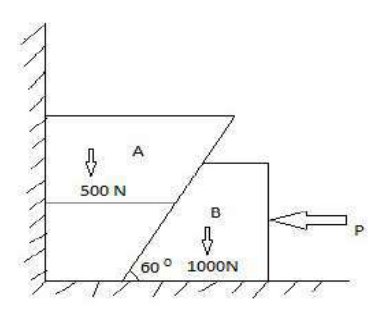


12. A string tied to a wall is made to pass over a pulley placed 2m away from it. A weight P is attached to the string such that the string stretches by 2m from the support on the wall to the location of attachment of weight. Determine the force P required to maintain 200 kg body in position for $\theta = 30^o$, The diameter of pulley B is negligible. (14 marks)

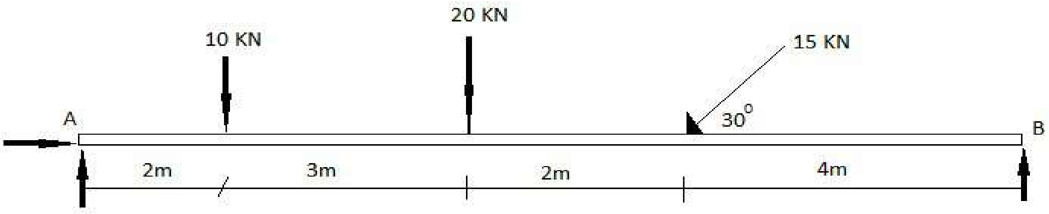
Module – 2

13. Two blocks A & B are resting against a wall and the floor as shown in figure below. Find the value of horizontal force P applied to the lower block that will hold the system in equilibrium. Coefficient of friction are : 0.25 at the floor, 0.3 at the wall and 0.2 between the blocks.

(14 marks)

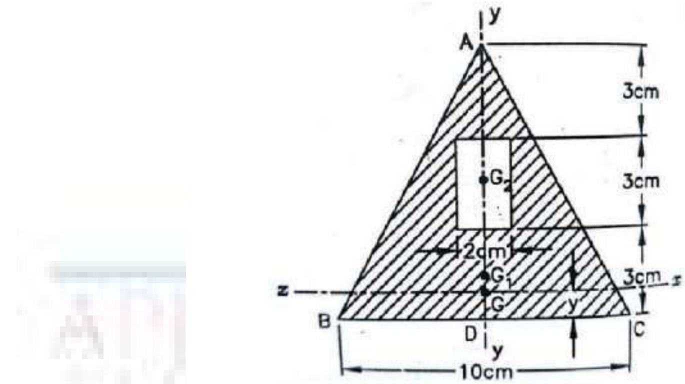


14. A beam is hinged at A and roller supported at B. It is acted upon by loads as shown below. Find the reactions at A & B. (14 marks)

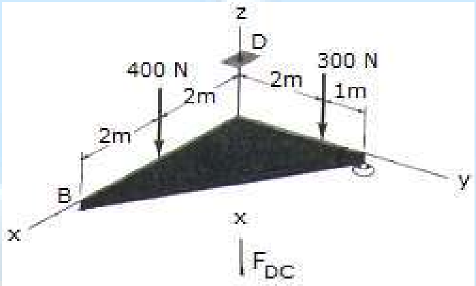


Module – 3

15. A rectangular hole is made in a triangular section as shown. Find moment of inertia about the section x-x passing through the CG of the section and parallel to BC. (14 marks)



16. Support A has ball and socket connection. Roller support at B prevents motion in the —z direction. Corner *C* is tied to *D* by a rope. The triangle is weightless. Determine the unknown force components acting at *A*, *B*, and *C*. (14 marks)



Module - 4

17. A cricket ball is thrown by a fielder from a height of 2m at an angle of 30^0 to the horizontal with an initial velocity of 20 m/s , hits the wickets at a height of 0.5 m from the ground. How far was the fielder from the wicket? (14 marks)

18. An engine of weight 500 kN pull a train weighing 1500 kN up an incline of 1 in 100. The train starts from rest and moves with constant acceleration against a resistance of 5 N/kN. It attains a maximum speed of 36 kmph in 1 km distance. Determine the tension in the coupling between train and engine and the traction force developed by the engine. (14marks)

Module – 5

19. A cylindrical disc, 50 cm diameter and 10 cm thickness having mass of 10 kg, is in contact with a horizontal conveyor belt running at uniform speeds of 5 m/s. Assuming there is no slip at points of contact determine (i) angular velocity of disc (ii) Angular acceleration of disc if velocity of conveyor changes to 8 m/s in 10 seconds. Also compute the moment acting about the axis of the disc in both cases. (14 marks)

20. A wheel rotating about fixed axis at 20 rpm is uniformly accelerated for 70 seconds during which time it makes 50 revolutions. Find the (i) angular velocity at the end of this interval and (ii) time required for the velocity to reach 100 revolutions per minute. (14 marks)

SYLLABUS

Module 1

Introduction to Engineering Mechanics-statics-basic principles of statics-Parallelogram law, equilibrium law, principles of superposition and transmissibility, law of action and reaction(review) free body diagrams.

Concurrent coplanar forces-composition and resolution of forces-resultant and equilibrium equations – methods of projections – methods of moments – Varignon's Theorem of moments.

Module 2

Friction – sliding friction - Coulomb's laws of friction – analysis of single bodies –wedges, ladder-analysis of connected bodies .

Parallel coplanar forces – couple - resultant of parallel forces – centre of parallel forces – equilibrium of parallel forces – Simple beam subject to concentrated vertical loads. General coplanar force system - resultant and equilibrium equations.

Module 3

Centroid of composite areas- – moment of inertia-parallel axis and perpendicular axis theorems. Polar moment of inertia,radius of gyration,mass moment of inertia-ring,cylinder and disc.

Theorem of Pappus Guldinus(demonstration only)

Forces in space - vectorial representation of forces, moments and couples –resultant and equilibrium equations – concurrent forces in space (simple problems only)

Module 4

Dynamics – rectilinear translation - equations of kinematics(review)

kinetics – equation of motion – D'Alembert's principle. – motion on horizontal and inclined surfaces, motion of connected bodies. Impulse momentum equation and work energy equation (concepts only).

Curvilinear translation - equations of kinematics –projectile motion(review), kinetics – equation of motion. Moment of momentum and work energy equation (concepts only).

Module 5

Rotation – kinematics of rotation- equation of motion for a rigid body rotating about a fixed axis – rotation under a constant moment.

Plane motion of rigid body – instantaneous centre of rotation (concept only).

Simple harmonic motion – free vibration –degree of freedom- undamped free vibration of spring mass system-effect of damping(concept only)

Text Books

1. Timoshenko and Young, Engineering Mechanics, McGraw Hill Publishers
2. Shames, I. H., Engineering Mechanics - Statics and Dynamics, Prentice Hall of India.
3. R. C. Hibbeler and Ashok Gupta, Engineering Mechanics, Vol. I statics, Vol II Dynamics, Pearson Education.

References

1. Merriam J. L and Kraige L. G., Engineering Mechanics - Vols. 1 and 2, John Wiley.

2. Tayal A K, Engineering Mechanics – Statics and Dynamics, Umesh Publications

3. Bhavikkatti, S.S., Engineering Mechanics, New Age International Publishers

4. F.P.Beer abd E.R.Johnston (2011), Vector Mechanics for Engineers, Vol.I-Statics, Vol.II-Dynamics, 9th Ed, Tata McGraw Hill

5. Rajasekaran S and Sankarasubramanian G, Engineering Mechanics - Statics and Dynamics, Vikas Publishing House Pvt Ltd.

Course Contents and Lecture Schedule:

Module	Topic	Course outcomes addressed	No. of Hours
1	**Module 1**		**Total: 7**
1.1	Introduction to engineering mechanics – introduction on statics and dynamics - Basic principles of statics – Parellogram law, equilibrium law – Superposition and transmissibility, law of action and reaction (review the topics)	CO1 and CO2	1
1.2	Free body diagrams. Degree of freedom-types of supports and nature of reactions - exercises for free body diagram preparation – composition and resolution of forces, resultant and equilibrium equations (review the topics) - numerical exercises for illustration.	CO1 and CO2	1
1.3	Concurrent coplanar forces - analysis of concurrent forces -methods of projections – illustrative numerical exercise – teacher assisted problem solving.	CO1 and CO2	1
1.4	Analysis of concurrent forces -methods of moment-Varignon's Theorem of Moments - illustrative numerical exercise– teacher assisted problem solving.	CO1 and CO2	1
1.5	Analysis of concurrent force systems – extended problem solving - Session I.	CO3,CO4 and CO5	1
1.6	Analysis of concurrent force systems – extended problem solving - Session II – learning review quiz.	CO3,CO4 and CO5	1
1.7	Analysis of concurrent force systems – extended problem solving - Session III.	CO3,CO4 and CO5	1
2	**Module 2**		**Total: 7**
2.1	Friction – sliding friction - Coulomb's laws of friction – analysis of single bodies –illustrative examples on wedges and ladder-teacher	CO1 and CO2	1

	assisted problem solving tutorials using problems from wedges and ladder.		
2.2	Problems on friction - analysis of connected bodies. illustrative numerical exercise– teacher assisted problem solving.	CO3, CO4 and CO5	1
2.3	Problems on friction-extended problem solving	CO3,C04 and CO5	1
2.4	Parallel coplanar forces – couple - resultant of parallel forces – centre of parallel forces – equilibrium of parallel forces – Simple beam subject to concentrated vertical loads.	CO1 and CO2	1
2.5	General coplanar force system - resultant and equilibrium equations - illustrative examples- teacher assisted problem solving.	CO1 and CO2	1
2.6	General coplanar force system-resultant and equilibrium equations - illustrative examples	CO3, CO4 and CO5	1
2.7	General coplanar force system - Extended problem solving - Quiz to evaluate learning level.	CO3, CO4 and CO5	1
3	**Module 3**		**Total: 7**
3.1	Centroid of simple and regular geometrical shapes – centroid of figures in combination - composite areas- examples for illustration – problems for practice to be done by self.	CO1 and CO2	1
3.2	Moment of inertia- parallel axis theorem –examples for illustration - problems for practice to be done by self.	CO1 and CO2	1
3.3	Moment of inertia - perpendicular axis theorem - example for illustration to be given as hand out and discussion on the solved example.	CO1 and CO2	1
3.4	Solutions to practice problems – problems related to centroid and moment of inertia - problems for practice to be done by self.	CO3, CO4 and CO5	1
3.5	Polar moment of inertia, Radius of gyration. Mass moment of inertia of ring, cylinder and uniform disc. Theorem of Pappus Guldinus - Demonstration	CO1 and CO2	1
3.6	Introduction to forces in space – vectorial representation of forces, moments and couples – simple problems to illustrate vector representations of forces, moments and couples to be done in class.	CO1,and CO2	1
3.7	Solution to practice problems - resultant and equilibrium equations for concurrent forces in space – concurrent forces in space - 2 simple problems to illustrate the application of resultant and equilibrium equations for concurrent forces in space.	CO3,CO4 and CO5	1
4	**Module 4**		**Total: 7**

4.1	Introduction to dynamics – review of rectilinear translation - equations of kinematics – problems to review the concepts – additional problems involving extended application as exercises .	CO1 and CO2	1
4.2	Solutions to exercises with necessary explanation given as hand out – introduction to kinetics – equation of motion – D’Alembert’s principle – illustration of the concepts using one numerical exercise from motion on horizontal and inclined surfaces.	CO1 and CO2	1
4.3	Motion of connected bodies - example for illustration to be given as hand out and discussion on the solved example – problems for practice to be done by self.	CO3, CO4 and CO5	1
4.4	Motion of connected bodies-extended problem solving.	CO3, CO4 & CO5	1
4.5	Curvilinear translation - Review of kinematics –projectile motion – simple problems to review the concepts – introduction to kinetics – equation of motion – illustration of the concepts using numerical exercises.	CO3, CO4 & CO5	1
4.6	Extended problem solving – rectilinear and curvilinear translation.	CO3, CO4 & CO5	1
4.7	Concepts on Impulse momentum equation and work energy equation (rectilinear translation – discussions to bring out difference between elastic and inelastic collusions). Concepts on Moment of momentum and work energy equation (curvilinear translation).	CO1 and CO2	1
5	**Module 5**		**Total: 7**
5.1	Rotation – kinematics of rotation- equation of motion for a rigid body rotating about a fixed axis – simple problems for illustration.	CO1 and CO2	1
5.2	Rotation under a constant moment – teacher assisted problem solving.	CO3,CO4 and CO5	1
5.3	Rotation under a constant moment - extended problem solving.	CO3, CO4 and CO5	1
5.4	Plane motion of rigid body- instantaneous centre of rotation (concept only).	CO1 and CO2	1
5.5	Introduction to harmonic oscillation –free vibrations - simple harmonic motion – differential equation and solution. Degree of freedom – examples of single degree of freedom (SDOF) systems – Idealisation of mechanical systems as spring-mass systems (concept only).	CO1 and CO2	1

5.6	SDOF spring mass system –equation of motion – undamped free vibration response - concept of natural frequency. Free vibration response due to initial conditions. Simple problems on determination of natural frequency and free vibration response to test the understanding level.	CO1 and CO2	1
5.7	Free vibration analysis of SDOF spring-mass systems – Problem solving Effect of damping on free vibration response (concept only).	CO1and CO2	1

CYT 100	ENGINEERING CHEMISTRY	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		BSC	3	1	0	4	2019

Preamble: To enable the students to acquire knowledge in the concepts of chemistry for engineering applications and to familiarize the students with different application oriented topics like spectroscopy, electrochemistry, instrumental methods etc. Also familiarize the students with topics like mechanism of corrosion, corrosion prevention methods, SEM, stereochemistry, polymers, desalination etc., which enable them to develop abilities and skills that are relevant to the study and practice of chemistry.

Prerequisite: Concepts of chemistry introduced at the plus two levels in schools

Course outcomes: After the completion of the course the students will be able to

CO 1	Apply the basic concepts of electrochemistry and corrosion to explore its possible applications in various engineering fields.
CO 2	Understand various spectroscopic techniques like UV-Visible, IR, NMR and its applications.
CO 3	Apply the knowledge of analytical method for characterizing a chemical mixture or a compound. Understand the basic concept of SEM for surface characterisation of nanomaterials.
CO 4	Learn about the basics of stereochemistry and its application. Apply the knowledge of conducting polymers and advanced polymers in engineering.
CO 5	Study various types of water treatment methods to develop skills for treating wastewater.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	1	2	1									
CO 2	1	1		1	2							
CO 3	1	1		1	2							
CO 4	2	1										
CO 5	1			1			3					

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	15	15	30
Understand	25	25	50
Apply	10	10	20
Analyse			
Evaluate			
Create			

End Semester Examination Pattern: There will be two parts- **Part A** and **Part B. Part A** contains **10** questions (**2** questions from each module), having **3** marks for each question. Students should answer **all** questions. **Part B** contains **2** questions from each module, of which student should answer any one. Each question can have maximum **2** subdivisions and carries **14** marks.

Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. What is calomel electrode? Give the reduction reaction (3 Marks)

2. List three important advantages of potentiometric titration (3 Marks)

3. (a) Explain how electroless plating copper and nickel are carried out (10 Marks)

(b) Calculate the emf of the following cell at 30°C, Z n / Zn^{2+} (0.1M) // Ag^+ (0.01M) // Ag.

Given E^0 Zn^{2+}/Zn = -0.76 V, E^0 Ag^+/Ag = 0.8 V. (4 Marks)

Course Outcome 2 (CO 2)

1. State Beer Lambert's law (3 Marks)

2. List the important applications of IR spectroscopy (3 Marks)

3. (a) What is Chemical shift? What are factors affecting Chemical shift? How ^1H NMR spectrum of CH_3COCH_2Cl interpreted using the concept of chemical shift. (10 Marks)

(b) Calculate the force constant of HF molecule, if it shows IR absorption at 4138 cm^{-1}. Given that atomic masses of hydrogen and fluorine are 1u and 19u respectively. (4 Marks)

Course Outcome 3 (CO 3):

1. Distinguish between TGA and DTA (3 Marks)

2. Give two differences between GSC and GLC (3 Marks)

3. (a) Explain the principle, instrumentation and procedure of HPLC (10 Marks)

(b) Interpret TGA of $CaC_2O_4 . H_2O$ (4 Marks)

Course Outcome 4 (CO 4):

1. Explain the geometrical isomerism in double bonds (3 Marks)

2. What are the rules of assigning R-S notation? (3 Marks)

3. (a) What are conducting polymers? How it is classified? Give the preparation of polyaniline (10 Marks)

(b) Draw the stereoisomers possible for $CH_3\text{-}(CHOH)_2\text{-}COOH$ (4 Marks)

Course Outcome 5 (CO 5):

1. What is degree of hardness? (3 Marks)

2. Define BOD and COD (3 Marks)

3. (a) Explain the EDTA estimation of hardness (10 Marks)

(b) Standard hard water contains 20 g of CaCO3 per liter,50 mL of this required 30mL of EDTA solution, 50mL of sample water required 20mL of EDTA solution. 50mL sample water after boiling required 14 mL EDTA solution. Calculate the temporary hardness of the given sample of water, in terms of ppm. (4 Marks)

MODEL QUESTION PAPER

Total Pages:

Reg No.:________________ Name:____________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIRST SEMESTER B.TECH DEGREE EXAMINATION

Course Code: CYT100,

Course Name: ENGINEERING CHEMISTRY

Max. Marks: 100 Duration: 3 Hours

PART A

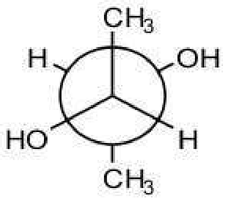
Answer all questions, each carries 3 marks

		Marks
1	What is potentiometric titration? How the end point is determined graphically?	(3)
2	What is Galvanic series? How is it different from electrochemical series?	(3)
3	Which of the following molecules can give IR absorption? Give reason?	(3)
	(a) O_2 (b) H_2O (c) N_2 (d) HCl	
4	Which of the following molecules show UV-Visible absorption? Give reason.	(3)
	(a) Ethane (b) Butadiene (c) Benzene	

5 What are the visualization techniques used in TLC? (3)

6 Write the three important applications of nanomaterials. (3)

7 Draw the Fischer projection formula and find R-S notation of (3)



8 Write the structure of a) Polypyrroleb) Kevlar. (3

9 What is break point chlorination? (3)

10 What is reverse osmosis? (3)

PART B

Answer any one full question from each module, each question carries 14 marks

Module 1

11 a) Give the construction of Li-ion cell. Give the reactions that take place at the electrodes during charging and discharging. What happens to anodic material when the cell is 100% charged. (10)

b) Calculate the standard electrode potential of Cu, if its electrode potential at 25 °C is 0.296 V and the concentration of Cu^{2+} is 0.015 M. (4)

OR

12 a) Explain the mechanism of electrochemical corrosion of iron in oxygen rich and oxygen deficient acidic and basic environments. (10)

b) Given below are reduction potentials of some species (4)

$MnO_4^- + 8H^+ + 5e \rightarrow Mn^{2+} + 4H_2O; E^0 = +1.51$ V

$Cl_2 + 2e \rightarrow 2Cl^-$; $E^0 = +1.36$ V

$S_2O_8^{2-} + 2e \rightarrow 2SO_4^{2-}$; $E^0 = +1.98$ V

Use the above data to examine whether the acids, dil. HCl and dil. H_2SO_4 , can be used to provide acid medium in redox titrations involving $KMnO_4$.

Module 2

13 a) What is spin-spin splitting? Draw the NMR spectrum of (i) CH_3 CH_2CH_2 Br (ii) $CH_3CH(Br)CH_3$ Explain how NMR spectrum can be used to identify the two isomers. (10)

b) A dye solution of concentration 0.08M shows absorbance of 0.012 at 600 nm; while a test solution of same dye shows absorbance of 0.084 under same conditions. Find the concentration of the test solution. (4)

OR

14 a) Explain the basic principle of UV-Visible spectroscopy. What are the possible electronic transitions? Explain with examples. (10)

b) Sketch the vibrational modes of CO_2 and H_2O. Which of them are IR active? (4)

Module 3

15 a) Explain the principle, instrumentation and procedure involved in gas chromatography. (10)

b) Explain the DTA of $CaC_2O_4.H_2O$ with a neat sketch. (4)

OR

16 a) Explain the various chemical methods used for the synthesis of nanomaterial (10)

b) How TGA is used to analyse the thermal stability of polymers? (4)

Module 4

17 a) What are conformers? Draw the*cis* and *trans*isomers of 1, 3-dimethylcylohexane. Which conformer (chair form) is more stable in each case? (10)

b) What is ABS? Give properties and applications. (4)

OR

18 a) Explain the various structural isomers with suitable example. (10)

b) What is OLED? Draw a labelled diagram. (4)

Module 5

19 a) What are ion exchange resins? Explain ion exchange process for removal of hardness of water? How exhausted resins are regenerated? (10)

b) 50 mL sewage water is diluted to 2000 mL with dilution water; the initial dissolved oxygen was 7.7 ppm. The dissolved oxygen level after 5 days of incubation was 2.4 ppm. Find the BOD of the sewage. (4)

OR

20 a) What are the different steps in sewage treatment? Give the flow diagram. Explain the working of trickling filter. (10)

b) Calculate the temporary and permanent hardness of a water sample which contains $[Ca^{2+}]$ = 160 mg/L, $[Mg^{2+}]$ = 192 mg/L and $[HCO_3^-]$ = 122 mg/L. (4)

Syllabus

Module 1

Electrochemistry and Corrosion

Introduction - Differences between electrolytic and electrochemical cells - Daniel cell - redox reactions - cell representation. Different types of electrodes (brief) - Reference electrodes - SHE - Calomel electrode - Glass Electrode - Construction and Working. Single electrode potential - definition - Helmholtz electrical double layer -Determination of E^0 using calomel electrode.Determination of pH using glass electrode.Electrochemical series and its applications. Free energy and EMF - Nernst Equation - Derivation - single electrode and cell (Numericals) -Application - Variation of emf with temperature. Potentiometric titration - Introduction -Redox titration only.Lithiumion cell - construction and working.Conductivity- Measurement of conductivity of a solution (Numericals).

Corrosion-Electrochemicalcorrosion – mechanism. Galvanic series- cathodic protection - electroless plating –Copper and Nickel plating.

Module 2

Spectroscopic Techniques and Applications

Introduction- Types of spectrum - electromagnetic spectrum - molecular energy levels - Beer Lambert’s law (Numericals). UV-Visible Spectroscopy – Principle - Types of electronic transitions - Energy level diagram of ethane, butadiene, benzene and hexatriene. Instrumentation of UV-Visible spectrometer and applications.IR-Spectroscopy – Principle - Number of vibrational modes - Vibrational energy states of a diatomic molecule and -Determination of force constant of diatomic molecule (Numericals) –Applications. ^{1}H NMR spectroscopy – Principle - Relation between field strength and frequency - chemical shift - spin-spin splitting (spectral problems) - coupling constant (definition) - applications of NMR- including MRI (brief).

Module 3

Instrumental Methods and Nanomaterials

Thermal analysis –TGA- Principle, instrumentation (block diagram) and applications – TGA of $CaC_2O_4.H_2O$ and polymers. DTA-Principle, instrumentation (block diagram) and applications - DTA of $CaC_2O_4.H_2O$. Chromatographic methods - Basic principles and applications of column and TLC-Retention factor. GC and HPLC-Principle, instrumentation (block diagram) - retention time and applications.

Nanomaterials - Definition - Classification - Chemical methods of preparation - Hydrolysis and Reduction - Applications of nanomaterials - Surface characterisation -SEM – Principle and instrumentation (block diagram).

Module 4

Stereochemistry and Polymer Chemistry

Isomerism-Structural, chain, position, functional, tautomerism and matamerism - Definition with examples - Representation of 3D structures-Newman, Sawhorse, Wedge and Fischer projection of substituted methane and ethane. Stereoisomerism - Geometrical isomerism in double bonds and cycloalkanes (cis-trans and E-Z notations). R-S Notation – Rules and examples - Optical isomerism, Chirality, Enantiomers and Diastereoisomers-Definition with examples.Conformational analysis of ethane, butane, cyclohexane, mono and di methyl substituted cyclohexane.

Copolymers - Definition - Types - Random, Alternating, Block and Graft copolymers - ABS - preparation, properties and applications.Kevlar-preparation, properties and applications.Conducting polymers - Doping -Polyaniline and Polypyrrole - preparation properties and applications. OLED - Principle, construction and advantages.

Module 5

Water Chemistry and Sewage Water Treatment

Water characteristics - Hardness - Types of hardness- Temporary and Permanent - Disadvantages of hard water -Units of hardness- ppm and mg/L -Degree of hardness (Numericals) - Estimation of hardness-EDTA method (Numericals). Water softening methods-Ion exchange process-Principle, procedure and advantages. Reverse osmosis – principle, process and advantages. Municipal water treatment (brief) - Disinfection methods - chlorination, ozone andUV irradiation.

Dissolved oxygen (DO) -Estimation (only brief procedure-Winkler's method), BOD and COD-definition, estimation (only brief procedure) and significance (Numericals). Sewage water treatment - Primary, Secondary and Tertiary - Flow diagram -Trickling filter and UASB process.

Text Books

1. B. L. Tembe, Kamaluddin, M. S. Krishnan, "Engineering Chemistry (NPTEL Web-book)", 2018.

2. P. W. Atkins, "Physical Chemistry", Oxford University Press, 10th edn., 2014.

Reference Books

1. C. N. Banwell, "Fundamentals of Molecular Spectroscopy", McGraw-Hill, 4thedn., 1995.
2. Donald L. Pavia, "Introduction to Spectroscopy", Cengage Learning India Pvt. Ltd., 2015.
3. B. R. Puri, L. R. Sharma, M. S. Pathania, "Principles of Physical Chemistry", Vishal Publishing Co., 47th Edition, 2017.
4. H. H. Willard, L. L. Merritt, "Instrumental Methods of Analysis", CBS Publishers, 7th Edition, 2005.
5. Ernest L. Eliel, Samuel H. Wilen, "Stereo-chemistry of Organic Compounds", WILEY, 2008.
6. Raymond B. Seymour, Charles E. Carraher, "Polymer Chemistry: An Introduction", Marcel Dekker Inc; 4th Revised Edition, 1996.
7. MuhammedArif, Annette Fernandez, Kavitha P. Nair "Engineering Chemistry", Owl Books, 2019.
8. Ahad J., "Engineering Chemistry", Jai Publication, 2019.
9. Roy K. Varghese, "Engineering Chemistry", Crownplus Publishers, 2019.
10. Soney C. George,RinoLaly Jose, "Text Book of Engineering Chemistry", S. Chand & Company Pvt Ltd, 2019.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures (hrs)
1	**Electrochemistry and Corrosion**	**9**
1.1	Introduction - Differences between electrolytic and electrochemical cells- Daniel cell - redox reactions - cell representation. Different types of electrodes (brief) - Reference electrodes- SHE - Calomel electrode - Glass Electrode - Construction and Working.	**2**
1.2	Single electrode potential – definition - Helmholtz electrical double layer - Determination of E^0 using calomel electrode. Determination of pH using glass electrode. Electrochemical series and its applications. Free energy and EMF - Nernst Equation – Derivation - single electrode and cell (Numericals) -Application -Variation of emf with temperature.	**3**
1.3	Potentiometric titration - Introduction -Redox titration only. Lithiumion cell - construction and working. Conductivity- Measurement of conductivity of a solution (Numericals).	**2**
1.4	Corrosion-Electrochemicalcorrosion – mechanism. Galvanic series- cathodic protection - electroless plating –Copper and Nickel plating.	**2**
2	**Spectroscopic Techniques and Applications**	**9**
2.1	Introduction- Types of spectrum - electromagnetic spectrum - molecular energy levels - Beer Lambert's law (Numericals).	**2**
2.2	UV-Visible Spectroscopy – Principle - Types of electronic transitions - Energy level diagram of ethane, butadiene, benzene and hexatriene. Instrumentation of UV-Visible spectrometer and applications.	**2**
2.3	IR-Spectroscopy – Principle - Number of vibrational modes -Vibrational energy states of a diatomic molecule and -Determination of force constant of diatomic molecule (Numericals) –Applications.	**2**
2.4	^{1}H NMR spectroscopy – Principle - Relation between field strength and frequency - chemical shift - spin-spin splitting (spectral problems) - coupling constant (definition) - applications of NMR- including MRI (brief).	**3**
3	**Instrumental Methods and Nanomaterials**	**9**
3.1	Thermal analysis –TGA- Principle, instrumentation (block diagram) and applications – TGA of $CaC_2O_4.H_2O$ and polymers. DTA-Principle, instrumentation (block diagram) and applications - DTA of $CaC_2O_4.H_2O$.	**2**

3.2	Chromatographic methods - Basic principles and applications of column and TLC-Retention factor.	**2**
3.3	GC and HPLC-Principle, instrumentation (block diagram) - retention time and applications.	**2**
3.4	Nanomaterials - Definition - Classification - Chemical methods of preparation - Hydrolysis and Reduction - Applications of nanomaterials - Surface characterisation -SEM – Principle and instrumentation (block diagram).	**3**
4	**Stereochemistry and Polymer Chemistry**	**9**
4.1	Isomerism-Structural, chain, position, functional, tautomerism and matamerism - Definition with examples - Representation of 3D structures-Newman, Sawhorse, Wedge and Fischer projection of substituted methane and ethane. Stereoisomerism - Geometrical isomerism in double bonds and cycloalkanes (cis-trans and E-Z notations).	**2**
4.2	R-S Notation – Rules and examples - Optical isomerism, Chirality, Enantiomers and Diastereoisomers-Definition with examples.	**1**
4.3	Conformational analysis of ethane, butane, cyclohexane, mono and di methyl substituted cyclohexane.	**2**
4.4	Copolymers - Definition - Types - Random, Alternating, Block and Graft copolymers - ABS - preparation, properties and applications. Kevlar-preparation, properties and applications. Conducting polymers - Doping -Polyaniline and Polypyrrole - preparation properties and applications. OLED - Principle, construction and advantages.	**4**
5	**Water Chemistry and Sewage Water Treatment**	**9**
5.1	Water characteristics - Hardness - Types of hardness- Temporary and Permanent - Disadvantages of hard water -Units of hardness- ppm and mg/L -Degree of hardness (Numericals) - Estimation of hardness-EDTA method (Numericals). Water softening methods-Ion exchange process-Principle, procedure and advantages. Reverse osmosis – principle, process and advantages.	**3**
5.2	Municipal water treatment (brief) - Disinfection methods - chlorination, ozone andUV irradiation.	**2**
5.3	Dissolved oxygen (DO) -Estimation (only brief procedure-Winkler's method), BOD and COD-definition, estimation (only brief procedure) and significance (Numericals).	**2**
5.4	Sewage water treatment - Primary, Secondary and Tertiary - Flow diagram - Trickling filter and UASB process.	**2**

CYL 120	ENGINEERING CHEMISTRY LAB	CATEGORY	L	T	P	CREDIT
		BSC	0	0	2	1

Preamble: To impart scientific approach and to familiarize with the experiments in chemistry relevant for research projects in higher semesters

Prerequisite: Experiments in chemistry introduced at the plus two levels in schools

Course outcomes: After the completion of the course the students will be able to

CO 1	Understand and practice different techniques of quantitative chemical analysis to generate experimental skills and apply these skills to various analyses
CO 2	Develop skills relevant to synthesize organic polymers and acquire the practical skill to use TLC for the identification of drugs
CO 3	Develop the ability to understand and explain the use of modern spectroscopic techniques for analysing and interpreting the IR spectra and NMR spectra of some organic compounds
CO 4	Acquire the ability to understand, explain and use instrumental techniques for chemical analysis
CO 5	Learn to design and carry out scientific experiments as well as accurately record and analyze the results of such experiments
CO 6	Function as a member of a team, communicate effectively and engage in further learning. Also understand how chemistry addresses social, economical and environmental problems and why it is an integral part of curriculum

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3				2							3
CO 2	3				3							3
CO 3	3				3							3
CO 4	3				3							3
CO 5	3				1							3
CO 6	3				1							3

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration(Internal)
100	100	-	1 hour

Continuous Internal Evaluation Pattern:

Attendance : 20 marks
Class work/ Assessment /Viva-voce : 50 marks
End semester examination (Internally by college) : 30 marks

End Semester Examination Pattern: Written Objective Examination of one hour

SYLLABUS

LIST OF EXPERIMENTS (MINIMUM 8 MANDATORY)

1. Estimation of total hardness of water-EDTA method
2. Potentiometric titration
3. Determination of cell constant and conductance of solutions.
4. Calibration of pH meter and determination of pH of a solution
5. Estimation of chloride in water
6. Identification of drugs using TLC
7. Determination of wavelength of absorption maximum and colorimetric estimation of Fe^{3+} in solution
8. Determination of molar absorptivity of a compound ($KMnO_4$ or any water soluble food colorant)
9. Synthesis of polymers (a) Urea-formaldehyde resin (b) Phenol-formaldehyde resin
10. Estimation of iron in iron ore
11. Estimation of copper in brass
12. Estimation of dissolved oxygen by Winkler’s method
13. (a) Analysis of IR spectra (minimum 3 spectra) (b) Analysis of ^{1}H NMR spectra (minimum 3 spectra)
14. Flame photometric estimation of Na^+ to find out the salinity in sand
15. Determination of acid value of a vegetable oil
16. Determination of saponification of a vegetable oil

Reference Books

1. G. Svehla, B. Sivasankar, “Vogel's Qualitative Inorganic Analysis”, Pearson, 2012.

2. R. K. Mohapatra, “Engineering Chemistry with Laboratory Experiments”, PHI Learning, 2017.

3. Muhammed Arif, “Engineering Chemistry Lab Manual”, Owl publishers, 2019.

4. Ahad J., “Engineering Chemistry Lab manual”, Jai Publications, 2019.

5. Roy K Varghese, “Engineering Chemistry Laboratory Manual”, Crownplus Publishers, 2019.

6. Soney C George, Rino Laly Jose, “Lab Manual of Engineering Chemistry”, S. Chand & Company Pvt Ltd, New Delhi, 2019.

PHT 100	ENGINEERING PHYSICS A (FOR CIRCUIT BRANCHES)	CATEGORY	L	T	P	CREDIT	YEAR OF INTRODUCTION
		BSC	3	1	0	4	2019

Preamble: The aim of the Engineering Physics Program is to offer students a solid background in the fundamentals of Physics and to impart that knowledge in engineering disciplines. The program is designed to develop scientific attitudes and enable the students to correlate the concepts of Physics with the core programmes

Prerequisite: Higher secondary level Physics, Mathematical course on vector calculus, differential equations and linear algebra

Course Outcomes: After the completion of the course the student will be able to

CO 1	Compute the quantitative aspects of waves and oscillations in engineering systems.
CO 2	Apply the interaction of light with matter through interference, diffraction and identify these phenomena in different natural optical processes and optical instruments.
CO 3	Analyze the behaviour of matter in the atomic and subatomic level through the principles of quantum mechanics to perceive the microscopic processes in electronic devices.
CO 4	Classify the properties of magnetic materials and apply vector calculus to static magnetic fields and use Maxwell's equations to diverse engineering problems
CO 5	Analyze the principles behind various superconducting applications, explain the working of solid state lighting devices and fibre optic communication system

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2						1	2			1
CO 2	3	2						1	2			1
CO 3	3	2						1	2			1
CO 4	3	1						1	2			1
CO 5	3	1						1	2			1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	15	15	30
Understand	25	25	50
Apply	10	10	20

Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the effect of damping force on oscillators.
2. Distinguish between transverse and longitudinal waves.
3. (a) Derive an expression for the fundamental frequency of transverse vibration in a stretched string.

   (b) Calculate the fundamental frequency of a string of length 2 m weighing 6 g kept stretched by a load of 600 kg.

Course Outcome 2 (CO2):

1. Explain colours in thin films.
2. Distinguish between Fresnel and Fraunhofer diffraction.
3. (a) Explain the formation of Newton's rings and obtain the expression for radii of bright and dark rings in reflected system. Also explain how it is used to determine the wavelength of a monochromatic source of light.

   (b) A liquid of refractive index μ is introduced between the lens and glass plate.

What happens to the fringe system? Justify your answer.

Course Outcome 3 (CO3):

1. Give the physical significance of wave function ?

2. What are excitons ?

3. (a) Solve Schrodinger equation for a particle in a one dimensional box and obtain its energy eigen values and normalised wave functions.

   (b) Calculate the first three energy values of an electron in a one dimensional box of width 1 A^0 in electron volt.

Course Outcome 4 (CO4):

1. Compare displacement current and conduction current.

2. Mention any four properties of ferro magnetic materials.

3. (a) Starting from Maxwell's equations, derive the free space electromagnetic wave equation and show that velocity of electromagnetic wave is $1/ (\mu_o \varepsilon_o)^{½}$

   (b) An electromagnetic wave is described by $E = 100 \exp 8\pi i [10^{14} t - (10^6 z / 3)]$ V/m. Find the direction of propagation of the wave,speed of the wave and magnetic flux density in the wave.

Course Outcome 5 (CO5):

1. Explain the working of a solar cell.

2. Distinguish between Type I and Type II super conductors.

3. (a) Define numerical aperture and derive an expression for it.

   (b) Explain the working of intensity modulated fibre optic sensor.

Model Question paper

QP CODE: PAGES:3

Reg No:______________

Name :______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: PHT 100

Course Name: Engineering Physics A

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Compare electrical and mechanical oscillators

2. Distinguish between longitudinal and transverse waves

3. Write a short note on antireflection coating.

4. Diffraction of light is not as evident in daily experience as that of sound waves. Give reason.

5. State and explain Heisenberg's Uncertainty principle. With the help of it explain natural line broadening.

6. Explain surface to volume ratio of nanomaterials.

7. State Faraday's laws of electromagnetic induction.

8. Compare displacement current and conduction current

9. List four important applications of superconductors.

10. Give the working principle of LED. (10x3=30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Derive the differential equation of damped harmonic oscillator and deduce its solution.Discuss the cases of over damped, critically damped and under damped cases. (10)

(b) The frequency of a tuning fork is 500 Hz and its Q factor is $7\times10^{4.}$ Find the relaxation time. Also calculate the time after which its energy becomes 1/10 of its initial undamped value.(4)

12. (a) Derive an expression for the velocity of propagation of a transverse wave in a stretched string. Deduce laws of transverse vibrations. (10)

(b) The equation of transverse vibration of a stretched string is given by y =0.00327 sin (72.1x-2.72t)m, in which the numerical constants are in S.I units. Evaluate (i) Amplitude (ii) Wavelength (iii) Frequency and (iv)Velocity of the wave. (4)

Module 2

13.(a)Explain the formation of Newton's rings and show that the radius of dark ring is proportional to the square root of natural numbers. How can we use Newton's rings experiment to determine the refractive index of a liquid. (10)

(b) Two pieces of plane glass are placed together with a piece of paper between two at one end. Find the angle of the wedge in seconds if the film is viewed with a monochromatic light of wavelength 4800Å. Given β = 0.0555 cm. (4)

14. (a) Explain the diffraction due to a plane transmission grating. Obtain the grating equation. (10)

(b) A grating has 6000 lines per cm. Find the angular separation of the two yellow lines of mercury of wavelengths 577 nm and 579 nm in the second order. (4)

Module 3

15.(a) Derive time dependent and independent Schrodinger equations. (10)

(b) An electron is confined to one dimensional potential box of length 2Å. Calculate the energies corresponding to the first and second quantum states in eV. (4)

16.(a) Classify nanomaterials based on dimensionality of quantum confinement and explain the following nanostructures. (i) nano sheets (ii) nano wires (iii) quantum dots. (10)

(b) Find the de Broglie wavelength of electron whose kinetic energy is 15 eV. (4)

Module 4

17.(a) State Poynting's Theorem. Calculate the value of Poynting vector at the surface of the sun if the power radiated by the sun is 3.8×10^{26} W and its radius is 7×10^{8} m. (5)

(b) Distinguish between paramagnetic, diamagnetic and ferromagnetic materials. (9)

18.(a) Starting from Maxwell's Equations, derive electromagnetic wave equations in free space. (10)

(b) If the magnitude of **H** in a plane wave is 1 A/m, find the magnitude of **E** in free space. (4)

Module 5

19.(a) Show that superconductors are perfect diamagnets. Distinguish between Type I and Type II superconductors with suitable examples. (10)

(b) Write a short note on high temperature superconductors. (4)

20.(a) Define numerical aperture of an optic fibre and derive an expression for the NA of a step index fibre with a neat diagram. (10)

(b) Calculate the numerical aperture and acceptance angle of a fibre with a core refractive index of 1.54 and a cladding refractive index of 1.50 when the fibre is inside water of refractive index 1.33. (4)

(14x5=70)

Syllabus

ENGINEERING PHYSICS A
(FOR CIRCUIT BRANCHES)

Module 1
Oscillations and Waves

Harmonic oscillations, Damped harmonic motion-Derivation of differential equation and its solution, Over damped, Critically damped and Under damped Cases, Quality factor-Expression, Forced oscillations-Differential Equation-Derivation of expressions for amplitude and phase of forced oscillations, Amplitude Resonance-Expression for Resonant frequency, Quality factor and Sharpness of Resonance, Electrical analogy of mechanical oscillators

Wave motion- Derivation of one dimensional wave equation and its solution, Three dimensional wave equation and its solution (no derivation), Distinction between transverse and longitudinal waves, Transverse vibration in a stretched string, Statement of laws of vibration

Module 2
Wave Optics

Interference of light-Principle of superposition of waves, Theory of thin films - Cosine law (Reflected system), Derivation of the conditions of constructive and destructive Interference, Interference due to wedge shaped films -Determination of thickness and test for optical planeness, Newton's rings - Measurement of wavelength and refractive index, Antireflection coatings

Diffraction of light, Fresnel and Fraunhofer classes of diffraction, Diffraction grating-Grating equation, Rayleigh criterion for limit of resolution, Resolving and Dispersive power of a grating with expression (no derivation)

Module 3
Quantum Mechanics & Nanotechnology

Introduction for the need of Quantum mechanics, Wave nature of Particles, Uncertainty principle, Applications-Absence of electrons inside a nucleus and Natural line broadening mechanism, Formulation of time dependent and independent Schrodinger wave equations-Physical meaning of wave function, Particle in a one dimensional box- Derivation for normalised wave function and energy eigen values, Quantum Mechanical Tunnelling (Qualitative)

Introduction to nanoscience and technology, Increase in surface to volume ratio for nanomaterials, Quantum confinement in one dimension, two dimension and three dimension-Nano sheets, Nano wires and Quantum dots, Properties of nanomaterials-mechanical, electrical and optical, Applications of nanotechnology (qualitative ideas)

Module 4
Magnetism & Electro Magnetic Theory

Magnetic field and Magnetic flux density, Gauss's law for Magnetic flux density, Ampere's Circuital law, Faraday's law in terms of EMF produced by changing magnetic flux, Magnetic permeability and susceptibility, Classification of magnetic materials-para, dia and ferromagnetic materials

Fundamentals of vector calculus, concept of divergence, gradient and curl along with physical significance, Line, Surface and Volume integrals, Gauss divergence theorem & Stokes' theorem, Equation of continuity, Derivation of Maxwell's equations in vacuum, Comparison of displacement current with conduction current. Electromagnetic waves, Velocity of Electromagnetic waves in free space, Flow of energy and Poynting's vector (no derivation)

Module 5

Superconductivity & Photonics

Superconducting phenomena, Meissner effect and perfect diamagnetism, Types of superconductors-Type I and Type II, BCS Theory (Qualitative), High temperature superconductors-Applications of super conductivity

Introduction to photonics-Photonic devices-Light Emitting Diode, Photo detectors -Junction and PIN photodiodes, Solar cells-I-V Characteristics, Optic fibre-Principle of propagation of light, Types of fibres-Step index and Graded index fibres, Numerical aperture –Derivation, Fibre optic communication system (block diagram), Industrial, Medical and Technological applications of optical fibre, Fibre optic sensors-Intensity Modulated and Phase modulated sensors.

Text Books

1. M.N.Avadhanulu, P.G.Kshirsagar,TVS Arun Murthy "A Text book of Engineering Physics", S.Chand &Co., Revised Edition 2019
2. H.K.Malik , A.K. Singh, "Engineering Physics" McGraw Hill Education, Second Edition 2017

Reference Books

1. Arthur Beiser, "Concepts of Modern Physics ", Tata McGraw Hill Publications, 6th Edition 2003
2. D.K. Bhattacharya, Poonam Tandon, "Engineering Physics", Oxford University Press, 2015
3. Md.N.Khan & S.Panigrahi "Principles of Engineering Physics 1&2", Cambridge University Press, 2016
4. Aruldhas G., "Engineering Physics", PHI Pvt. Ltd., 2015
5. Ajoy Ghatak, "Optics", Mc Graw Hill Education, Sixth Edition, 2017
6. T. Pradeep, "Nano:The Essentials'', McGraw Hill India Ltd, 2007
7. Halliday, Resnick, Walker, "Fundamentals of Physics'', John Wiley & Sons.Inc, 2001
8. David J Griffiths, "Introduction to Electrodynamics'', Addison-Wesley publishing, 3rd Edition, 1999
9. Premlet B., "Advanced Engineering Physics", Phasor Books,10th edition,2017
10. I. Dominic and. A. Nahari, "A Text Book of Engineering physics", Owl Books Publishers, Revised edition, 2016

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Oscillations and Waves (9 hours)**	
1.1	Harmonic oscillations, Damped harmonic motion-Derivation of differential equation and its solution, Over damped, Critically damped and Under damped Cases, Quality factor-Expression	2 hrs
1.2	Forced oscillations-Differential Equation-Derivation of expressions for amplitude and phase of forced oscillations, Amplitude Resonance-Expression for Resonant frequency, Quality factor and Sharpness of Resonance, Electrical analogy of mechanical oscillators	3hrs
1.3	Wave motion- Derivation of one dimensional wave equation and its solution, Three dimensional wave equation and its solution (no derivation)	2 hrs
1.4	Distinction between transverse and longitudinal waves. Transverse vibration in a stretched string, Statement of laws of vibration	2 hrs
2	**Wave Optics (9 hours)**	
2.1	Interference of light-Principle of superposition of waves, Theory of thin films - Cosine law (Reflected system), Derivation of the conditions of constructive and destructive Interference	2 hrs
2.2	Interference due to wedge shaped films -Determination of thickness and test for optical planeness, Newton's rings - Measurement of wavelength and refractive index, Antireflection coatings	4 hr
2.3	Diffraction of light, Fresnel and Fraunhofer classes of diffraction, Diffraction grating-Grating equation	2 hrs
2.4	Rayleigh criterion for limit of resolution, Resolving and Dispersive power of a grating with expression (no derivation)	1 hr
3	**Quantum Mechanics &Nanotechnology (9hours)**	
3.1	Introduction for the need of Quantum mechanics, Wave nature of Particles, Uncertainty principle, Applications-Absence of electrons inside a nucleus and Natural line broadening mechanism	2 hrs
3.2	Formulation of time dependent and independent Schrodinger wave equations-Physical Meaning of wave function, Particle in a one dimensional box- Derivation for normalised wave function and energy eigen values, Quantum Mechanical Tunnelling (Qualitative)	4 hrs
3.3	Introduction to nanoscience and technology, Increase in surface to volume ratio for nanomaterials, Quantum confinement in one dimension, two dimension and three dimension-Nano sheets, Nano wires and Quantum dots	2 hrs
3.4	Properties of nanomaterials-mechanical, electrical and optical Applications of nanotechnology (qualitative ideas)	1 hr
4	**Magnetism & Electro Magnetic Theory (9 hours)**	
4.1	Magnetic field and Magnetic flux density, Gauss's law for Magnetic flux	2 hrs

	density, Ampere's Circuital law, Faraday's law in terms of EMF produced by changing magnetic flux	
4.2	Explanation for Magnetic permeability and susceptibility Classification of magnetic materials- para, dia and ferromagnetic materials	1 hr
4.3	Fundamentals of vector calculus, concept of divergence, gradient and curl along with physical significance, Line, Surface and Volume integrals, Gauss divergence theorem & Stokes' theorem	2 hrs
4.4	Equation of continuity, Derivation of Maxwell's equations in vacuum, Comparison of displacement current with conduction current. Electromagnetic waves, Velocity of Electromagnetic waves in free space, Flow of energy and Poynting's vector (no derivation)	4 hrs
5	**Superconductivity &Photonics (9hours)**	
5.1	Super conducting Phenomena, Meissner effect and perfect diamagnetism, Types of superconductors-Type I and Type II	2 hrs
5.2	BCS Theory (Qualitative), High temperature superconductors, Applications of super conductivity	2 hrs
5.3	Introduction to photonics-Photonic devices-Light Emitting Diode, Photo detectors -Junction and PIN photodiodes, Solar cells-I-V Characteristics	2 hrs
5.4	Optic fibre-Principle of propagation of light, Types of fibres-Step index and Graded index fibres, Numerical aperture –Derivation, Fibre optic communication system (block diagram), Industrial, Medical and Technological applications of optical fibre, Fibre optic sensors-Intensity Modulated and Phase modulated sensors	3 hrs

PHT 110	ENGINEERING PHYSICS B (FOR NON-CIRCUIT BRANCHES)	Category	L	T	P	CREDIT	Year of Introduction
		BSC	3	1	0	4	2019

Preamble: The aim of the Engineering Physics program is to offer students a solid background in the fundamentals of Physics and to impart that knowledge in engineering disciplines. The program is designed to develop scientific attitudes and enable the students to correlate the concepts of Physics with the core programmes

Prerequisite: Higher secondary level Physics, Mathematical course on vector calculus, differential equations and linear algebra

Course Outcomes: After the completion of the course the student will be able to

CO 1	Compute the quantitative aspects of waves and oscillations in engineering systems.
CO 2	Apply the interaction of light with matter through interference, diffraction and identify these phenomena in different natural optical processes and optical instruments.
CO 3	Analyze the behaviour of matter in the atomic and subatomic level through the principles of quantum mechanics to perceive the microscopic processes in electronic devices.
CO 4	Apply the knowledge of ultrasonics in non-destructive testing and use the principles of acoustics to explain the nature and characterization of acoustic design and to provide a safe and healthy environment
CO 5	Apply the comprehended knowledge about laser and fibre optic communication systems in various engineering applications

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2						1	2			1
CO 2	3	2						1	2			1
CO 3	3	2						1	2			1
CO 4	3							1	2			1
CO 5	3	2						1	2			1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	15	15	30
Understand	25	25	50

Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE MARKS	ESE MARKS	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the effect of damping force on oscillators.
2. Distinguish between transverse and longitudinal waves.
3. (a) Derive an expression for the fundamental frequency of transverse vibration in a stretched string.
   (b) Calculate the fundamental frequency of a string of length 2 m weighing 6 g kept stretched by a load of 600 kg.

Course Outcome 2 (CO2):

1. Explain colours in thin films.
2. Distinguish between Fresnel and Fraunhofer diffraction.
3. (a) Explain the formation of Newton's rings and obtain the expression for radii of bright and dark rings in reflected system. Also explain how it is used to determine the wavelength of a monochromatic source of light.
   (b) A liquid of refractive index μ is introduced between the lens and glass plate. What happens to the fringe system? Justify your answer.

Course Outcome 3 (CO3):

1. Give the physical significance of wave function?

2. What are excitons ?
3. (a) Solve Schrodinger equation for a particle in a one dimensional box and obtain its energy eigen values and normalised wave functions.
   (b) Calculate the first three energy values of an electron in a one dimensional box of width 1 A^0 in electron volt.

Course Outcome 4 (CO4):

1. Explain reverberation and reverberation time.
2. How ultrasonic waves are used in non-destructive testing.
3. (a) With a neat diagram explain how ultrasonic waves are produced by a piezoelectric oscillator.
   (b) Calculate frequency of ultrasonic waves that can be produced by a nickel rod of length 4 cm. (Young's Modulus = 207 G Pa, Density = 8900 Kg /m^3)

Course Outcome 5 (CO 5):

1. Distinguish between spontaneous emission and stimulated emission.
2. Explain optical resonators.
3. (a) Explain the construction and working of Ruby Laser.
   (b) Calculate the numerical aperture and acceptance angle of a fibre with a core refractive index of 1.54 and a cladding refractive index of 1.50 when the fibre is inside water of refractive index 1.33.

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Model Question paper

QP CODE: PAGES:3

Reg No:_______________

Name :_______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: PHT 110

Course Name: Engineering Physics B

Max.Marks: 100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Compare electrical and mechanical oscillators.

2. Distinguish between longitudinal and transverse waves.

3. Write a short note on antireflection coating.

4. Diffraction of light is not as evident in daily experience as that of sound waves. Give reason.

5. State and explain Heisenberg's Uncertainty principle. With the help of it explain natural line broadening.

6. Explain surface to volume ratio of nanomaterials.

7. Define sound intensity level. Give the values of threshold of hearing and threshold of pain.

8. Describe the method of non-destructive testing using ultra sonic waves

9. Explain the condition of population inversion

10. Distinguish between step index and graded index fibre. (10x3=30)

PART B

Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Derive the differential equation of damped harmonic oscillator and deduce its solution. Discuss the cases of over damped, critically damped and under damped cases. (10)

(b) The frequency of a tuning fork is 500 Hz and its Q factor is $7\times10^{4.}$ Find the relaxation time. Also calculate the time after which its energy becomes 1/10 of its initial undamped value. (4)

12. (a) Derive an expression for the velocity of propagation of a transverse wave in a stretched string. Deduce laws of transverse vibrations. (10)

(b) The equation of transverse vibration of a stretched string is given by y =0.00327 sin (72.1x-2.72t) m, in which the numerical constants are in S.I units. Evaluate (i) Amplitude (ii) Wavelength (iii) Frequency and (iv) Velocity of the wave. (4)

Module 2

13. (a) Explain the formation of Newton's rings and show that the radius of dark ring is proportional to the square root of natural numbers. How can we use Newton's rings experiment to determine the refractive index of a liquid? (10)

(b) Two pieces of plane glass are placed together with a piece of paper between two at one end. Find the angle of the wedge in seconds if the film is viewed with a monochromatic light of wavelength 4800Å. Given β = 0.0555 cm. (4)

14. (a) Explain the diffraction due to a plane transmission grating. Obtain the grating equation. (10)

(b) A grating has 6000 lines per cm. Find the angular separation of the two yellow lines of mercury of wavelengths 577 nm and 579 nm in the second order. (4)

Module 3

15. (a) Derive time dependent and independent Schrodinger equations. (10)

(b) An electron is confined to one dimensional potential box of length 2Å. Calculate the energies corresponding to the first and second quantum states in eV. (4)

16. (a) Classify nanomaterials based on dimensionality of quantum confinement and explain the following nanostructures. (i) nano sheets (ii) nano wires (iii) quantum dots. (10)

(b) Find the de Broglie wavelength of electron whose kinetic energy is 15 eV. (4)

Module 4

17. (a) Explain reverberation and reverberation time? What is the significance of Reverberation time. Explain the factors affecting the acoustics of a building and their corrective measures? (10)

(b) The volume of a hall is 3000 m^3. It has a total absorption of $100m^2$ sabine. If the hall is filled with audience who add another 80 m^2sabine, then find the difference in reverberation time. (4)

18. (a) With a neat diagram explain how ultrasonic waves are produced by piezoelectric oscillator. Also discuss the piezoelectric method of detection of ultrasonic waves. (10)

(b) An ultrasonic source of 0.09 MHz sends down a pulse towards the sea bed which returns after 0.55 sec. The velocity of sound in sea water is 1800 m/s. Calculate the depth of the sea and the wavelength of the pulse. (4)

Module 5

19. (a) Outline the construction and working of Ruby laser. (8)

(b) What is the principle of holography? How is a hologram recorded? (6)

20. (a) Define numerical aperture of an optic fibre and derive an expression for the NA of a step index fibre with a neat diagram. (10)

(b) An optical fibre made with core of refractive index 1.5 and cladding with a fractional index difference of 0.0006. Find refractive index of cladding and numerical aperture. (4)

(14x5=70)

SYLLABUS

ENGINEERING PHYSICS B (FOR NON-CIRCUIT BRANCHES)

Module 1

Oscillations and Waves

Harmonic oscillations, Damped harmonic motion-Derivation of differential equation and its solution, Over damped, Critically damped and Under damped Cases, Quality factor-Expression, Forced oscillations-Differential Equation-Derivation of expressions for amplitude and phase of forced oscillations, Amplitude Resonance-Expression for Resonant frequency, Quality factor and Sharpness of Resonance, Electrical analogy of mechanical oscillators

Wave motion- Derivation of one dimensional wave equation and its solution, Three dimensional wave equation and its solution (no derivation), Distinction between transverse and longitudinal waves, Transverse vibration in a stretched string, Statement of laws of vibration

Module 2

Wave Optics

Interference of light-Principle of superposition of waves, Theory of thin films - Cosine law (Reflected system), Derivation of the conditions of constructive and destructive Interference, Interference due to wedge shaped films -Determination of thickness and test for optical planeness, Newton’s rings - Measurement of wavelength and refractive index, Antireflection coatings

Diffraction of light, Fresnel and Fraunhofer classes of diffraction, Diffraction grating-Grating equation, Rayleigh criterion for limit of resolution, Resolving and Dispersive power of a grating with expression (no derivation)

Module 3

Quantum Mechanics & Nanotechnology

Introduction for the need of Quantum mechanics, Wave nature of Particles, Uncertainty principle, Applications-Absence of electrons inside a nucleus and Natural line broadening Mechanism, Formulation of time dependent and independent Schrodinger wave equations-Physical Meaning of wave function, Particle in a one dimensional box- Derivation for normalised wave function and energy eigen values, Quantum Mechanical Tunnelling (Qualitative)

Introduction to nanoscience and technology, Increase in surface to volume ratio for nanomaterials, Quantum confinement in one dimension, two dimension and three dimension-Nano sheets, Nano wires and Quantum dots, Properties of nanomaterials-mechanical, electrical and optical, Applications of nanotechnology (qualitative ideas)

Module 4

Acoustics & Ultrasonics

Acoustics, Classification of sound-Musical sound-Noise, Characteristics of Musical Sounds-Pitch or frequency-Loudness or Intensity-Measurement of Intensity level-Decibel-Quality or timbre, Absorption coefficient, Reverberation-Reverberation time-Significance- Sabine’s formula (no derivation), Factors affecting architectural acoustics and their remedies

Ultrasonics-Production- Magnetostriction effect and Piezoelectric effect, Magnetostriction oscillator and Piezoelectric oscillator –Working, Detection of ultrasonic waves - Thermal and Piezoelectric methods, Ultrasonic diffractometer- Expression for the velocity of ultrasonic waves in a liquid , Applications of ultrasonic waves -SONAR,NDT and Medical

Module 5

Laser and Fibre optics

Properties of laser, Absorption and emission of radiation, Spontaneous and stimulated emission, Einstein's coefficients (no derivation), Population inversion, Metastable states, basic components of laser, Active medium, Pumping mechanism, Optical resonant cavity, working principle, Construction and working of Ruby laser and Helium neon laser ,Construction and working of semiconductor laser(Qualitative) ,Applications of laser, Holography, Difference between hologram and photograph, Recording of hologram and reconstruction of image, Applications

Optic fibre-Principle of propagation of light, Types of fibres-Step index and Graded index fibres, Numerical aperture –Derivation, Fibre optic communication system (block diagram), Industrial, Medical and Technological applications, Fibre optic sensors-Intensity Modulated and Phase modulated sensors

Text Books

1. M.N.Avadhanulu, P.G.Kshirsagar,TVS Arun Murthy "A Text book of Engineering Physics", S.Chand &Co., Revised Edition, 2019.

2. H.K.Malik , A.K. Singh, "Engineering Physics" McGraw Hill Education, Second Edition, 2017.

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1. Arthur Beiser, "Concepts of Modern Physics ", Tata McGraw Hill Publications, 6th Edition 2003
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3. Md.N.Khan & S.Panigrahi "Principles of Engineering Physics 1&2", Cambridge University Press, 2016
4. Aruldhas G., "Engineering Physics", PHI Pvt. Ltd., 2015
5. Ajoy Ghatak, "Optics", Mc Graw Hill Education, Sixth Edition, 2017
6. T. Pradeep, "Nano:The Essentials'', McGraw Hill India Ltd, 2007
7. B. B. Laud, "Lasers and Non linear optics", New age International Publishers, 2nd Edition ,2005
8. Premlet B., "Advanced Engineering Physics", Phasor Books,10th edition ,2017
9. I. Dominic and. A. Nahari, "A Text Book of Engineering physics", Owl Books Publishers, Revised edition, 2016

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
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1.1	Harmonic oscillations, Damped harmonic motion-Derivation of differential equation and its solution, Over damped, Critically damped and Under damped Cases, Quality factor-Expression	2 hrs
1.2	Forced oscillations-Differential Equation-Derivation of expressions for amplitude and phase of forced oscillations, Amplitude Resonance-Expression for Resonant frequency, Quality factor and Sharpness of Resonance, Electrical analogy of mechanical oscillators	3hrs
1.3	Wave motion- Derivation of one dimensional wave equation and its solution, Three dimensional wave equation and its solution (no derivation)	2 hrs
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2.1	Interference of light-Principle of superposition of waves, Theory of thin films - Cosine law (Reflected system), Derivation of the conditions of constructive and destructive Interference	2 hrs
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2.4	Rayleigh criterion for limit of resolution, Resolving and Dispersive power of a grating with expression (no derivation)	1 hr
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3.1	Introduction for the need of Quantum mechanics, Wave nature of Particles, Uncertainty principle, Applications-Absence of electrons inside a nucleus and Natural line broadening mechanism	2 hrs
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3.4	Properties of nanomaterials-mechanical, electrical and optical Applications of nanotechnology (qualitative ideas)	1 hr
4	**Acoustics & Ultrasonics (9hrs)**	
4.1	Acoustics, Classification of sound-Musical sound-Noise, Characteristics	3 hrs

	of Musical Sounds-Pitch or frequency-Loudness or Intensity-Measurement of Intensity level-Decibel-Quality or timbre, Absorption coefficient, Reverberation-Reverberation time-Significance- Sabine's formula (no derivation)	
4.2	Factors affecting architectural acoustics and their remedies	1 hr
4.3	Ultrasonics-Production- Magnetostriction effect and Piezoelectric effect, Magnetostriction oscillator and Piezoelectric oscillator – Working, Detection of ultrasonic waves - Thermal and Piezoelectric methods	3hrs
4.4	Ultrasonic diffractometer- Expression for the velocity of ultrasonic waves in a liquid ,Applications of ultrasonic waves -SONAR,NDT and Medical.	2 hr
5	**Laser and Fibre optics (9hours)**	
5.1	Properties of laser, Absorption and emission of radiation, Spontaneous and stimulated emission, Einstein's coefficients (no derivation), Population inversion, Metastable states, basic components of laser, Active medium, Pumping mechanism, Optical resonant cavity, working principle	2 hrs
5.2	Construction and working of Ruby laser and Helium neon laser ,Construction and working of semiconductor laser(Qualitative) Applications of laser	3 hrs
5.3	Holography, Difference between hologram and photograph, Recording of hologram and reconstruction of image, Applications	1 hr
5.4	Optic fibre-Principle of propagation of light, Types of fibres-Step index and Graded index fibres, Numerical aperture –Derivation, Fibre optic communication system (block diagram), Industrial, Medical and Technological applications, Fibre optic sensors-Intensity Modulated and Phase modulated sensors	3 hrs

PHL 120	**ENGINEERING PHYSICS LAB**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**	**YEAR OF INTRODUCTION**
		BSC	0	0	2	1	2019

Preamble: The aim of this course is to make the students gain practical knowledge to co-relate with the theoretical studies and to develop practical applications of engineering materials and use the principle in the right way to implement the modern technology.

Prerequisite: Higher secondary level Physics

Course Outcomes: After the completion of the course the student will be able to

CO 1	Develop analytical/experimental skills and impart prerequisite hands on experience for engineering laboratories
CO 2	Understand the need for precise measurement practices for data recording
CO 3	Understand the principle, concept, working and applications of relevant technologies and comparison of results with theoretical calculations
CO 4	Analyze the techniques and skills associated with modern scientific tools such as lasers and fiber optics
CO 5	Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3				3			1	2			1
CO 2	3				3			1	2			1
CO 3	3				3			1	2			1
CO 4	3				3			1	2			1
CO 5	3				3			1	2			1

Mark distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration(Internal)
100	100	-	1 hour

Continuous Internal Evaluation Pattern:

Attendance : 20 marks
Class work/ Assessment /Viva-voce : 50 marks
End semester examination (Internally by college) : 30 marks

End Semester Examination Pattern: Written Objective Examination of one hour

SYLLABUS

LIST OF EXPERIMENTS

(Minimum 8 experiments should be completed)

1. CRO-Measurement of frequency and amplitude of wave forms
2. Measurement of strain using strain gauge and wheatstone bridge
3. LCR Circuit – Forced and damped harmonic oscillations
4. Melde's string apparatus- Measurement of frequency in the transverse and longitudinal mode
5. Wave length measurement of a monochromatic source of light using Newton's Rings method.
6. Determination of diameter of a thin wire or thickness of a thin strip of paper using air wedge method.
7. To measure the wavelength using a millimeter scale as a grating.
8. Measurement of wavelength of a source of light using grating.
9. Determination of dispersive power and resolving power of a plane transmission grating
10. Determination of the particle size of lycopodium powder
11. Determination of the wavelength of He-Ne laser or any standard laser using diffraction grating
12. Calculate the numerical aperture and study the losses that occur in optical fiber cable.
13. I-V characteristics of solar cell.
14. LED Characteristics.
15. Ultrasonic Diffractometer- Wavelength and velocity measurement of ultrasonic waves in a liquid
16. Deflection magnetometer-Moment of a magnet- Tan A position.

Reference books

1. S.L.Gupta and Dr.V.Kumar, "Practical physics with viva voice", Pragati PrakashanPublishers, Revised Edition, 2009

2. M.N.Avadhanulu, A.A.Dani and Pokely P.M, "Experiments in Engineering Physics", S.Chand&Co,2008

3. S. K. Gupta, "Engineering physics practicals", Krishna Prakashan Pvt. Ltd., 2014

4. P. R. Sasikumar "Practical Physics", PHI Ltd., 2011.

HUN 101	**LIFE SKILLS**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**	**YEAR OF INTRODUCTION**
		MNC	2	0	2	---	**2019**

Preamble: Life skills are those competencies that provide the means for an individual to be resourceful and positive while taking on life's vicissitudes. Development of one's personality by being aware of the self, connecting with others, reflecting on the abstract and the concrete, leading and generating change, and staying rooted in time-tested values and principles is being aimed at. This course is designed to enhance the employability and maximize the potential of the students by introducing them to the principles that underly personal and professional success, and help them acquire the skills needed to apply these principles in their lives and careers.

Prerequisite: None

Course Outcomes: After the completion of the course the student will be able to

CO 1	Define and Identify different life skills required in personal and professional life
CO 2	Develop an awareness of the self and apply well-defined techniques to cope with emotions and stress.
CO 3	Explain the basic mechanics of effective communication and demonstrate these through presentations.
CO 4	Take part in group discussions
CO 5	Use appropriate thinking and problem solving techniques to solve new problems
CO 6	Understand the basics of teamwork and leadership

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1						2		1	2	2	1	3
CO 2									3			2
CO 3						1			1	3		
CO 4										3		1
CO 5		3	2	1								
CO 6						1			3			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
100	50	50	2 hours

Continuous Internal Evaluation
Total Marks: 50

Attendance	: 10 marks
Regular assessment	: 15 marks
Series test (one test only, should include first three modules)	: 25 marks

Regular assessment

- Group Discussion (Marks: 9)

  Create groups of about 6 students each and engage them on a GD on a suitable topic for about 20 minutes. Parameters to be used for evaluation are as follows:

Communication Skills	: 3 marks
Subject Clarity	: 2 marks
Group Dynamics	: 2 marks
Behaviours & Mannerisms	: 2 marks

- Presentation Skills (Marks: 6)

  Identify a suitable topic and ask the students to prepare a presentation (preferably a power point presentation) for about 10 minutes. Parameters to be used for evaluation are as follows:

Communication Skills	: 2 marks
Platform Skills	: 2 marks
Subject Clarity/Knowledge	: 2 marks

End Semester Examination
Total Marks: 50 **Time: 2 hrs.**

Part A: Short answer question (25 marks)

There will be one question from each MODULE (five questions in total, five marks each). Each question should be written in about maximum of 400 words. Parameters to be used for evaluation are as follows:

(i) Content Clarity/Subject Knowledge
(ii) Presentation style
(iii) Organization of content

Part B: Case Study (25 marks)

The students will be given a case study with questions at the end. The students have to analyze the case and answer the question at the end. Parameters to be used for evaluation are as follows:

(i) Analyze the case situation
(ii) Key players/characters of the case
(iii) Identification of the problem (both major & minor if exists)
(iv) Bring out alternatives
(v) Analyze each alternative against the problem
(vi) Choose the best alternative
(vii) Implement as solution
(viii) Conclusion

(ix) Answer the question at the end of the case

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List 'life skills' as identified by WHO
2. What do you mean by effective communication?
3. What are the essential life skills required by a professional?

Course Outcome 2 (CO2)

1. Identify an effective means to deal with workplace stress.
2. How can a student apply journaling to stress management?
3. What is the PATH method? Describe a situation where this method can be used effectively.

Course Outcome 3(CO3):

1. Identify the communication network structure that can be observed in the given situations. Describe them.

   (a) A group discussion on development.

   (b) An address from the Principal regarding punctuality.

   (c) A reporter interviewing a movie star.

   (d) Discussing the answers of a test with a group of friends.

2. Elucidate the importance of non-verbal communication in making a presentation
3. Differentiate between kinesics, proxemics, and chronemics with examples.

Course Outcome 4 (CO4):

1. How can a participant conclude a group discussion effectively?
2. 'Listening skills are essential for effectively participating in a group discussion.' Do you agree? Substantiate your answer.

Course Outcome 5 (CO5):

1. Illustrate the creative thinking process with the help of a suitable example
2. Translate the following problem from verbal to graphic form and find the solution : *In a quiz, Ananth has 50 points more than Bimal, Chinmay has 60 points less than Ananth, and Dharini is 20 points ahead of Chinmay. What is the difference in points between Bimal and Dharini?*

3. List at least five ways in which the problem "How to increase profit?" can be redefined

Course Outcome 6 (CO6):

1. A group of engineers decided to brainstorm a design issue on a new product. Since no one wanted to disagree with the senior members, new ideas were not flowing freely. What group dynamics technique would you suggest to avoid this 'groupthink'? Explain the procedure.

2. “A group focuses on individual contribution, while a team must focus on synergy.” Explain.

3. Identify the type of group formed / constituted in each of the given situations

    a) A Police Inspector with subordinates reporting to him

    b) An enquiry committee constituted to investigate a specific incident

    c) The Accounts Department of a company

    d) A group of book lovers who meet to talk about reading

Syllabus

Module 1

Overview of Life Skills: Meaning and significance of life skills, Life skills identified by WHO: Self-awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem solving, Effective communication, interpersonal relationship, coping with stress, coping with emotion.

Life skills for professionals: positive thinking, right attitude, attention to detail, having the big picture, learning skills, research skills, perseverance, setting goals and achieving them, helping others, leadership, motivation, self-motivation, and motivating others, personality development, IQ, EQ, and SQ

Module 2

Self-awareness: definition, need for self-awareness; Coping With Stress and Emotions, Human Values, tools and techniques of SA: questionnaires, journaling, reflective questions, meditation, mindfulness, psychometric tests, feedback.

Stress Management: Stress, reasons and effects, identifying stress, stress diaries, the four A's of stress management, techniques, Approaches: action-oriented, emotion-oriented, acceptance-oriented, resilience, Gratitude Training,

Coping with emotions: Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques.

Morals, Values and Ethics: Integrity, Civic Virtue, Respect for Others, Living Peacefully. Caring, Sharing, Honesty, Courage, Valuing Time, Time management, Co operation, Commitment, Empathy, Self-Confidence, Character, Spirituality, Avoiding Procrastination, Sense of Engineering Ethics.

Module 3

21st century skills: Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making, Need for Creativity in the 21st century, Imagination, Intuition, Experience, Sources of Creativity, Lateral Thinking, Myths of creativity, Critical thinking Vs Creative thinking, Functions of Left Brain & Right brain, Convergent & Divergent Thinking, Critical reading & Multiple Intelligence.

Steps in problem solving: Problem Solving Techniques, Six Thinking Hats, Mind Mapping, Forced Connections. Analytical Thinking, Numeric, symbolic, and graphic reasoning. Scientific temperament and Logical thinking.

Module 4

Group and Team Dynamics: Introduction to Groups: Composition, formation, Cycle, thinking, Clarifying expectations, Problem Solving, Consensus, Dynamics techniques, Group vs Team, Team Dynamics, Virtual Teams. Managing team performance and managing conflicts, Intrapreneurship.

Module 5

Leadership: Leadership framework, entrepreneurial and moral leadership, vision, cultural dimensions. Growing as a leader, turnaround leadership, managing diverse stakeholders, crisis management. Types of Leadership, Traits, Styles, VUCA Leadership, Levels of Leadership, Transactional vs Transformational Leaders, Leadership Grid, Effective Leaders.

Lab Activities

Verbal

Effective communication and Presentation skills.
Different kinds of communication; Flow of communication; Communication networks, Types of barriers; Miscommunication
Introduction to presentations and group discussions.
Learning styles: visual, aural, verbal, kinaesthetic, logical, social, solitary; Previewing, KWL table, active listening, REAP method
Note-taking skills: outlining, non-linear note-taking methods, Cornell notes, three column note taking.
Memory techniques: mnemonics, association, flashcards, keywords, outlines, spider diagrams and mind maps, spaced repetition.
Time management: auditing, identifying time wasters, managing distractions, calendars and checklists; Prioritizing - Goal setting, SMART goals; Productivity tools and apps, Pomodoro technique.

Non Verbal:

Non-verbal Communication and Body Language: Forms of non-verbal communication; Interpreting body-language cues; Kinesics; Proxemics; Chronemics; Effective use of body language, Communication in a multi cultural environment.

Reference Books

1. Shiv Khera, You Can Win, Macmillan Books, New York, 2003.
2. Barun K. Mitra, “Personality Development & Soft Skills”, Oxford Publishers, Third impression, 2017.
3. ICT Academy of Kerala, "Life Skills for Engineers", McGraw Hill Education (India) Private Ltd., 2016.
4. Caruso, D. R. and Salovey P, “The Emotionally Intelligent Manager: How to Develop and Use the Four Key Emotional Skills of Leadership”, John Wiley & Sons, 2004.
5. Kalyana, “Soft Skill for Managers”; First Edition; Wiley Publishing Ltd, 2015.
6. Larry James, “The First Book of Life Skills”; First Edition, Embassy Books, 2016.
7. Shalini Verma, “Development of Life Skills and Professional Practice”; First Edition; Sultan Chand (G/L) & Company, 2014.
8. Daniel Goleman, "Emotional Intelligence"; Bantam, 2006.
9. Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publications, First Edition, 2016.
10. Butterfield Jeff, “Soft Skills for Everyone”, Cengage Learning India Pvt Ltd; 1 edition, 2011.
11. Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India; 6 edition, 2015.
12. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education; 1 edition, 2013.

MAT 101	LINEAR ALGEBRA AND CALCULUS	CATEGORY	L	T	P	CREDIT	Year of Introduction
		BSC	3	1	0	4	2019

Preamble: This course introduces students to some basic mathematical ideas and tools which are at the core of any engineering course. A brief course in Linear Algebra familiarises students with some basic techniques in matrix theory which are essential for analysing linear systems. The calculus of functions of one or more variables taught in this course are useful in modelling and analysing physical phenomena involving continuous change of variables or parameters and have applications across all branches of engineering.

Prerequisite: A basic course in one-variable calculus and matrix theory.

Course Outcomes: After the completion of the course the student will be able to

CO 1	solve systems of linear equations, diagonalize matrices and characterise quadratic forms
CO 2	compute the partial and total derivatives and maxima and minima of multivariable functions
CO 3	compute multiple integrals and apply them to find areas and volumes of geometrical shapes, mass and centre of gravity of plane laminas
CO 4	perform various tests to determine whether a given series is convergent, absolutely convergent or conditionally convergent
CO 5	determine the Taylor and Fourier series expansion of functions and learn their applications.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	2	1			1	2		2
CO 2	3	3	3	3	2	1			1	2		2
CO 3	3	3	3	3	2	1			1	2		2
CO 4	3	2	3	2	1	1			1	2		2
CO 5	3	3	3	3	2	1			1	2		2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 2 (Marks)	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE marks	ESE marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

Assignments: Assignment should include specific problems highlighting the applications of the methods introduced in this course in science and engineering.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Solve systems of linear equations, diagonalize matrices and characterise quadratic forms

1. A is a real matrix of order $3 \times 3$and $X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}$. What can you say about the solution of $AX = 0$if rank of A is 1? 2 ?3?
2. Given$A = \begin{bmatrix} 3 & 0 & 2 \\ 0 & 2 & 0 \\ -2 & 0 & 0 \end{bmatrix}$, find an orthogonal matrix Pthat diagonalizes A.
3. Find out what type of conic section the following quadratic form represents

$$17x^2 - 30x_1x_2 + 17x_2^2 = 128$$

4. The matrix $A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$has an eigen value5 with corresponding Eigen vector$X = \begin{bmatrix} 1 \\ 2 \\ -1 \end{bmatrix}$. Find A^5X

Course Outcome 2 (CO2): compute the partial and total derivatives and maxima and minima of multivariable functions

1. Find the slope of the surface $z = x^2y + 5y^3$in the x-direction at the point (1,-2)

2. Given the function $w = xy + z$, use chain rule to find the instantaneous rate of change of $w$at each point along the curve $x = cost, y = sint, z = t$

3. Determine the dimension of rectangular box open at the top , having a volume 32 cubic ft and requiring the least amount of material for it's construction.

Course Outcome 3(CO3): compute multiple integrals and apply them to find areas and volumes of geometrical shapes, mass and centre of gravity of plane laminas.

1. Evaluate $\iint_D (x + 2y)\, DA$where D is the region bounded by the parabolas $y = 2x^2$and $y = 1 + x^2$
2. Explain how you would find the volume under the surface $z = f(x, y)$and over a specific region Din the xyplane using (i) double integral (ii) triple integral?
3. Find the mass and centre of gravity of a triangular lamina with vertices (0,0), (2,1), (0,3) if the density function is $f(x, y) = x + y$
4. Use spherical coordinates to evaluate $\iiint_B (x^2 + y^2 + z^2)^3\, dV$where B is the unit ball defined by $B = \{(x, y, z): x^2 + y^2 + z^2 \leq 1\}$

Course Outcome 4 (CO4): perform various tests to determine whether a given series is convergent, absolutely convergent or conditionally convergent.

1. What is the difference between a sequence and a series and when do you say that they are convergent? Divergent?
2. Determine whether the series $\sum_{n=1}^{n=\infty} \frac{5}{2n^2+4n+3}$converges or diverges.
3. Is the series $\sum_{n=1}^{n=\infty} \frac{(-1)^{n-1}}{n}$convergent? Absolutely convergent? Conditionally convergent?

Course Outcome 5 (CO5): determine the Taylor and Fourier series expansion of functions and learn their applications.

1. Assuming the possibility of expansion find the Maclaurin series expansion of

   $f(x) = (1 + x)^k$for$|x| < 1$where $k$is any real number. What happens if $k$is a positive

   integer?
2. Use Maclaurin series of $ln(1 + x), -1 < x \leq 1$to find an approximate value of$ln2$.
3. Find the Fourier series of the function$f(x) = x^2, -2 \leq x < 2, f(x + 4) = f(x)$. Hence using Parseval's identity prove that $1 + \frac{1}{2^4} + \frac{1}{3^4} + \ldots = \frac{\pi^4}{90}$
4. Expand the function $f(x) = x\ (0 < x < 1/2)$ into a (i) Fourier sine series (ii) Fourier cosine series.

Model Question paper

QP CODE: PAGES:3

Reg No:_______________

Name :_______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIRST SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: **MAT 101**

Max. Marks: 100 **Duration: 3 Hours**

LINEAR ALGEBRA AND CALCULUs

(2019-Scheme)

(Common to all branches)

PART A

(Answer **all** questions, **each** question carries 3 marks)

1. Determine the rank of the matrix $A = \begin{bmatrix} 1 & 2 & -1 \\ -2 & -4 & 2 \\ 3 & 6 & -3 \end{bmatrix}$.
2. Write down the eigen values of $= \begin{bmatrix} 2 & 0 \\ 0 & -1 \end{bmatrix}$. What are the eigen values of $P^{-1}AP$ where $P = \begin{bmatrix} -4 & 2 \\ 3 & -1 \end{bmatrix}$?
3. Find $f_x(1,3)$ and $f_y(1,3)$ for the function $f(x,y) = 2x^3y^2 + 2y + 4x$.
4. Show that the function $u(x,t) = \sin(x - ct)$ is a solution of the equation $\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$.
5. Use double integral to find the area of the region enclosed between the parabolas $y = \frac{1}{2}x^2$ and the line $y = 2x$.
6. Use polar coordinates to evaluate the area of the region bounded by $x^2 + y^2 = 4$, the line $y = x$ and the y axis in the first quadrant
7. Test the convergence of the series $\sum_{k=1}^{\infty} \frac{k}{k+1}$.
8. Test the convergence of the alternating series $\sum_{k=1}^{\infty} (-1)^{k+1} \frac{1}{k}$ using Leibnitz test.
9. Find the Taylor series expansion of $sin\pi x$about$x = \frac{1}{2}$.
10. Find the values to which the Fourier series of

    $f(x) = x$for$-\pi < x < \pi$, with $f(x + 2\pi) = f(x)$ converges (10x3=30)

PART B

(Answer **one full** question from each module, each question carries **14** marks)

Module -I

11. (a) Solve the following system of equations

$$y + z - 2w = 0$$
$$2x - 3y - 3z + 6w = 2$$
$$4x + y + z - 2w = 4$$

(b) Find the eigen values and eigen vectors of the matrix $\begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}$

12. (a) Diagonalize the matrix $\begin{bmatrix} -1 & 2 & -2 \\ 2 & 4 & 1 \\ 2 & 1 & 4 \end{bmatrix}$

(b) What kind of conic section the quadratic form$3x_1^2 + 22x_1x_2 + 3x_2^2 = 0$ represents? Transform it to principal axes.

Module - II

13. (a) Find the local linear approximation to $f(x, y) = \sqrt{x^2 + y^2}$ at the point $(3, 4)$.Use it to approximate $f(3.04,3.98)$

(b) Let $w = \sqrt{x^2 + y^2 + z^2}$, $x = cos\theta, y = sin\theta, z = tan\theta$. Use chain rule to find $\frac{dw}{d\theta}$when $\theta = \frac{\pi}{4}$.

14. (a) Let $z = f(x, y)$ where $x = rcos\theta, y = rsin\theta$, prove that $\left(\frac{\partial z}{\partial x}\right)^2 + \left(\frac{\partial z}{\partial y}\right)^2 = \left(\frac{\partial z}{\partial r}\right)^2 + \frac{1}{r^2}\left(\frac{\partial z}{\partial \theta}\right)^2$.

(b) Locate all relative maxima, relative minima and saddle points

$f(x, y) = xy + \frac{a^3}{x} + \frac{b^3}{y}(a \neq 0, b \neq 0)$.

Module - III

15. (a) Evaluate$\iint_D (2x^2y + 9y^3)\, dxdy$ where D is the region bounded by $y = \frac{2}{3}x$ and $y = 2\sqrt{x}$

(b) Evaluate $\int_0^4 \int_{\sqrt{y}}^2 e^{x^3}\, dxdy$ changing the order of integration.

16. (a) Find the volume of the solid bounded by the cylinder $x^2 + y^2 = 4$ and the planes $y + z = 4$ and $z = 0$..

(b) Evaluate $\iiint \sqrt{1 - x^2 - y^2 - z^2}\, dxdydz$, taken throughout the volume of the sphere $x^2 + y^2 + z^2 = 1$, by transforming to spherical polar coordinates

Module - IV

17. (a) Test the convergence of the series

(i) $\sum_{k=1}^{\infty} \frac{k^k}{k!}$ (ii) $\sum_{k=2}^{\infty} \left(\frac{4k-5}{2k+1}\right)^k$

(b) Determine the convergence or divergence of the series $\sum_{k=1}^{\infty} (-1)^k \frac{(2k-1)!}{3^k}$

18. (a) Check whether the series $\sum_{k=1}^{\infty} (-1)^{k+1} \frac{(2k)!}{(3k-2)!}$is absolutely convergent, conditionally convergent or divergent.

(b) Test the convergence of the series $1 + \frac{1.2}{1.3} + \frac{1.2.3}{1.3.5} + \frac{1.2.3.4}{1.3.5.7} + \cdots$

Module - V

19. (a) Obtain the Fourier series of for$f(x) = e^{-x}$, in the interval $0 < x < 2\pi$.with $f\big(x + 2\pi\big) = f(x)$. Hence deduce the value of$\sum_{n=2}^{\infty} \frac{(-1)^n}{1+n^2}$.

    (b) Find the half range sine series of $f(x) = \begin{cases} \frac{2kL}{x} & if\ 0 < x < \frac{L}{2} \\ \frac{2k(L-x)}{L} & if\ \frac{L}{2} < x < L \end{cases}$

20. (a)Expand $(1 + x)^{-2}$.as a Taylor series about $x = 0$and state the region of convergence of the series.

    (b) Find the Fourier series for $f(x) = x^2$ in the interval $-\pi < x < \pi$

    with $f(x + 2\pi) = f(x)$.Hence show that $\frac{1}{1^4} + \frac{1}{2^4} + \frac{1}{3^4} + \cdots = \frac{\pi^4}{90}$. (14X5=70)

Syllabus

Module 1 (Linear algebra)

(Text 2: Relevant topics from sections 7.3, 7.4, 7.5, 8.1,8.3,8.4)

Systems of linear equations, Solution by Gauss elimination, row echelon form and rank of a matrix, fundamental theorem for linear systems (homogeneous and non-homogeneous, without proof), Eigen values and eigen vectors. Diagonaliztion of matrices, orthogonal transformation, quadratic forms and their canonical forms.

Module 2 (multivariable calculus-Differentiation)

(Text 1: Relevant topics from sections 13.3, 13.4, 13.5, 13.8)

Concept of limit and continuity of functions of two variables, partial derivatives, Differentials, Local Linear approximations, chain rule, total derivative, Relative maxima and minima, Absolute maxima and minima on closed and bounded set.

Module 3(multivariable calculus-Integration)

(Text 1: Relevant topics from sections 14.1, 14.2, 14.3, 14.5, 14.6, 14.8)

Double integrals (Cartesian), reversing the order of integration, Change of coordinates (Cartesian to polar), finding areas and volume using double integrals, mass and centre of gravity of inhomogeneous laminas using double integral. Triple integrals, volume calculated as triple integral, triple integral in cylindrical and spherical coordinates (computations involving spheres, cylinders).

Module 4 (sequences and series)

(Text 1: Relevant topics from sections 9.1, 9.3, 9.4, 9.5, 9.6)

Convergence of sequences and series, convergence of geometric series and p-series(without proof), test of convergence (comparison, ratio and root tests without proof); Alternating series and Leibnitz test, absolute and conditional convergence.

Module 5 (Series representation of functions)

(Text 1: Relevant topics from sections 9.8, 9.9. Text 2: Relevant topics from sections 11.1, 11.2, 11.6)

Taylor series (without proof, assuming the possibility of power series expansion in appropriate domains), Binomial series and series representation of exponential, trigonometric, logarithmic functions (without proofs of convergence); Fourier series, Euler formulas, Convergence of Fourier series (without proof), half range sine and cosine series, Parseval's theorem (without proof).

Text Books

1. H. Anton, I. Biven,S.Davis, "Calculus", Wiley, 10th edition, 2015.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10thEdition, John Wiley & Sons, 2016.

Reference Books

1. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9 th Edition, Pearson, Reprint, 2002.
3. Peter V. O'Neil, Advanced Engineering Mathematics , Cengage, 7th Edition, 2012
4. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
5. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36 Edition, 2010.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Linear Algebra (10 hours)**	
1.1	Systems of linear equations, Solution by Gauss elimination	1
1.2	Row echelon form, finding rank from row echelon form, fundamental theorem for linear systems	3
1.3	Eigen values and eigen vectors	2
1.4	Diagonaliztion of matrices, orthogonal transformation, quadratic forms	4

	and their canonical forms.	
2	**Multivariable calculus-Differentiation (8 hours)**	
2.1	Concept of limit and continuity of functions of two variables, partial derivatives	2
2.2	Differentials, Local Linear approximations	2
2.3	Chain rule, total derivative	2
2.4	Maxima and minima	2
3	**Multivariable calculus-Integration (10 hours)**	
3.1	Double integrals (Cartesian)-evaluation	2
3.2	Change of order of integration in double integrals, change of coordinates (Cartesian to polar),	2
3.3	Finding areas and volumes, mass and centre of gravity of plane laminas	3
3.4	Triple integrals	3
4	**Sequences and series (8 hours)**	
4.1	Convergence of sequences and series, geometric and p-series	2
4.2	Test of convergence(comparison, ratio and root)	4
4.3	Alternating series and Leibnitz test, absolute and conditional convergence	2
5	**Series representation of functions (9 hours)**	
5.1	Taylor series, Binomial series and series representation of exponential, trigonometric, logarithmic functions;	3
5.2	Fourier series, Euler formulas, Convergence of Fourier series(Dirichlet's conditions)	3
5.3	Half range sine and cosine series, Parseval's theorem.	3

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B. Tech 2019 Regulations

Mathematics Minor

Curriculum & Syllabus

Minor in Mathematics - Basket of 5 courses

Curriculum

Sl.No.	Course Code	Course Name	Semester of Study
1	MAT281	Advanced Linear Algebra	S3
2	MAT282	Mathematical Optimization	S4
3	MAT381	Random Process and Queuing Theory	S5
4	MAT382	Algebra and Number Theory	S6
5	MAT481	Functional Analysis	S7

SEMESTER III

MINOR

CODE MAT 281	Advanced Linear Algebra	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course introduces the concept of a vector space which is a unifying abstract frame work for studying linear operations involving diverse mathematical objects such as n-tuples, polynomials, matrices and functions. Students learn to operate within a vector and between vector spaces using the concepts of basis and linear transformations. The concept of inner product enables them to do approximations and orthogonal projects and with them solve various mathematical problems more efficiently.

Prerequisite: A basic course in matrix algebra**.**

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify many of familiar systems as vector spaces and operate with them using vector space tools such as basis and dimension.
CO 2	Understand linear transformations and manipulate them using their matrix representations.
CO 3	Understand the concept of real and complex inner product spaces and their applications in constructing approximations and orthogonal projections
CO 4	Compute eigen values and eigen vectors and use them to diagonalize matrices and simplify representation of linear transformations
CO 5	Apply the tools of vector spaces to decompose complex matrices into simpler components, find least square approximations, solution of systems of differential equations etc.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	2	1			1	2		2
CO 2	3	3	3	3	2	1			1	2		2
CO 3	3	3	3	3	2	1			1	2		2
CO 4	3	2	3	2	1	1			1	2		2
CO 5	3	3	3	3	2	1			1	2		2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	10	10	20
Analyse	10	10	20
Evaluate	15	15	30
Create			

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Show that the $S_1 = \{(x, y, 0) \in R^3\}$ is a subspace of R^3 and $S_2 = \{(x, y, z) \in R^3 : x + y + z = 2\}$ is not a subspace of R^3

2. Let S_1 and S_2 be two subspaces of a finite dimensional vector space. Prove that $S_1 \cap S_2$ is also a subspace. Is $S_1 \cup S_2$ s subspace. Justify your answer.

3. Prove that the vectors $\{(1,1,2,4), (2, -1,5,2), (1, -1, -4,0), (2,1,1,6)\}$ are linearly independent

4. Find the null space of $A = \begin{bmatrix} 1 & 2 & 0 & -1 \\ 2 & 6 & -3 & -3 \\ 3 & 10 & -6 & -5 \end{bmatrix}$ and verify the rank nullity theorem for $m \times n$matrix in case of A

Course Outcome 2 (CO2)

1. Show that the transformation $T; R^2 \to R^3$defined by $T(x, y) = (x - y, x + y, y)$ is a linear transformation.

2. Determine the linear mapping $\varphi; R^2 \to R^3$ which maps the basis $(1,0,0), (0,1,0)$ and $(0,0,1)$to the vectors $(1,1), (2,3)$and$(-1,2)$. Hence find the image of $(1,2,0)$
3. Prove that the mapping $\varphi; R^3 \to R^3$ defined by $T(x, y, z) = (x + y, \quad y + z, z + x)$ is an isomorphism

Course Outcome 3(CO3):

1. Prove that the definition $f(u, v) = x_1y_1 - 2x_1y_2 + 5x_2y_2$for $u = (x_1, y_1)$ and $v = (x_2, y_2)$ is an inner product in R^2.

2. Prove the triangle inequality $\|u + v\| \leq \|u\| + \|v\|$ in any inner product space.

3. Find an orthonormal basis corresponding to the basis $\{1, tcost, sint\}$ of the subspace of the vector space of continuous functions with the inner product defined by $\int_0^\pi f(t)g(t)dt$ using Gram Schimdt process .

Course Outcome 4 (CO4):

1. Consider the transformation $T: R^2 \to R^2$ defined by $(x, y) = (x - y, 2x - y)$. Is T diagonalizable. Give reasons.

2. Use power method to find the dominant eigen value and corresponding eigen vector of $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 18 & -1 & -7 \end{bmatrix}$.

3. Prove that a square matrix A is invertible if and only if all of its eigen values are non-zero.

Course Outcome 5 (CO5):

1. Find a singular value decomposition of $\begin{bmatrix} 1 & -1 \\ -1 & 1 \\ 2 & -2 \end{bmatrix}$
2. Find the least square solution to the system of equations

$$x + 2y + z = 1, 3x - y = 2, 2x + y - z = 2, x + 2y + 2z = 1$$

3. Solve the system of equations $2x_1 + x_2 + x_3 = 2$,$x_1 + 3x_2 + 2x_3 = 2$, and $3x_1 + x_2 + 2x_3 = 2$ by LU decomposition method.

Syllabus

Module 1

Vector Spaces, Subspaces -Definition and Examples. Linear independence of vectors, Linear span, Bases and dimension, Co-ordinate representation of vectors. Row space, Column space and null space of a matrix

Module 2

Linear transformations between vector spaces, matrix representation of linear transformation, change of basis, Properties of linear transformations, Range space and Kernel of Linear transformation, Inverse transformations, Rank Nullity theorem, isomorphism

Module 3

Inner Product: Real and complex inner product spaces, properties of inner product, length and distance, Cauchy-Schwarz inequality, Orthogonality , Orthonormal basis, Gram Schmidt orthogonalization process. Orthogonal projection. Orthogonal subspaces, orthogonal compliment and direct sum representation.

Module 4

Eigen values, eigenvectors and eigen spaces of linear transformation and matrices, Properties of eigen values and eigen vectors, Diagonalization of matrices, orthogonal diagonalization of real symmetric matrices, representation of linear transformation by diagonal matrix, Power method for finding dominant eigen value,

Module 5

LU-decomposition of matrices, QR-decomposition, Singular value decomposition, Least squares solution of inconsistent linear systems, curve-fitting by least square method, solution of linear systems of differential equations by diagonalization

Text Books

1. Richard Bronson, Gabriel B. Costa, *Linear Algebra-an introduction,* 2nd edition, Academic press, 2007
2. Howard Anton, Chris Rorres, *Elementary linear algebra: Applications versio,* 9th edition, Wiley

References

1. Gilbert Strang, *Linear Algebra and It's Applications,* 4th edition, Cengage Learning, 2006
2. Seymour Lipschutz, Marc Lipson, *Schaum's outline of linear algebra*, 3rd Ed., Mc Graw Hill Edn.2017
3. David C Lay, *Linear algebra and its applications,3rd edition, Pearson*
4. Stephen Boyd, Lieven Vandenberghe, I*ntroduction to Applied Linear Algebra: Vectors, Matrices,and Least Squares,* Cambridge University Press, 2018
5. W. Keith Nicholson, *Linear Algebra with applications*, 4th edition, McGraw-Hill, 2002

Assignments:

Assignment should include specific problems highlighting the applications of the methods introduced in this course in science and engineering.

Course Contents and Lecture Schedule

No	**Topic**	**No. of Lectures**
1	**Vector spaces (9 hours)**	
1.1	Defining of vector spaces , example	2
1.2	Subspaces	1
1.3	Linear dependence, Basis , dimension	3
1.4	Row space, column space, rank of a matrix	2

1.5	Co ordinate representation	1
2	**Linear Mapping (9 hours)**	
2.1	General linear transformation, Matrix of transformation.	2
2.2	Kernel and range of a linear mapping	1
2.3	Properties of linear transformations,	2
2.4	Rank Nullity theorem.	1
2.5	Change of basis .	2
2.6	Isomorphism	1
3	**Inner product spaces (9 hours)**	
3.1	Inner Product: Real and complex inner product spaces,	2
3.2	Properties of inner product, length and distance	2
3.3	Triangular inequality, Cauchy-Schwarz inequality	1
3.4	Orthogonality, Orthogonal complement, Orthonormal bases,	1
3.5	Gram Schmidt orthogonalization process, orthogonal projection	2
3.6	Direct sum representation	1
4	**Eigen values and Eigen vectors (9 hours)**	
4.1	Eigen values and Eigen vectors of a linear transformation and matrix	2
4.2	Properties of Eigen values and Eigen vectors	1
4.3	Diagonalization., orthogonal diagonalization	4
4.4	Power method	1
4.5	Diagonalizable linear transformation	1
5	**Applications (9)**	
5.1	LU decomposition, QR Decomposition	2
5.2	Singular value decomposition	2
5.3	Least square solution	2
5.4	Curve fitting	1
5.5	Solving systems of differential equations.	2

SEMESTER IV

MINOR

CODE MAT 282	Mathematical optimization	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course introduces basic theory and methods of optimization which have applications in all branches of engineering. Linear programming problems and various methods and algorithms for solving them are covered. Also introduced in this course are transportation and assignment problems and methods of solving them using the theory of linear optimization.Network analysis is applied for planning, scheduling, controlling, monitoring and coordinating large or complex projects involving many activities. The course also includes a selection of techniques for non-linear optimization

Prerequisite: A basic course in the solution of system of equations, basic knowledge on calculus.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Formulate practical optimization problems as linear programming problems and solve them using graphical or simplex method.
CO 2	Understand the concept of duality in linear programming and use it to solve suitable problems more efficiently .
CO 3	Identify transportation and assignment problems and solve them by applying the theory of linear optimization
CO 4	Solve sequencing and scheduling problems and gain proficiency in the management of complex projects involving numerous activities using appropriate techniques.
CO 5	Develop skills in identifying and classifying non-linear optimization problems and solving them using appropriate methods.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	2	1			1	2		2
CO 2	3	3	3	3	2	1			1	2		2
CO 3	3	3	3	3	2	1			1	2		2
CO 4	3	2	3	2	1	1			1	2		2
CO 5	3	3	3	3	2	1			1	2		2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	10	10	20
Analyse	10	10	20
Evaluate	15	15	30
Create			

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question.

Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Without sketching find the vertices of the possible solutions of $-x + y \leq 1, 2x + y \leq 2\ ,\ x,\ y \geq 0$
2. Solve the LPP $Max\ 8x_1 + 9x_2$ subject to $2x_1 + 3x_2\ \leq 50\ ,\ 3x_1 + x_2 \leq 3\ ,x_1 + 3x_2 \leq 70\ ,\ x_1, x_2 \geq 0$ by simplex method
3. Solve the LPP $Max\ -x_1 + 3x_2$ subject to $x_1 + 2x_2\ \geq 2\ ,\ 2x_1 + 6x_2 \leq 80\ ,x_1 \leq 4\ ,\ x_1, x_2 \geq 0$ by Big M method.

Course Outcome 2 (CO2)

1. Formulate the dual of the following problem and show that dual of the dual is the primal $Max\ 5x_1 + 6x_2$ subject to $x_1 + 9x_2\ \geq 60\ ,\ 2x_1 + 3x_2 \leq 45\ ,\ x_1, x_2 \geq 0$
2. Using duality principle solve $Min\ 2x_1 + 9x_2 + x_3$ subject to $x_1 + 4x_2 + 2x_3\ \geq 5\ ,\ 3x_1 + x_2 + 2x_3\ \geq 4\ \ ,,\ x_1, x_2 \geq 0$
3. Use dual simplex method to solve $Min\ z = x_1 + 2x_2 + 4x_3$ subject to $2x_1 + 3x_2 - 5x_3\ \leq 2\ ,\ 3x_1 - x_2 + 6x_3\ \geq 1\ \ ,x_1 + x_2 + x_3\ \leq 3\ \ ,\ x_1 \geq 0\ x_2 \leq 0\ ,\ x_3$ unrestricted

Course Outcome 3(CO3):

1. Explain the steps involved in finding the initial basic solution feasible solution of a transportation problem by North West Corner rule..
2. A company has factories A, B and C which supply warehouses at W_1 , W_2 and W_3. Weekly factory capacities are 200, 160 and 90 units respectively. Weekly warehouse requirement are 180,120 and 150 respectively. Unit shipping cost in rupees is as follows

16	20	12
14	8	16
26	24	16

Determine the optimal distribution of this company to minimise the shipping cost

3. In a textile sales emporium, sales man A, B and C are available to handle W, X Y and Z. Each sales man can handle any counter . The service time in hours of each counter when manned by each sales man is as follows

	A	B	C	D
W	41	72	39	52
X	22	29	49	65
Y	27	39	60	51
Z	45	50	48	52

Course Outcome 4 (CO4):

1. Draw the network diagram to the following activities.

Activity	1-2	1-3	1-4	2-5	3-5	4-6	5-6
Time duration	2	4	3	1	6	5	7

2. The following table gives the activities in a construction project and other relevant information

Activity	1-2	1-3	1-4	2-5	3-5	4-6	5-6
Time duration	2	4	3	1	6	5	7

Find the free , total and independent float for each activity and determine the critical activities.

3. For a project given below find (i) the expected time for each activity (ii) T_E, T_L values of all events (iii) the critical path.

Task	A	B	C	D	E	F	G	H	I	J	K
Least time	4	5	8	2	4	7	8	4	3	5	6
Greatest time	6	9	12	6	10	15	16	8	7	11	12
Most likely time	5	7	10	4	7	8	12	6	5	8	9

Course Outcome 5 (CO5):

1. Consider the unconstrained optimization problem $max\ \ f(\boldsymbol{x}) = 2x_1x_2 + x_2 - {x_1}^2 - 2{x_2}^2$. Starting from the initial solution $(x_1, x_2) = (1{,}1)$ interactively apply gradient search procedure with $\in = 025$ to get an approximate solution.
2. Consider the following nonlinear programming problem.

$$Max\ f(\boldsymbol{x}) = \frac{1}{1+x_2} \text{ subject to } x_1 - x_2 \leq 2, x_1 \geq 0, . \ x_2 \geq 0$$

Use KKT condition to show that$(x_1, x_2) = (4, 2)$ is not an optimal solution

3. Minimize $f = -4x_1 + x_1^2 - 2x_1x_2 + 2x_2^2$ subject to $2\,x_1 +\ x_2\ \leq 6,\ \ x_1 - 4\,x_2 \leq 0, x_1 \geq 0,\ \ x_2 \geq 0$ using Quadratic programming method.

Syllabus

MODULE I

Linear Programming – 1 : Convex set and Linear Programming Problem – Mathematical Formulation of LPP, Basic feasible solutions, Graphical solution of LPP, Canonical form of LPP, Standard form of LPP, slack variables and Surplus variables, Simplex Method, Artificial variables in LPP, Big-M method.

MODULE II

Linear Programming – 2 : Two-phase method, Degeneracy and unbounded solutions of LPP, Duality of LPP, Solution of LPP using principle of duality, Dual Simplex Method.

MODULE III

Transportation and assignment problems: Transportation Problem, Balanced Transportation Problem, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method, Vogel's approximation method. MODI method. Assignment problem, Formulation of assignment problem, Hungarian method for optimal solution, Solution of unbalanced problem. Travelling salesman problem

MODULE IV

Sequencing and Scheduling : Introduction, Problem of Sequencing, the problem of n jobs and two machines, problem of m jobs and m machines, Scheduling Project management-Critical path method (CPM), Project evaluation and review technique (PERT), Optimum scheduling by CPM, Linear programming model for CPM and PERT.

MODULE V

Non Linear Programming: Examples nonlinear programming problems- graphical illustration**.** One variable unconstrained optimization, multiple variable unconstrained optimization- gradient search**.** The Karush –Kuhn Tucker condition for constraint optimization-convex function and concave function. Quadratic programming-modified simplex method-restricted entry rule, Separable programming.

Text Book

1. Frederick S Hillier, Gerald J. Lieberman, Introduction to Operations Research, Seventh Edition, McGraw-Hill Higher Education, 1967.
2. Kanti Swarup, P. K. Gupta, Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi, 2008.

Reference

1. Singiresu S Rao, Engineering Optimization: Theory and Practice ,New Age International Publishers, 1996
2. H A Taha, Operations research : An introduction , Macmillon Publishing company,1976
3. B. S. Goel, S. K. Mittal, Operations research, Pragati Prakashan, 1980
4. S.D Sharma, "Operation Research", Kedar Nath and RamNath - Meerut , 2008.
5. Phillips, Solberg Ravindran ,Operations Research: Principles and Practice, Wiley,2007

Assignments:

Assignment should include specific problems highlighting the applications of the methods introduced in this course in science and engineering.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Linear programming – I (9 hours)**	
1.1	Convex set and Linear Programming Problem – Mathematical Formulation of LPP	2
1.2	Basic feasible solutions, Graphical solution of LPP	2
1.3	Canonical form of LPP, Standard form of LPP, slack variables and Surplus variables, Artificial variables in LPP	1
1.4	Simplex Method	2
1.5	Big-M method.	2
2	**Linear programming – II (9 hours)**	
2.1	Two-phase method	2
2.2	Degeneracy and unbounded solutions of LPP	2
2.4	Duality of LPP	1
2.5	Solution of LPP using principle of duality	2

2.3	Dual Simplex Method.	2
3	**Transportation and assignment problems - (9 hours)**	
3.1	Balanced transportation problem	2
3.2	unbalanced Transportation problem	1
3.3	Finding basic feasible solutions – Northwest corner rule, least cost method	1
3.4	Vogel's approximation method. MODI method	2
3.5	Assignment problem, Formulation of assignment problem	1
3.6	Hungerian method for optimal solution, Solution of unbalanced problem. Travelling salesman problem	2
4	**Sequencing and Scheduling - (9 hours)**	
4.1	Introduction, Problem of Sequencing, the problem of n jobs and two machines	2
4.2	problem of m jobs and m machines	1
4.3	Scheduling Project management-Critical path method (CPM)	2
4.4	Project evaluation and review technique (PERT),	2
4.5	Optimum scheduling by CPM, Linear programming model for CPM and PERT.	2
5	**Non Linear Programming - (9 hours)**	
5.1	Examples , Graphical illustration, One variable unconstrained optimization	2
5.2	Multiple variable unconstraint optimization-- gradient search	2
	The Karush –Kuhn Tucker condition for constraint optimization	1
5.3	Quadratic programming-modified simplex method-	2
5.5	Separable programming	2

SEMESTER V

MINOR

CODE	Course Name	CATEGORY	L	T	P	CREDIT
MAT 381	RANDOM PROCESS AND QUEUEING THEORY	VAC	3	1	0	4

Preamble: This course introduces learners to the applications of probability theory in the modelling and analysis of stochastic systems, covering important models of random processes such as Poisson Process, Markov chain and queueing systems. The tools and models introduced here have important applications in engineering and are indispensable tools in signal analysis, reliability theory, network queues and decision analysis.

Prerequisite: A basic knowledge in calculus and matrix algebra.

Course Outcomes: After the completion of the course the student will be able to

CO1	Characterize phenomena which evolve probabilistically in time using the tools autocorrelation and power spectrum (Cognitive knowledge level: **Understand**).
CO2	Characterize stationary processes using ergodic property and analyse processes using poisson model wherever appropriate (Cognitive knowledge level: **Apply**).
CO3	Model and analyze random phenomena using discrete time Markov chains (Cognitive knowledge level: **Apply**).
CO4	Explain basic characteristic features of a queuing system and analyse queuing models (Cognitive knowledge level: **Apply**).
CO5	Analyse complex queueing systems by applying basic principles of queueing theory (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	2	2	2								2
CO 2	3	2	2	2								2
CO 3	3	2	2	2								2
CO 4	3	2	2	2						2		2
CO 5	3	2	2	2								2

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (%)		End Semester Examination (%)
	1	2	
Remember	20	20	20
Understand	35	35	35
Apply	45	45	45
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment - Test : 25 marks

Continuous Assessment - Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

MAT 381 - RANDOM PROCESS AND QUEUEING THEORY

Syllabus

Module 1 (Random processes and stationarity)

Random processes-definition and classification, mean, autocorrelation, stationarity-strict sense and wide sense, properties of autocorrelation function of WSS processes.

Power spectral density of WSS processes and its properties- relation to autocorrelation function. White noise.

Module 2 (Poisson processes)

Ergodic processes-ergodic in the mean and autocorrelation. Mean ergodic theorems (without proof).

Poisson processes-definition based on independent increments and stationarity, distribution of inter-arrival times, sum of independent Poisson processes, splitting of Poisson processes.

Module 3 (Markov chains)

Discrete time Markov chain -Transition probability matrix, Chapman Kolmogorov theorem (without proof), computation of probability distribution, steady state probabilities. Classification of states of finite state chains , irreducible and ergodic chains.

Module 4 (Queueing theory-I)

Queueing systems, Little's formula (without proof), Steady state probabilities for Poisson queue systems, M/M/1 queues with infinite capacity and finite capacity and their characteristics-expected number of customers in queue and system, average waiting time of a customer in the queue and system

Module 5 (Queueing theory-II)

Multiple server queue models, M/M/s queues with infinite capacity, M/M/s queues with finite capacity-in all cases steady state distributions and system characteristics-expected number of customers in queue and system, average waiting time of a customer in the queue and system

Books

1. Alberto leon Garciai, Probability and random processes for electrical engineering, Pearson Education, Second edition
2. V Sundarapandian, Probability statistics and queueing theory, Prentice-Hall Of India.

Assignments

Assignments should include specific problems highlighting the applications of the methods introduced in this course in physical sciences and engineering.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the various classes of random processes? Explain with examples
2. Consider the random process $X(t) = acos(\omega t + \Theta)$ where $a$and $\omega$are constants and Θ is a random variable uniformly distributed in $(0,2\pi)$. Show that $X(t)$is WSS.
3. If $X(t)$ is a wide sense stationary process with autocorrelation function $R_X(\tau) = 3 + 9e^{-3|\tau|}$, find the mean, variance and average power of the process.
4. Given that a random process $x(t)$ has power spectral density $S_X(\omega) = \dfrac{1}{1 + \omega^2}$of a WSS process, find the average power of the process.

Course Outcome 2 (CO2)

1. Give one example each of a process which is (i) ergodic (ii) non-ergodic.
2. Derive the mean, autocorrelation and autocovariance of a Poisson process.
3. Suppose that customers arrive at a bank according to a Poisson process with a mean rate of 20 per hour. Find the probability that during a time interval of 10 minutes (i) exactly 3 customers arrive (ii) more than 3 customers arrive.
4. Prove that the inter-arrival time of a Poisson process follows an exponential distribution.

Course Outcome 3(CO3):

1. Give an example of a discrete time Markov process
2. Consider the experiment of sending a sequence of messages across a communication channel. Due to noise, there is a small probability p that the message may be received in error. Let X_n denote the number of messages received correctly up to and including the n-th transmission. Show that $X_n$is a homogeneous Markov chain. What are the transition probabilities?
3. Find the steady state probability distribution of a Markov chain with transition probability matrix

$$P = \begin{bmatrix} 0.2 & 0.3 & 0.5 \\ 0.1 & 0.6 & 0.3 \\ 0.4 & 0.3 & 0.3 \end{bmatrix}$$

4. Three boys A, B, C are throwing a ball to each other. A always throws the ball to B and B always throws the ball to C, but C is as likely to throw the ball to B as to A. Show that the process is Markovian. Find the transition probability matrix and classify the states.

Course Outcome 4(CO4):

1. What are the basic characteristics of a queueing system
2. Derive the expressions for the steady state probability distribution of a Poisson queueing system
3. A concentrator receives messages from a group of terminals and transmits them over a single transmission line. Suppose that messages arrive according to a Poisson process at a rate of 1 message every 4 milliseconds, and suppose that message transmission times are exponentially distributed with mean 3 ms. Find the mean number of messages in the system and the mean total delay in the system. What percentage increase in the arrival rate results in doubling of the above mean total delay.
4. Patients arrive at a doctor's clinic according to Poisson distribution at a rate of 30 per hour. The waiting room does not accommodate more than 9 patients. Examination time per patient is exponential with a mean rate of 20 per hour. Find the probability that an arriving patient will have to go back because the waiting room is full.

Course Outcome 5 (CO5):

1. Obtain the steady state probability distribution of an M/M/s queueing system with infinite capacity.
2. A company has four printers to handle the print jobs arriving at a server. Suppose that print jobs arrive according to a Poisson process at a rate of one job every 2 minutes, and suppose the printing durations are exponentially distributed with mean 4 minutes. When all printers are busy the system queues the call requests until a line becomes available. Find the probability that a print job will have to wait.
3. How will you model the mean arrival rate and mean service rate in a Poisson queueing system with 4 servers and capacity limited to 5?
4. A dispensary has two doctors and four chairs in the waiting room. The patients who arrive at the dispensary leave if they find all the chairs occupied. Patients arrive at an average rate of 8 per hour and spend an average of 10 minutes for their check-up. The arrival process is assumed to be Poisson and the service times are exponential. Find the probability that an arriving patient will not have to wait. What is the expected waiting time of a patient in the queue?

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Course Code: MAT381

Course Name: Random process and queueing theory

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks Marks

1 What are the various classes of random processes? Give examples (3)

2 Consider the random process $X(t) = c$ where c is a constant. Is it SSS? WSS? (3)

3 Explain the terms mean-ergodic process, correlation ergodic process (3)

4 Find the autocorrelation of a Poisson process (3)

5 A fair die is tossed repeatedly and let X_n denote the maximum of the numbers obtained upto the n-th toss. Is X_n a Markov chain? Justify. (3)

6 Prove that if P is a Markov matrix then P^2 is also a Markov matrix (3)

7 What do the letters in the symbolic representation (a/b/c): (d/e) of a queueing model represent? (3)

8 What are the conditions for a M/M/1 queueing system to have a steady state distribution? (3)

9 Find the probability that an arriving customer is forced to join the queueing system M/M/s. (3)

10 A two-server queueing system is in a steady state condition and the steady state probabilities are $p_0 = \frac{1}{16}$, $p_1 = \frac{4}{16}$, $p_2 = \frac{6}{16}$, $p_3 = \frac{4}{16}$, $p_4 = \frac{1}{16}$ and $p_n = 0$ if $n > 4$. Find the mean number of customers in the system and in the the queue. (3)

PART B

Answer any one full question from each module. Each question carries 14 marks

Module 1

11 (a) Show that the mean of a first order stationary random process is a constant. (7)

(b) Consider the random process $X(t) = Acos(\omega t)$ where $\omega$is a constant and $A$is a random variable uniformly distributed in $(0,2\pi)$. Find the mean and autocorrelation of Is $X(t)$. Is it stationary? Justify. . (7)

12 (a) Find the mean and variance of a WSS process with autocorrelation function $R_X(\tau) = 1 + 4e^{-3|\tau|}$. (7)

(b) Let X(t) and Y(t) be both zero-mean, uncorrelated WSS random processes. Consider the random process Z(t) defined by .Determine the autocorrelation function and the power spectral density ofZ(t) (7)

Module 2

13 (a) Using mean ergodic theorem show that a constant random process $X(t) = C$, where C is a random variable with mean $\mu$and variance σ^2 , is not mean ergodic. (7)

(b) Patients arrive at the doctor's office according to a Poisson process with rate $\lambda = \frac{1}{10}$ minute. The doctor will not see a patient until at least three patients are in the waiting room. Find the expected waiting time until the first patient is admitted to see the doctor. (7)

14 (a) The number of telephone calls arriving at a certain switch board within a time interval of length measured in minutes is a Poisson process with parameter $\lambda = 2$. Find the probability of (6)

(i) No telephone calls arriving at this switch board during a 5 minute period.

(ii) More than one telephone calls arriving at this switch board during a given $\frac{1}{2}$minute period.

(b) Let $X(t)$ be a Poisson process with rate λ . Find (8)

(i) $E[X^2(t)]$

(ii) $E\{[X(t) - X(s)]^2\}$ for $t > s$.

Module 3

15 The transition probability matrix of a Markov chain $\{X_n, n \geq 0.\}$ with three state 1,2 and 3 is (14)

$$\begin{bmatrix} 0.5 & 0.3 & 0.2 \\ 0.4 & 0.2 & 0.4 \\ 0.1 & 0.6 & 0.3 \end{bmatrix}$$

and the initial probability distribution is $p(0) = [0.5\ 0.3\ 0.2]$. FInd

(a) $P\{X_2 = 2\}$

(b) $P\{X_3 = 3, X_2 = 2, X_1 = 1, X_0 = 3\}$

16 Let $\{X_n;\ n = 1,2,3,...\}$be a discrete time Markov Chain with state space $S = \{0,1,2\}$and one step transition probability matrix given by (14)

$$P = \begin{bmatrix} 0 & 1 & 0 \\ 0.25 & 0.5 & 0.25 \\ 0 & 1 & 0 \end{bmatrix}$$

(a) Is the chain ergodic? Explain.

(b) Find the invariant probabilities.

Module 4

17 (a) Find the mean number of customers in the queue, system, average waiting time in the queue and system of M/M/I queueing model with infinite capacity. (8)

(b) A T.V repairman finds that the time spent on his job has an exponential distribution with mean 30 minutes. He repairs the sets in the order in which they came in. The arrival of sets is approximately Poisson with an average rate of 10 per 8 hours a day. (6)

(i) Find the repairman's expected idle time each day.

(ii) Find the average number of jobs he handles on a given day.

18 Customers arrive at a one-window drive-in bank according to a Poisson distribution, with a mean of 10 per hour. The service time per customer is exponential, with a mean of 5 minutes. There are three spaces in front of the window, including the car being served. Other arriving cars line up outside this 3-car space. (14)

(a) What is the probability that an arriving car can enter one of the 3-car spaces?

(b) What is the probability that an arriving car will wait outside the designated 3-car space?

(c) How long is an arriving customer expected to wait before starting service?

(d) How many car spaces should be provided in front of the window (including the car being served) so that an arriving car can find a space there at least 90% of the time?

Module 5

19 A telephone exchange has two long distance operators. It is observed that long distance calls arrive in a Poisson fashion at an average rate of 15 per hour. The length of service on these calls is approximately exponential distributed with mean length 2 minutes. Find (14)

(i) the probability a subscriber will have to wait for a long distance call,

(ii) the expected number of customers in the system,

(iii) the expected number of customers in the queue,

(iv) the expected time a customers spends in the system and

(v) the expected waiting time for a customer in the queue.

20 A dispensary has two doctors and four chairs in the waiting room. The patients who arrive at the dispensary leave when all four chairs in the waiting room of the dispensary are occupied. It is known that the patients arrive at the average rate of 8 per hour and spend an average of 10 minutes for their check-up and medical consultation. The arrival process is Poisson and the service time is an exponential random variable. Find (14)

(i) the probability that an arriving patient will not wait,

(ii) the effective arrival rate at the dispensary,

(iii) the expected number of patients at the queue,

(iv) the expected waiting time of a patient at the queue,

(v) the expected number of patients at the dispensary and

(vi) the expected time a patient spends at the dispensary.

Teaching Plan

No	Topic	No. of Lectures
1	**Random processes and stationarity**	**9 hours**
1.1	Random-process, classification,	1
1.2	Mean, variance, autocorrelation, autocovariance	1
1.3	Strict sense stationary processes	1
1.4	WSS processes (Lecture 1)	1
1.5	WSS processes (Lecture 2)	1
1.6	Properties of autocorrelation of a WSS process	1
1.7	Power spectral density, relation to autocorrelation	2
	Delta function, white noise	1
2	**Ergodicity, Poisson process**	**9 hours**
2.1	Ergodic property, definition, examples	1
2.2	Mean ergodic theorems and applications (Lecture 1)	1
2.3	Mean ergodic theorems and applications (Lecture 2)	1
2.4	Poisson process-independent increments, stationarity (Lecture 1)	1
2.5	Poisson process-independent increments, stationarity (Lecture 2)	1
2.6	Mean, variance, autocorrelation, autocovariance of Poisson process	1
2.7	Distribution of inter-arrival times	1
2.8	Splitting (thinning) of Poisson processes	1
2.9	Merging of Poisson process	1
3	**Discrete time Markov chains**	**9 hours**
3.1	Discrete time Markov chain-memorylessness, examplesition probability matrix, Chapman-Kolmogorov theorem	1
3.2	Transition probabilities and transition matrices	1
3.3	Chapman-Kolmogorov theorem and applications	1
3.4	Computation of transient probabilities (Lecture 1)	1
3.5	Computation of transient probabilities (Lecture 2)	1
3.6	classification of states of finite-state chains, irreducible and ergodic chains (Lecture 1)	1
3.7	classification of states of finite-state chains, irreducible and ergodic chains (Lecture 2)	1
3.8	Steady state probability distribution of ergodic chains (Lecture 1)	1

3.9	Steady state probability distribution of ergodic chains (Lecture 2)	1
4	**Queueing theory 1**	**9 hours**
4.1	Basic elements of Queueing systems, Little’s formula,	1
4.2	Steady state probabilities for Poisson queue systems (Lecture 1)	1
4.3	Steady state probabilities for Poisson queue systems (Lecture 2)	1
4.4	M/M/1 queues with infinite capacity, steady state probabilities	1
4.5	M/M/1 queues with infinite capacity- computating system characteristics (Lecture 1)	1
4.6	M/M/1 queues with infinite capacity- computating system characteristics (Lecture 2)	1
4.7	M/M/1 queues with finite capacity, steady state probabilities	1
4.8	M/M/1 queues with finite capacity- computating system characteristics (Lecture 1)	1
4.9	M/M/1 queues with finite capacity- computating system characteristics (Lecture 2)	1
5	**Queueing theory II**	**9 hours**
5.1	Basic elements of multiple server queues	1
5.2	M/M/s queues with infinite capacity, steady state probabilities (Lecture 1)	1
5.3	M/M/s queues with infinite capacity, steady state probabilities (Lecture 2)	1
5.4	M/M/s queues with infinite capacity- computing system characteristics (Lecture 1)	1
5.5	M/M/s queues with infinite capacity- computing system characteristics (Lecture 2)	1
5.6	M/M/s queues with finite capacity, steady state probabilities (Lecture 1)	1
5.7	M/M/s queues with finite capacity, steady state probabilities (Lecture 2)	1
5.8	M/M/s queues with finite capacity- computing system characteristics (Lecture 1)	1
5.9	M/M/s queues with finite capacity- computing system characteristics (Lecture 2)	1

SEMESTER VI

MINOR

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MAT382	ALGEBRA AND NUMBER THEORY	VAC	3	1	0	4

Preamble: This is an introductory course in algebra and number theory with special emphasis on applications including RSA, prime factorization and the interplay between rings and numbers.

Prerequisite: A basic understanding of set theory and logic.

Course Outcomes: After the completion of the course the student will be able to

CO1	Solve number theoretic problems by applying the concept and properties of natural numbers and applications of division algorithm and related results (Cognitive knowledge level: **Apply**).
CO2	Utilise the concepts and properties learned about prime numbers and basic factorisation algorithms to solve number theoretic problems (Cognitive knowledge level: **Apply**).
CO3	Solve algebraic problems using the concepts and properties of groups and group structures (Cognitive knowledge level: **Apply**).
CO4	Utilise the concept, properties and applications of cyclic groups, permutations and symmetric groups to solve algebraic problems (Cognitive knowledge level: **Apply**).
CO5	Solve algebraic problems using the concept, properties and applications of rings and ring structures (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2								2
CO2	3	2	2	2								2
CO3	3	2	2	2								2
CO4	3	2	2	2								2
CO5	3	2	2	2								2

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern:

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	35	35	70
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment - Test : 25 marks

Continuous Assessment - Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1 (Elementary Number Theory)

Division with remainder, congruences, greatest common divisor, Euclidean algorithm, Chinese remainder theorem, Euler's theorem **(**Sections 1.2-1.7)

Module 2 (Prime Numbers)

Prime Numbers- basic results, unique factorisation, computing Euler $\varphi -$ function, RSA explained, Fermat's little theorem, pseudoprimes, Algorithms for prime factorisation- Fermat's and Fermat-Kraitchik algorithms (evaluation only), Quadratic residues. **(**Relevant topics from sections 1.8-1.11)

Module 3 (Introduction to Groups)

Groups- Definition- basic properties and examples, subgroups and cosets, normal subgroups, group homomorphisms. Isomorphism theorem (Sections 2.1- 2.5)

Module 4 (Further topics in Group theory)

Order of a group element, Cyclic groups, symmetric groups, cycles, simple transpositions and bubble sort, alternating groups. (Sections 2.6-2.7, 2.9.1, 2.9.2, 2.9.3)

Module 5 (Ring Theory)

Rings- Definition, ideals, principal ideal domain, Quotient rings, Prime and maximal ideals, Ring homomorphisms, unique factorisation domain, irreducible and prime elements, Euclidean domain. (Sections 3.1, 3.2, 3.3, 3.3.1, 3.5.1-3.5.4)

Text Book

Niels Lauritzen, "Concrete Abstract Algebra", Cambridge University Press,2003

Reference Books

1. David M Burton, "Elementary Number Theory", 7th edition, McGraw Hill, 2011
2. John B Fraleigh, "A first course in Abstract Algebra". 7th edition, Pearson Education India, 2013
3. Joseph A Gallian, "Contemporary Abstract Algebra", 9th edition, Cengage Learning India Pvt. Ltd

Assignments

Assignments should include specific problems highlighting the applications of the methods introduced in this course in physical sciences and engineering.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Find the remainder of 2^{340} after division by 341 using repeated squaring algorithm.
2. What is the smallest natural number that leaves a remainder of 2 when divided by 3 and a remainder of 3 when divided by 5 ?

Course Outcome 2 (CO2)

1. Find a prime factorization of 2041 using Fermat Kraitchik algorithm.
2. What is the product of the greatest common divisor and least common multiple of 2 numbers ?

Course Outcome 3(CO3):

1. Write down the subgroups of Z/8Z.
2. Show that every subgroup of an abelian group is normal.

Course Outcome 4(CO4):

1. Prove that $(Z/13Z)^*$ is a cyclic group.
2. Write $\sigma = \begin{pmatrix} 1 & 2 & 3 & 4 & 5 & 6 \\ 6 & 5 & 4 & 3 & 2 & 1 \end{pmatrix} \in S_6$ as a product of the minimal number of simple transpositions.

Course Outcome 5 (CO5):

1. Write down the units of Z/8Z .
2. Show that $Z\left[\sqrt{-6}\ \right]$ is not a Unique Factorisation Domain .

Model Question Paper

APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH. DEGREE

EXAMINATION (MONTH & YEAR)

Course Code: MAT382

Course Name: ALGEBRA AND NUMBER THEORY

MAX.MARKS: 100 DURATION: 3 Hours

PART A

Answer all questions, each question carries 3 marks.

1. Find the remainder when 2^{50} is divided by 7.
2. Prove that if $a|bc$ with $gcd(a,b) = 1$, then $a|c$.
3. Prove that there exists infinitely many prime numbers.
4. Prove that 25 is a strong pseudoprime relative to 7.
5. Prove that a group has only one idempotent element.
6. Find all the subgroups of $\mathbb{Z}/6\mathbb{Z}$.
7. Write down all the elements of order 7 in $\mathbb{Z}/28\mathbb{Z}$.
8. Find the generators of $\mathbb{Z}_{18}$.
9. Find a zero divisor in $\mathbb{Z}_5[i] = \{a + ib : a, b \in \mathbb{Z}_5\}$.
10. Write down all the maximal ideals in $\mathbb{Z}_{10}$.

PART B

Answer any one full question from each module, each question carries 14 marks.

Module-I

11. (a) Compute $\lambda, \mu \in \mathbb{Z}$ such that $89\lambda + 55\mu = 1$ and find all solutions $x \in \mathbb{Z}$ to $89x \cong 7mod(55)$.

(b) Solve the system of simultaneous congruences $x \cong 2(mod3),\ x \cong 3(mod5), x \cong 2(mod7)$.

12. (a) Suppose $a, b \in \mathbb{N}$ such that $gcd(a, b) = 1$. Prove that $gcd(a^m, b^n) = 1$, for $m, n \in \mathbb{N}$

(b) Use Euclidean algorithm to find integers x and y satisfying
$gcd(1769{,}2378) = 1769x + 2378y$

Module – II

13. (a) Using Fermat's factorization method factorise $2^{11} - 1$.

(b) Decrypt the cipher text 1030 1511 0744 1237 1719 that was encrypted using the
RSA algorithm using the public key $(N, e) = (2623{,}869)$.

14. (a) Determine the quadratic residues and non-residues modulo 13.

(b) Show that $\varphi(n) = \varphi(2n)$, if n is odd.

Module-III

15. (a) Prove that $GL_2(\mathbb{R})$ is a non abelian group.

(b) Let $\varnothing\colon\ S_n \rightarrow \mathbb{Z}_2$ defined by $\varnothing(\sigma) = \begin{cases} 0, \text{ if } \sigma \text{ is even} \\ 1, \text{ if } \sigma \text{ is odd} \end{cases}$. Prove that $\varnothing$ is a homomorphism.
Also find Ker $\varnothing$.

16. (a) Show that every subgroup of an abelian group is normal.

(b) Let $\varnothing\colon\ G \rightarrow G'$ where G and G' are groups. Prove that $\varnothing$ is an isomorphism if and only if Ker $\varnothing = \{e\}$.

Module-IV

17. (a) Prove that an even permutation cannot be the product of an odd number of transpositions

(b) Show that every permutation $\sigma \in S_n$ is a product of unique disjoint cycles.

18. (a) Show that if σ is a cycle of odd length then σ^2 is a cycle.

(b) Check whether $(\mathbb{Q}\backslash\{0\},\ .)$ is a cyclic group.

Module- V

19. (a) Show that every field is a domain. Is the converse of the statement true ? Justify.

(b) Write all the units of the Gaussian integers $\mathbb{Z}$ [i].

20. (a) Prove that every principal ideal domain is a unique factorisation domain.

(b) Let R be a non-commutative ring. Prove that R/P is a domain if P is a prime ideal.

Teaching Plan		
Sl. No	**Topic**	**No. Of Lecture Hours**
1	**Elementary Number Theory**	**8 Hours**
1.1	Division with remainder	1
1.2	Congruence	1
1.3	Properties of Congruence	1
1.4	Greatest Common divisor	1
1.5	Euclidean algorithm	1
1.6	Relatively prime numbers	1
1.7	Chinese Remainder Theorem	1
1.8	Euler's Theorem	1
2	**Prime Numbers**	**9 Hours**
2.1	Basic Results	1
2.2	unique factorisation	1
2.3	Computing $\varphi-$function	1
2.4	RSA explained	1
2.5	Fermat's Little theorem, Pseudoprimes	1
2.6	Factorisation algorithms- Fermat's algorithm	1
2.7	Fermat-Kraitchik algorithm	1
2.8	Quadratic residue	1
2.9	Quadratic residue applications	1
3	**Introduction to Groups**	**9 Hours**
3.1	Definition	1
3.2	Basic Properties	1
3.3	Examples	1
3.4	Subgroups	1
3.5	Cosets	1

3.6	Normal Subgroups	1
3.7	Quotient Groups	1
3.8	Group homomorphisms	1
3.9	Isomorphism theorem	1
4	**Further topics in Group Theory**	**9 Hours**
4.1	Order of a group element	1
4.2	Cyclic Groups	1
4.3	Properties	1
4.4	Symmetric groups	1
4.5	Cycles	1
4.6	Properties	1
4.7	Simple transpositions	1
4.8	Bubble sort	1
4.9	Alternating groups	1
5	**Ring Theory**	**9 Hours**
5.1	Definition, basic properties,	1
5.2	ideals	1
5.3	Quotient rings	1
5.4	Prime and Maximal ideals	1
5.5	Ring homomorphisms,	1
5.6	Unique factorisation	1
5.7	Irreducible elements	1
5.8	prime elements	1
5.9	Euclidean domain	1

SEMESTER VII

MINOR

MAT481	**FUNCTIONAL ANALYSIS**	**Category**	**L**	**T**	**P**	**CREDIT**	**YEAR OF INTRODUCTION**
		VAC	**3**	**1**	**0**	**4**	**2019**

Preamble: This course will cover the foundations of functional analysis in the context of basic real analysis, Metric spaces, Banach spaces and Hilbert spaces. Students learn various types of distances and associated results in these spaces. The important notion of linear functionals and duality will be developed in Banach space. An introduction to the concept of orthonormal sequences in Hilbert spaces enables them to efficiently handle with a variety of applications in engineering problems.

Prerequisite: Basic knowledge in set theory and linear algebra

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the concept and analytical properties of the real number system (Cognitive knowledge level: **Understand**).
CO2	Illustrate the concept of metric space and discuss the properties interior, closure, denseness and separability in a metric space (Cognitive knowledge level: **Understand**).
CO3	Explain the concepts of Cauchy sequence, completeness and Banach spaces and apply these concepts to metric and Banach spaces (Cognitive knowledge level: **Apply**).
CO4	Demonstrate the concepts of linear operator, linear functional, dual basis and dual space of normed linear spaces (Cognitive knowledge level: **Understand**).
CO5	Explain the notions of inner product and Hilbert space and apply the tools to construct orthonormal sequences in Hilbert spaces (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			2					1	2		2
CO2	3	3	2	2					1	2		2
CO3	3	3	2	2					1	2		2
CO4	3	3	2	2					1	2		2
CO5	3	3	2	2					1	2		2

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(%)		End Semester Examination(%)
	1	2	
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyse			
Evaluate			
Create			

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment - Test	: 25 marks
Continuous Assessment - Assignment	: 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1 (Real Analysis) (9 hours)

(Text 1 - Relevant topics from sections 1.3, 2.3, 3.1, 3.2, 3.3, 3.4, 3.5, 8.1)

Denumerable set, Countable set, Supremum and Infimum of a set, Sequence of real numbers, Convergent and Divergent sequence, Limit, Bounded sequence, Monotone sequence, Monotone convergence Theorem(without proof), Subsequence, Bolzano-Weierstrass theorem(without proof) , Cauchy sequence, Cauchy convergence criterion, Sequence of functions, Pointwise convergence, Uniform convergence, Uniform norm

Module 2 (Metric Space) (9 hours)

(Text 2 - Relevant topics from sections 1.1, 1.2, 1.3, 1.4[1.4-1 to 1.4- 2])

Metric Space: $\mathbb{R}^n, \mathbb{C}^n, l^\infty, C[a,b]$, Discrete space, Sequence space, B(A), l^p, Subspace, Holder inequality (without proof), Cauchy- Schwarz inequality (without proof), Minkowski inequality (without proof), Open set, Closed set, Neighbourhood, Interior, Continuous function, Accumulation point, Closure, Dense set, Separable space, Convergence of sequence, Limit, Bounded sequence.

Module 3 (Complete Metric Space and Normed space) (8 hours)

(Text 2 - Relevant topics from sections 1.4[1.4-3 to 1.4-8], 1.5, 2.1, 2.2)

Cauchy sequence in a metric space, Complete Metric Space, Completeness of $\mathbb{R}^n, \mathbb{C}^n, l^\infty, C[a,b]$, Convergent Sequence space, l^p, Examples of incomplete metric spaces, Vector space with examples, Normed space, Banach space: $\mathbb{R}^n, \mathbb{C}^n, l^\infty, C[a,b]$, Metric induced by norm, Examples of incomplete normed spaces

Module 4 (Space of Functionals and Operators) (9 hours)

(Text 2 - Relevant topics from sections 2.3, 2.6, 2.7, 2.8, 2.9, 2.10)

Properties of Normed Spaces ,Subspaces , Closed subspace, Schauder basis, Linear Operator, Range , Null space, Bounded Linear Operator, Norm of an operator, Linear operator on a finite dimensional space, Continuous linear operator, Relation between bounded and continuous operators, Linear functional, bounded linear functional, Algebraic dual space, Dual basis, Space B(X,Y) , Completeness of B(X,Y)(without proof), Dual space X' , Examples of dual space

Module - 5 (Hilbert Spaces) (10 hours)

(Text 2 - Relevant topics from sections 3.1, 3.2, 3.3, 3.4)

Inner Product Space, Hilbert Space, Parallelogram equality, Orthogonality, Examples of Hilbert Spaces – $\mathbb{R}^{\mathrm{n}}$, $\mathbb{C}^n$, l^2, Examples of Non-Hilbert spaces - l^p with $p \neq 2$, $C[a,b]$, Polarization identity, Further properties of inner product spaces - Schwartz inequality, Triangle inequality, Continuity of inner product, Subspace of an inner product space and Hilbert Space, Subspace Theorem, Convex set, Minimizing vector Theorem (without proof), Orthogonality Lemma (without proof), Direct sum, Orthogonal complement, Direct sum Theorem, Orthogonal projection, Null space Lemma, Closed subspace Lemma, Dense set Lemma, Orthonormal sets and sequences, Examples and properties, Bessel inequality, Gram-Schmidt process (without proof).

Text Book

1. Robert G. Bartle and Donald R. Sherbert, Introduction to Real Analysis, JohnWiley & Sons, Inc., 4th Edition, 2011.
2. Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wiley & Sons (Asia) Pte Ltd.

Reference Books

1. Ajit Kumar, S. Kumaresan, A Basic Course in Real Analysis, CRC Press.
2. Herbert S. Gaskill, P P Narayanaswami, Elements of Real Analysis, Pearson.
3. Hiroyuki Shima, Functional Analysis for Physics and Engineering – An introduction, CRC Press, Taylor & Francis Group.
4. Balmohan V. Limaye, Linear Functional Analysis for Scientists and Engineers, Springer, Singapore, 2016.
5. Rabindranath Sen, A First Course in Functional Analysis- Theory and Applications, Anthem Press - An imprint of Wimbledon Publishing Company.
6. M. Tamban Nair, Functional Analysis- A first course, Prentice Hall of India Pvt. Ltd.

Assignments

Assignments should include specific problems highlighting the applications of the methods introduced in this course in science and engineering.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Show that set of odd numbers greater than 10 is countable by finding a bijection
2. Show that $\lim_{n\to\infty}\left(\frac{2n}{n+1}\right) = 2$, by using the definition$[\epsilon - K(\epsilon)]$ of limit
3. State Bolzano-Weierstrass theorem

Course Outcome 2 (CO2)

1. Let $X = \mathbb{R}^2, x = (x_1, x_2), y = (y_1, y_2) \in X$. Define $d(x, y) =\mid x_1 - y_1 \mid$. Check whether d is a metric on X?
2. Show that $A = \{(x, y) \in \mathbb{R}^2/x^2 + y^2 < 2y\}$ is open in $\mathbb{R}^2$ under the Euclidean metric.
3. Suppose $f : X \longrightarrow Y$ is a constant function between metric spaces, say $f(x) = y_0$ for all $x \in X$. Show that f is continuous.

Course Outcome 3 (CO3)

1. Show that l^∞ is a complete metric space
2. Let X be the set of all integers and $d(x, y) = |x - y|$. Show that (X, d) is a complete metric space.
3. Prove that $C[a, b]$ is vector space

Course Outcome 4 (CO4)

1. If T is a linear operator, then show that range $R(T)$ is a vector space
2. Find the dual basis of the basis $\{(1, 0, 0), (0, 1, 0), (0, 0, 1)\}$ for $\mathbb{R}^3$
3. Show that $f(x) = \sup_{t\in J} x(t)$, where $J = [a, b]$ defines a linear functional on $C[a, b]$. Does it bounded?

Course Outcome 5 (CO5)

1. Show that every inner product space V is a normed space.
2. If x, y are two elements in a Hilbert space with $\| x \| = 2, \| y \| = 3$ and $\| x + y \| = 5$, then find the value of $\| x - y \|$?
3. Construct an orthonormal sequence of vectors $\{e_1, e_2, e_3\}$ in the Hilbert space $\mathbb{R}^3$ using the sequence of vectors $\{x_1, x_2, x_3\}$ where $x_1 = (1, 1, 1), x_2 = (0, 1, 1), x_3 = (0, 0, 1)$

Model Question Paper

No. of Pages: QP CODE

Reg No:_______________ Name:_______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH (MINOR) DEGREE EXAMINATION, MONTH & YEAR

Course Code: MAT481

Course Name: Functional Analysis

Max. Marks: 100 **Duration: 3 hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Let $S = \left\{ 1 - \frac{1}{n} \ / \ n \in \mathbb{N} \right\}$. Find infimum and supremum of S.
2. Show that a sequence in $\mathbb{R}$ can have at most one limit
3. Does $d(x, y) = |x - y|$ define a metric on $\mathbb{R}$? Justify.
4. Show that $A^\circ = A$, for any subset A of a discrete metric space (X, d). [A° : Interior of A]
5. Define metric induced norm and give an example
6. Show that $C[a, b]$ is a vector space
7. If T is a linear operator, then show that null space $N(T)$ is a vector space
8. Find a Schauder basis for the normed space l^2. Justify
9. Let V be the vector space of polynomials with inner product defined by $\langle f, g\rangle = \int_0^1 f(t)g(t)\,dt$, where $f(t) = t + 2,\ g(t) = 3t - 2$. Find $\|f - g\|$.
10. Define orthogonal complement $Y^\perp$ in a Hilbert space H. Also show that $Y^\perp$ is a subspace of H

PART B

Answer any one full question from each module

Module-1

11. (a) Show that convergent sequence of real numbers is bounded (7)

    (b) Check whether the sequence $(x^2 e^{-nx})$ converges uniformly on $[0, \infty)$. Justify (7)

OR

12. (a) Show that the set $\mathbb{Q}$ of all rational numbers is denumerable (7)

    (b) Prove that a sequence (f_n) of bounded functions on $A \subseteq \mathbb{R}$ converges uniformly on A to f if and only if $sup\{|f_n(x) - f(x)|/x \in A\} \longrightarrow 0$ (7)

Module-2

13. (a) If (X,d) is any metric space, show that $d_1 = \frac{d(x,y)}{1+d(x,y)}$ is also a metric on X. (7)

    (b) Let (X,d) be a metric space and A, B be subsets of X. Show that $\overline{A \cup B} = \overline{A} \cup \overline{B}$ (7) [$\overline{A}$:Closure of A]

OR

14. (a) Show that the space ℓ^p with $1 \leq p < +\infty$ is separable. (7)

    (b) Let $X = (X,d)$ be a metric space. If $x_n \longrightarrow x$ and $y_n \longrightarrow y$, then show that $d(x_n, y_n) \longrightarrow d(x,y)$ (7)

Module-3

15. (a) Let X be the set of all integers and $d(x,y) = |x-y|$. Find the general form of a Cauchy sequence in the metric space (X,d) (9)

    (b) Give an example of a incomplete normed space. Justify (5)

OR

16. (a) Show that the space l^∞ is Banach space (9)

    (b) Show that every convergent sequence in a metric space is a Cauchy sequence (5)

Module-4

17. (a) If X is the space of ordered n tuples of real numbers and $||x|| = \underset{j}{max}|\xi_j|$, where $x = (\xi_1, \xi_2, \cdots, \xi_n)$. What is the corresponding norm on the dual space X' (7)

    (b) Show that the operator $T : l^\infty \longrightarrow l^\infty$ defined by $T(x) = (\eta_j)$, $\eta_j = \dfrac{\xi_j}{j}$, $x = (\xi_j)$ is a bounded linear operator (7)

OR

18. (a) Show that every linear operator on a finite dimensional normed space X is bounded (7)

    (b) Find the norm of operator $T : l^2 \longrightarrow l^2$ defined by $T(x) = \left(\dfrac{\xi_j}{j}\right)$ for each $x = (\xi_j)$ (7)

Module-5

19. (a) Prove that the space ℓ^2 is a Hilbert space with inner product defined by $\langle x, y\rangle = \sum_{j=1}^{\infty} \xi_j \overline{\eta_j}$ (7)

    (b) If Y is a finite dimensional subspace of a Hilbert space H, then show that Y is complete. (7)

OR

20. (a) Show that a subspace Y of a Hilbert space H is closed in H if and only if $Y = Y^{\perp\perp}$(7)

    (b) Let $x_1(t) = t^2, x_2(t) = t, x_3(t) = 1$. Orthonormalize x_1, x_2, x_3 in this order, on the interval $[-1,1]$ with respect to the inner product $\langle x, y\rangle = \int_{-1}^{1} x(t)y(t)\,dt$ (7)

******

Teaching Plan

No	Topic	No. of Lectures
1	**Real Analysis (9 hours)**	
1.1	Denumerable set ,Countable set, Supremum and Infimum of a set	1
1.2	Sequence of real numbers, Convergent sequence	1
1.3	Limit , Divergent sequence	1
1.4	Bounded sequence, Monotone sequence, Monotone convergence Theorem(without proof)	1
1.5	Subsequence, Bolzano-Weierstrass theorem(without proof)	1
1.6	Cauchy sequence, Cauchy convergence criterion	1
1.7	Sequence of functions, Pointwise convergence	1
1.8	Uniform convergence	1
1.9	Uniform norm	1
2	**Metric Space (9 hours)**	
2.1	Metric Space: $\mathbb{R}^{\mathrm{n}}, \mathbb{C}^{n}, \ l^{\infty}$	1
2.2	$C[a,b]$, Discrete space, Sequence space	1
2.3	Space of bounded functions −B(A), l^{p}, Subspace, Holder inequality (without proof), Cauchy- Schwarz inequality (without proof), Minkowski inequality (without proof)	1
2.4	Open set, Closed set	1
2.5	Neighbourhood, Interior	1
2.6	Continuous function, Accumulation point	1
2.7	Closure, Dense set	1
2.8	Separable space	1
2.9	Convergence of sequence, Limit, Bounded sequence	1
3	**Complete Metric Space and Normed space (8 hours)**	
3.1	Cauchy sequence, Complete Metric Space	1
3.2	Completeness of $\mathbb{R}^{\mathrm{n}}, \mathbb{C}^{n}$	1
3.3	Completeness of $l^{\infty}, \ C[a,b]$	1

3.4	Completeness of Convergent Sequence space, l^p	1
3.5	Examples of incomplete metric spaces	1
3.6	Vector space with examples, Normed space	1
3.7	Banach space: $\mathbb{R}^n, \mathbb{C}^n,\ l^\infty,\ C[a,b]$	1
3.8	Metric induced by norm, Examples of incomplete normed spaces	1
4	**Space of Functionals and Operators (9 hours)**	
4.1	Properties of Normed Spaces ,Subspaces	1
4.2	Closed subspace, Schauder basis	1
4.3	Linear Operator, Range , Null space	1
4.4	Bounded Linear Operator, Norm of an operator, Linear operator on a finite dimensional space	1
4.5	Continuous linear operator, Relation between bounded and continuous operators	1
4.6	Linear functional, bounded linear functional	1
4.7	Algebraic dual space, Dual basis	1
4.8	Space B(X,Y) , Completeness of B(X,Y)(without proof)	1
4.9	Dual space X' , Examples of dual space	1
5	**Hilbert Space (10 hours)**	
5.1	Inner Product Space, Hilbert Space, Parallelogram equality, Orthogonality	1
5.2	Examples of Hilbert Spaces: $\mathbb{R}^n$, $\mathbb{C}^n$, l^2	1
5.3	Examples of Non-Hilbert spaces- l^p with $p \neq 2$, $C[a,b]$, Polarization identity.	1
5.4	Schwartz inequality, Triangle inequality, Continuity of Inner product.	1
5.5	Subspace of an inner product space and Hilbert Space, Subspace Theorem.	1
5.6	Convex set, Minimizing vector Theorem (without proof), Orthogonality Lemma (without proof), Direct sum, Orthogonal complement.	1
5.7	Direct Sum Theorem, Orthogonal Projection, Null space Lemma	1
5.8	Closed subspace Lemma, Dense set Lemma, Orthonormal sets and sequences	1
5.9	Examples and properties of Orthonormal sets, Bessel inequality.	1
5.10	Gram-Schmidt process (without proof).	1

HUN 102	PROFESSIONAL COMMUNICATION	CATEGORY	L	T	P	CREDIT
		MNC	2	0	2	--

Preamble: Clear, precise, and effective communication has become a *sine qua non* in today's information-driven world given its interdependencies and seamless connectivity. Any aspiring professional cannot but master the key elements of such communication. The objective of this course is to equip students with the necessary skills to listen, read, write, and speak so as to comprehend and successfully convey any idea, technical or otherwise, as well as give them the necessary polish to become persuasive communicators.

Prerequisite: None

Course Outcomes: After the completion of the course the student will be able to

CO 1	Develop vocabulary and language skills relevant to engineering as a profession
CO 2	Analyze, interpret and effectively summarize a variety of textual content
CO 3	Create effective technical presentations
CO 4	Discuss a given technical/non-technical topic in a group setting and arrive at generalizations/consensus
CO 5	Identify drawbacks in listening patterns and apply listening techniques for specific needs
CO 6	Create professional and technical documents that are clear and adhering to all the necessary conventions

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1										3		2
CO 2										1		3
CO 3						1			1	3		
CO 4										3		1
CO 5		1							2	3		
CO 6	1					1			1	3		

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	50	50	2 hours

Continuous Internal Evaluation

Total Marks: 50

Attendance : 10 marks

Regular assessment : 25 marks

Series test (one test only, should include verbal aptitude for placement and higher studies, this test will be conducted for 50 marks and reduced to 15) : 15 marks

Regular assessment

Project report presentation and Technical presentation through PPT : 7.5 marks

Listening Test : 5 marks

Group discussion/mock job interview : 7.5 marks

Resume submission : 5 marks

End Semester Examination

Total Marks: 50, Time: 2 hrs.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List down the ways in which gestures affect verbal communication.
2. Match the words and meanings

Ambiguous	promotion
Bona fide	referring to whole
Holistic	not clear
Exaltation	genuine

3. Expand the following Compound Nouns - a. Water supply. b. Object recognition. c. Steam turbine

Course Outcome 2 (CO2)

1. Read the passage below and prepare notes:

Mathematics, rightly viewed, possesses not only truth, but supreme beauty—a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show. The true spirit of delight, the exaltation, the sense of being more than man, which is the touchstone of the highest excellence, is to be found in mathematics as surely as in poetry. What is best in mathematics deserves not merely to be learnt as a task, but to be assimilated as a part of daily thought, and brought again and again before the mind with ever-renewed encouragement. Real life is, to most men, a long second-best, a perpetual compromise between the ideal and the possible; but the world of pure reason knows no compromise, no practical limitations, no barrier to the creative activity embodying in splendid edifices the passionate aspiration after the perfect from which all great work springs. Remote from human passions, remote even from the pitiful facts of nature, the generations have gradually created an ordered cosmos, where pure thought can dwell as in its natural home, and where one, at least, of our nobler impulses can escape from the dreary exile of the actual world.

So little, however, have mathematicians aimed at beauty, that hardly anything in their work has had this conscious purpose. Much, owing to irrepressible instincts, which were better than avowed *beliefs, has been moulded by an unconscious taste; but much also has been spoilt by false notions of what was fitting. The characteristic excellence of mathematics is only to be found where the reasoning is rigidly logical: the rules of logic are to mathematics what those of structure are to architecture. In the most beautiful work, a chain of argument is presented in which every link is important on its own account, in which there is an air of ease and lucidity throughout, and the premises achieve more than would have been thought possible, by means which appear natural and inevitable. Literature embodies what is general in particular circumstances whose universal significance shines through their individual dress; but mathematics endeavours to present whatever is most general in its purity, without any irrelevant trappings.*

How should the teaching of mathematics be conducted so as to communicate to the learner as much as possible of this high ideal? Here experience must, in a great measure, be our guide; but some maxims may result from our consideration of the ultimate purpose to be achieved.

- From "On the teaching of mathematics" – Bertrand Russell

2. Enumerate the advantages and disadvantages of speed reading. Discuss how it can impact comprehension.

Course Outcome 3(CO3):

1. What are the key elements of a successful presentation?
2. Elucidate the importance of non-verbal communication in making a presentation
3. List out the key components in a technical presentation.

Course Outcome 4 (CO4):

1. Discuss: 'In today's world, being a good listener is more important than being a good Speaker.'
2. Listen to a video/live group discussion on a particular topic, and prepare a brief summary of the proceedings.
3. List the do's and don'ts in a group discussion.

Course Outcome 5 (CO5):

1. Watch a movie clip and write the subtitles for the dialogue.
2. What do you mean by barriers to effective listening? List ways to overcome each of these.
3. What are the different types of interviews? How are listening skills particularly important in Skype/telephonic interviews?

Course Outcome 6 (CO6):

1. Explain the basic structure of a technical report.
2. You have been offered an internship in a much sought-after aerospace company and are very excited about it. However, the dates clash with your series tests. Write a letter to the Manager – University Relations of the company asking them if they can change the dates to coincide with your vacation.
3. You work in a well-reputed aerospace company as Manager – University Relations. You are in charge of offering internships. A student has sent you a letter requesting you to change the dates allotted to him since he has series exams at that time. But there are no vacancies available during the period he has requested for. Compose an e-mail informing him of this and suggest that he try to arrange the matter with his college.

Syllabus

Module 1

Use of language in communication: Significance of technical communication Vocabulary Development: technical vocabulary, vocabulary used in formal letters/emails and reports, sequence words, misspelled words, compound words, finding suitable synonyms, paraphrasing, verbal analogies. Language Development: subject-verb agreement, personal passive voice, numerical adjectives, embedded sentences, clauses, conditionals, reported speech, active/passive voice.

Technology-based communication: Effective email messages, slide presentations, editing skills using software. Modern day research and study skills: search engines, repositories, forums such as Git Hub, Stack Exchange, OSS communities (MOOC, SWAYAM, NPTEL), and Quora; Plagiarism

Module 2

Reading, Comprehension, and Summarizing: Reading styles, speed, valuation, critical reading, reading and comprehending shorter and longer technical articles from journals, newspapers, identifying the various transitions in a text, SQ3R method, PQRST method, speed reading. Comprehension: techniques, understanding textbooks, marking and underlining, Note-taking: recognizing non-verbal cues.

Module 3

Oral Presentation: Voice modulation, tone, describing a process, Presentation Skills: Oral presentation and public speaking skills, business presentations, Preparation: organizing the material, self-Introduction, introducing the topic, answering questions, individual presentation practice, presenting visuals effectively.

Debate and Group Discussions: introduction to Group Discussion (GD), differences between GD and debate; participating GD, understanding GD, brainstorming the topic, questioning and clarifying, GD strategies, activities to improve GD skills

Module 4

Listening and Interview Skills Listening: Active and Passive listening, listening: for general content, to fill up information, intensive listening, for specific information, to answer, and to understand. Developing effective listening skills, barriers to effective listening, listening to longer technical talks, listening to classroom lectures, talks on engineering /technology, listening to documentaries and making notes, TED talks.

Interview Skills: types of interviews, successful interviews, interview etiquette, dress code, body language, telephone/online (skype) interviews, one-to-one interview & panel interview, FAQs related to job interviews

Module 5

Formal writing: Technical Writing: differences between technical and literary style. Letter Writing (formal, informal and semi formal), Job applications, Minute preparation, CV preparation (differences between Bio-Data, CV and Resume), and Reports. Elements of style, Common Errors in Writing: describing a process, use of sequence words, Statements of Purpose, Instructions, Checklists.

Analytical and issue-based Essays and Report Writing: basics of report writing; Referencing Style (IEEE Format), structure of a report; types of reports, references, bibliography.

Lab Activities

Written: Letter writing, CV writing, Attending a meeting and Minute Preparation, Vocabulary Building
Spoken: Phonetics, MMFS (Multimedia Feedback System), Mirroring, Elevator Pitch, telephone etiquette, qualities of a good presentation with emphasis on body language and use of visual aids.
Listening: Exercises based on audio materials like radio and podcasts. Listening to Song. practice and exercises.
Reading: Speed Reading, Reading with the help of Audio Visual Aids, Reading Comprehension Skills
Mock interview and Debate/Group Discussion: concepts, types, Do’s and don’ts- intensive practice

Reference Books

1. English for Engineers and Technologists (Combined edition, Vol. 1 and 2), Orient Blackswan 2010.
2. Meenakshi Raman and Sangeetha Sharma,”Technical Communication: Principles and Practice”, 2nd Edition, Oxford University Press, 2011
3. Stephen E. Lucas, "The Art of Public Speaking", 10th Edition; McGraw Hill Education, 2012.
4. Ashraf Rizvi, "Effective Technical Communication", 2nd Edition, McGraw Hill Education, 2017.
5. William Strunk Jr. & E.B. White, "The Elements of Style", 4th Edition, Pearson, 1999.
6. David F. Beer and David McMurrey, Guide to writing as an Engineer, John Willey. New York, 2004.
7. Goodheart-Willcox, "Professional Communication", First Edition , 2017.
8. Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India, 6 edition, 2015.
9. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education; 1 edition, 2013.
10. Anand Ganguly, “Success in Interview”, RPH, 5th Edition, 2016.
11. Raman Sharma, “Technical Communications”, Oxford Publication, London, 2004.

SEMESTER -3

CODE MCN201	SUSTAINABLE ENGINEERING	CATEGORY	L	T	P	CREDIT
			2	0	0	NIL

Preamble: Objective of this course is to inculcate in students an awareness of environmental issues and the global initiatives towards attaining sustainability. The student should realize the potential of technology in bringing in sustainable practices.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the relevance and the concept of sustainability and the global initiatives in this direction
CO 2	Explain the different types of environmental pollution problems and their sustainable solutions
CO 3	Discuss the environmental regulations and standards
CO 4	Outline the concepts related to conventional and non-conventional energy
CO 5	Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1						2	3					2
CO 2						2	3					2
CO 3						2	3					2
CO 4						2	3					2
CO 5						2	3					2

Assessment Pattern

Mark distribution

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	20	20	40
Understand	20	20	40
Apply	10	10	20
Analyse			
Evaluate			
Create			

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the relevance and the concept of sustainability and the global initiatives in this direction

1. Explain with an example a technology that has contributed positively to sustainable development.
2. Write a note on Millennium Development Goals.

Course Outcome 2 (CO2): Explain the different types of environmental pollution problems and their sustainable solutions

1. Explain the 3R concept in solid waste management?
2. Write a note on any one environmental pollution problem and suggest a sustainable solution.
3. In the absence of green house effect the surface temperature of earth would not have been suitable for survival of life on earth. Comment on this statement.

Course Outcome 3(CO3): Discuss the environmental regulations and standards

1. Illustrate Life Cycle Analysis with an example of your choice.
2. "Nature is the most successful designer and the most brilliant engineer that has ever evolved". Discuss.

Course Outcome 4 (CO4): Outline the concepts related to conventional and non-conventional energy

1. Suggest a sustainable system to generate hot water in a residential building in tropical climate.
2. Enumerate the impacts of biomass energy on the environment.

Course Outcome 5 (CO5): Demonstrate the broad perspective of sustainable practices by utilizing engineering knowledge and principles

1. Suggest suitable measures to make the conveyance facilities used by your institution sustainable.

Model Question paper

Part A

(Answer all questions. Each question carries 3 marks each)

1. Define sustainable development.
2. Write a short note on Millennium Development Goals.
3. Describe carbon credit.
4. Give an account of climate change and its effect on environment.
5. Describe biomimicry? Give two examples.
6. Explain the basic concept of Life Cycle Assessment.
7. Name three renewable energy sources.

8. Mention some of the disadvantages of wind energy.

9. Enlist some of the features of sustainable habitat.

10. Explain green engineering.

Part B

(Answer one question from each module. Each question carries 14 marks)

11. Discuss the evolution of the concept of sustainability. Comment on its relevance in the modern world.

OR

12. Explain Clean Development Mechanism.

13. Explain the common sources of water pollution and its harmful effects.

OR

14. Give an account of solid waste management in cities.

15. Explain the different steps involved in the conduct of Environmental Impact Assessment.

OR

16. Suggest some methods to create public awareness on environmental issues.

17. Comment on the statement, “Almost all energy that man uses comes from the Sun”.

OR

18. Write notes on:
    a. Land degradation due to water logging.
    b. Over exploitation of water.

19. Discuss the elements related to sustainable urbanisation.

OR

20. Discuss any three methods by which you can increase energy efficiency in buildings.

Syllabus

Sustainability- need and concept, technology and sustainable development-Natural resources and their pollution, Carbon credits, Zero waste concept. Life Cycle Analysis, Environmental Impact Assessment studies, Sustainable habitat, Green buildings, green materials, Energy, Conventional and renewable sources, Sustainable urbanization, Industrial Ecology.

Module 1

Sustainability: Introduction, concept, evolution of the concept; Social, environmental and economic sustainability concepts; Sustainable development, Nexus between Technology and Sustainable development; Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM).

Module 2

Environmental Pollution: Air Pollution and its effects, Water pollution and its sources, Zero waste concept and 3 R concepts in solid waste management; Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, legal provisions for environmental protection.

Module 3

Environmental management standards: ISO 14001:2015 frame work and benefits, Scope and goal of Life Cycle Analysis (LCA), Circular economy, Bio-mimicking, Environment Impact Assessment (EIA), Industrial ecology and industrial symbiosis.

Module 4

Resources and its utilisation: Basic concepts of Conventional and non-conventional energy, General idea about solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans and Geothermal energy.

Module 5

Sustainability practices: Basic concept of sustainable habitat, Methods for increasing energy efficiency in buildings, Green Engineering, Sustainable Urbanisation, Sustainable cities, Sustainable transport.

Reference Books

1. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
3. Environment Impact Assessment Guidelines, Notification of Government of India, 2006
4. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
5. ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
6. Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.
7. Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).
8. Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios Publication

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Sustainability	
1.1	Introduction, concept, evolution of the concept	1
1.2	Social, environmental and economic sustainability concepts	1
1.3	Sustainable development, Nexus between Technology and Sustainable development	1
1.4	Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs)	1
1.5	Clean Development Mechanism (CDM)	1
2	Environmental Pollution	
2.1	Air Pollution and its effects	1
2.2	Water pollution and its sources	1
2.3	Zero waste concept and 3 R concepts in solid waste management	1
2.4	Greenhouse effect, Global warming, Climate change, Ozone layer depletion	1
2.5	Carbon credits, carbon trading and carbon foot print.	1
2.6	Legal provisions for environmental protection.	1
3	Environmental management standards	
3.1	Environmental management standards	1
3.2	ISO 14001:2015 frame work and benefits	1
3.3	Scope and Goal of Life Cycle Analysis (LCA)	1
3.4	Circular economy, Bio-mimicking	1
3.5	Environment Impact Assessment (EIA)	1
3.6	Industrial Ecology, Industrial Symbiosis	1
4	Resources and its utilisation	
4.1	Basic concepts of Conventional and non-conventional energy	1
4.2	General idea about solar energy, Fuel cells	1
4.3	Wind energy, Small hydro plants, bio-fuels	1
4.4	Energy derived from oceans and Geothermal energy	1
5	Sustainability Practices	
5.1	Basic concept of sustainable habitat	1
5.2	Methods for increasing energy efficiency of buildings	1
5.3	Green Engineering	1
5.4	Sustainable Urbanisation, Sustainable cities, Sustainable transport	1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EST 200	DESIGN AND ENGINEERING		2	0	0	2

Preamble:

The purpose of this course is to

i) introduce the undergraduate engineering studentsthe fundamental principles of design engineering,

ii) make them understand the steps involved in the design process and

iii) familiarize them with the basic tools used and approaches in design.

Students are expected to apply design thinking in learning as well as while practicing engineering, which is very important and relevant for today. Case studies from various practical situations will help the students realize that design is not only concerned about the function but also many other factors like customer requirements, economics, reliability, etc. along with a variety of life cycle issues.

The course will help students to consider aesthetics, ergonomics and sustainability factors in designs and also to practice professional ethics while designing.

Prerequisite:

Nil. The course will be generic to all engineering disciplines and will not require specialized preparation or prerequisites in any of the individual engineering disciplines.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain the different concepts and principles involved in design engineering.
CO 2	Apply design thinking while learning and practicing engineering.
CO 3	Develop innovative, reliable, sustainable and economically viable designs incorporating knowledge in engineering.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1					1			1		
CO 2		2				1		1				2
CO 3			2			1	1		2	2		1

Assessment Pattern

Continuous Internal Evaluation (CIE) Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination (ESE) Pattern: There will be two parts; Part A and Part B.

Part A	: 30 marks
part B	: 70 marks

Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.

Part B contains 2 case study questions from each module of which student should answer any one. Each question carry 14 marks and can have maximum 2 sub questions.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	35	35	70
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1): Appreciate the different concepts and principles involved in design engineering.

1. State how engineering design is different from other kinds of design

2. List the different stages in a design process.

3. Describedesign thinking.

4. State the function of prototyping and proofing in engineering design.

5. Write notes on the following concepts in connection with design engineering 1) Modular Design, 2) Life Cycle Design , 3) Value Engineering, 4) Concurrent Engineering, and 5) Reverse Engineering

6. State design rights.

Course Outcome 2 (CO2) Apply design thinking while learning and practicing engineering.

1. Construct the iterative process for design thinking in developing simple products like a pen, umbrella, bag, etc.

2. Show with an example how divergent-convergent thinking helps in generating alternative designs and then how to narrow down to the best design.

3. Describe how a problem-based learning helps in creating better design engineering solutions.

4. Discuss as an engineer, how ethics play a decisive role in your designs

Course Outcome 3(CO3): Develop innovative, reliable, sustainable and economically viable designs incorporating different segments of knowledge in engineering.

1. Illustratethe development of any simple product by passing through the different stages of design process

2. Show thegraphical design communication with the help of detailed 2D or 3D drawings for any simple product.

3. Describe how to develop new designs for simple products through bio-mimicry.

Model Question paper

Page 1 of 2

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: EST 200

Course Name: DESIGN AND ENGINEERING

Max. Marks: 100Duration: 3 Hours

PART A

Answer all questions, each question carries 3 marks

Use only hand sketches

(1)Write aboutthe basic design process.

(2) Describe how to finalize the design objectives.

(3) State the role of divergent-convergent questioning in design thinking.

(4) Discuss how to perform design thinking in a team managing the conflicts.

(5) Show how engineering sketches and drawings convey designs.

(6)Explain the role of mathematics and physics in design engineering process.

(7) Distinguish between project-based learning and problem-based learning in design engineering.

(8) Describe how concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?

(9) Show how designs are varied based on the aspects of production methods, life span, reliability and environment?

(10) Explain how economics influence the engineering designs?

(10x3 marks =30 marks)

Part B

Answer any ONE question from each module. Each question carry 14 marks

Module 1

(11) Show the designing of a wrist watch going through the various stages of the design process. Use hand sketches to illustrate the processes.

or

(12)Find the customer requirements for designing a new car showroom. Show how the design objectives were finalized considering the design constraints?

Module 2

(13)Illustrate the design thinking approach for designing a bag for college students within a limited budget. Describe each stage of the process and the iterative procedure involved. Use hand sketches to support your arguments.

or

(14)Construct a number of possible designs and then refine them to narrow down to the best design for a drug trolley used in hospitals. Show how the divergent-convergent thinking helps in the process. Provide your rationale for each step by using hand sketches only.

Module 3

(15) Graphically communicate the design of a thermo flask used to keep hot coffee. Draw the detailed 2D drawings of the same with design detailing, material selection, scale drawings, dimensions, tolerances, etc. Use only hand sketches.

or

(16)Describe the role of mathematical modelling in design engineering. Show how mathematics and physics play a role in designing a lifting mechanism to raise 100 kg of weight to a floor at a height of 10 meters in a construction site.

Module 4

(17) Show the development of a nature inspired design for a solar poweredbus waiting shed beside a highway. Relate between natural and man-made designs. Use hand sketches to support your arguments.

or

(18)Show the design of a simple sofa and then depict how the design changes when considering 1) aesthetics and 2) ergonomics into consideration. Give hand sketches and explanations to justify the changes in designs.

Module 5

(19)Examine the changes in the design of a foot wear with constraints of 1) production methods, 2) life span requirement, 3) reliability issues and 4) environmental factors. Use hand sketches and give proper rationalization for the changes in design.

or

(20)Describe the how to estimate the cost of a particular design using ANY of the following: i) a website, ii) the layout of a plant, iii) the elevation of a building, iv) anelectrical or electronic system or device and v) a car.

Show how economics will influence the engineering designs. Use hand sketches to support your arguments.

(5x14 marks =70 marks)

Syllabus

Module 1

Design Process:- Introduction to Design and Engineering Design, Defining a Design Process-:Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.

Module 2

Design Thinking Approach:-Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Design Thinking in a Team Environment.

Module 3

Design Communication (Languages of Engineering Design):-Communicating Designs Graphically, Communicating Designs Orally and in Writing. Mathematical Modeling In Design, Prototyping and Proofing the Design.

Module 4

Design Engineering Concepts:-Project-based Learning and Problem-based Learning in Design.Modular Design and Life Cycle Design Approaches. Application of Bio-mimicry,Aesthetics and Ergonomics in Design. Value Engineering, Concurrent Engineering, and Reverse Engineering in Design.

Module 5

Expediency, Economics and Environment in Design Engineering:-Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design

Text Books

1) YousefHaik, SangarappillaiSivaloganathan, Tamer M. Shahin, Engineering Design Process, Cengage Learning 2003, Third Edition, ISBN-10: 9781305253285,

2) Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

Reference Books

1.Philip Kosky, Robert Balmer, William Keat, George Wise, Exploring Engineering, Fourth Edition: An Introduction to Engineering and Design, Academic Press 2015, 4th Edition, ISBN: 9780128012420.

2. Clive L. Dym, Engineering Design: A Project-Based Introduction, John Wiley & Sons, New York 2009, Fourth Edition, ISBN: 978-1-118-32458-5

3. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Berg Publishers 2011, First Edition, ISBN: 978-1847886361

4. Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., Engineering Design: A Systematic Approach, Springer 2007, Third Edition, ISBN 978-1-84628-319-2

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1: Design Process**	
1.1	Introduction to Design and Engineering Design. *What does it mean to design something? How Is engineering design different from other kinds of design? Where and when do engineers design? What are the basic vocabularyin engineering design? How to learn and do engineering design.*	1
1.2	*Defining a Design Process*-: Detailing Customer Requirements. *How to do engineering design? Illustrate the process with an example. How to identify the customer requirements of design?*	1
1.3	*Defining a Design Process*-: Setting Design Objectives, Identifying Constraints, Establishing Functions. *How to finalize the design objectives? How to identify the design constraints? How to express the functions a design in engineering terms?*	1
1.4	*Defining a Design Process*-: Generating Design Alternatives and Choosing a Design. *How to generate or create feasible design alternatives? How to identify the "best possible design"?*	1
1.5	Case Studies:- Stages of Design Process. *Conduct exercises for designing simple products going through the different stages of design process.*	1
2	**Module 2: Design Thinking Approach**	
2.1	Introduction to Design Thinking *How does the design thinking approach help engineers in creating innovative and efficient designs?*	1
2.2	Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. *How can the engineers arrive at better designs utilizing the iterative design thinking process (in which knowledge acquired in the later stages can be applied back to the earlier stages)?*	1
2.3	Design Thinking as Divergent-Convergent Questioning. *Describe how to create a number of possible designs and then how to refine and narrow down to the 'best design'.*	1
2.4	Design Thinking in a Team Environment. *How to perform design thinking as a team managing the conflicts ?*	1
2.5	Case Studies: Design Thinking Approach. *Conduct exercises using the design thinking approach for*	1

	designing any simple products within a limited time and budget	
3	**Module 3: Design Communication (Languages of Engineering Design)**	
3.1	Communicating Designs Graphically. *How do engineering sketches and drawings convey designs?*	1
3.2	Communicating Designs Orally and in Writing. *How can a design be communicated through oral presentation or technical reports efficiently?*	1
	First Series Examination	
3.3	Mathematical Modelling in Design. *How do mathematics and physics become a part of the design process?*	1
3.4	Prototyping and Proofing the Design. *How to predict whether the design will function well or not?*	1
3.5	Case Studies: Communicating Designs Graphically. *Conduct exercises for design communication through detailed 2D or 3D drawings of simple products with design detailing, material selection, scale drawings, dimensions, tolerances, etc.*	1
4	**Module 4: Design Engineering Concepts**	
4.1	Project-based Learning and Problem-based Learning in Design. *How engineering students can learn design engineering through projects?* *How students can take up problems to learn design engineering?*	1
4.2	Modular Design and Life Cycle Design Approaches. *What is modular approach in design engineering? How it helps?* *How the life cycle design approach influences design decisions?*	1
4.3	Application of Bio-mimicry, Aesthetics and Ergonomics in Design. *How do aesthetics and ergonomics change engineering designs?* *How do the intelligence in nature inspire engineering designs? What are the common examples of bio-mimicry in engineering?*	1
4.4	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design. *How do concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?*	1
4.5	Case Studies: Bio-mimicry based Designs. *Conduct exercises to develop new designs for simple*	1

	products using bio-mimicry and train students to bring out new nature inspired designs.	
5	**Module 5: Expediency, Economics and Environment in Design Engineering**	
5.1	Design for Production, Use, and Sustainability. *How designs are finalized based on the aspects of production methods, life span, reliability and environment?*	1
5.2	Engineering Economics in Design. *How to estimate the cost of a particular design and how will economics influence the engineering designs?*	1
5.3	Design Rights. *What are design rights and how can an engineer put it into practice?*	1
5.4	Ethics in Design. *How do ethics play a decisive role in engineering design?*	1
5.5	Case Studies: Design for Production, Use, and Sustainability. *Conduct exercises using simple products to show how designs change with constraints of production methods, life span requirement, reliability issues and environmental factors.*	1
Second Series Examination		

Code.	Course Name	L	T	P	Hrs	Credit
HUT 200	**Professional Ethics**	2	0	0	2	2

Preamble: To enable students to create awareness on ethics and human values.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the core values that shape the ethical behaviour of a professional.
CO 2	Adopt a good character and follow an ethical life.
CO 3	Explain the role and responsibility in technological development by keeping personal ethics and legal ethics.
CO 4	Solve moral and ethical problems through exploration and assessment by established experiments.
CO 5	Apply the knowledge of human values and social values to contemporary ethical values and global issues.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1								2			2	
CO 2								2			2	
CO 3								3			2	
CO 4								3			2	
CO 5								3			2	

Assessment Pattern

Bloom's category	Continuous Assessment Tests		End Semester Exam
	1	2	
Remember	15	15	30
Understood	20	20	40
Apply	15	15	30

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	:	10 marks
Continuous Assessment Tests (2 Nos)	:	25 marks
Assignments/Quiz	:	15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define integrity and point out ethical values.
2. Describe the qualities required to live a peaceful life.
3. Explain the role of engineers in modern society.

Course Outcome 2 (CO2)

1. Derive the codes of ethics.
2. Differentiate consensus and controversy.
3. Discuss in detail about character and confidence.

Course Outcome 3(CO3):

1. Explain the role of professional's ethics in technological development.
2. Distinguish between self interest and conflicts of interest.
3. Review on industrial standards and legal ethics.

Course Outcome 4 (CO4):

1. Illustrate the role of engineers as experimenters.
2. Interpret the terms safety and risk.
3. Show how the occupational crimes are resolved by keeping the rights of employees.

Course Outcome 5 (CO5):

1. Exemplify the engineers as managers.
2. Investigate the causes and effects of acid rain with a case study.
3. Explorate the need of environmental ethics in technological development.

Model Question paper

QP CODE: **Reg No:**______________

PAGES:3 **Name :**______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: HUT 200
Course Name: PROFESSIONAL ETHICS

Max. Marks: 100 **Duration: 3 Hours**

(2019-Scheme)

PART A

(Answer all questions, each question carries 3 marks)

1. Define empathy and honesty.

2. Briefly explain about morals, values and ethics.

3. Interpret the two forms of self-respect.

4. List out the models of professional roles.

5. Indicate the advantages of using standards.

6. Point out the conditions required to define a valid consent?

7. Identify the conflicts of interests with an example?

8. Recall confidentiality.

9. Conclude the features of biometric ethics.

10. Name any three professional societies and their role relevant to engineers.

(10x3 = 30 marks)

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Classify the relationship between ethical values and law?

b) Compare between caring and sharing. (10+4 = 14 marks)

Or

12. a) Exemplify a comprehensive review about integrity and respect for others.

b) Discuss about co-operation and commitment. (8+6 = 14 marks)

MODULE II

13.a) Explain the three main levels of moral developments, deviced by Kohlberg.

b) Differentiate moral codes and optimal codes. (10+4 = 14 marks)

Or

14. a) Extrapolate the duty ethics and right ethics.

b) Discuss in detail the three types of inquiries in engineering ethics (8+6 = 14 marks)

MODULE III

15.a) Summarize the following features of morally responsible engineers.

(i) Moral autonomy **(ii)** Accountability

b)Explain the rights of employees (8+6 = 14 marks)

Or

16. a) Explain the reasons for Chernobyl mishap ?

b) Describe the methods to improve collegiality and loyalty. (8+6 = 14 marks)

MODULE IV

17.a) Execute collegiality with respect to commitment, respect and connectedness.

b) Identify conflicts of interests with an example. (8+6 = 14 marks)

Or

18. a) Explain in detail about professional rights and employee rights.

b) Exemplify engineers as managers.

MODULE V

19.a) Evaluate the technology transfer and appropriate technology.

b) Explain about computer and internet ethics. (8+6 = 14 marks)

Or

20. a) Investigate the causes and effects of acid rain with a case study.

b) Conclude the features of ecocentric and biocentric ethics. (8+6 = 14 marks)

Syllabus

Module 1 – Human Values.

Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue- Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment- Empathy-Self Confidence -Social Expectations.

Module 2 - Engineering Ethics & Professionalism.

Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas –Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy-Profession and Professionalism- Models of professional roles-Theories about right action –Self interest-Customs and Religion- Uses of Ethical Theories.

Module 3- Engineering as social Experimentation.

Engineering as Experimentation – Engineers as responsible Experimenters- Codes of Ethics- Plagiarism- A balanced outlook on law - Challenges case study- Bhopal gas tragedy.

Module 4- Responsibilities and Rights.

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining- Confidentiality- Role of confidentiality in moral integrity-Conflicts of interest- Occupational crime- Professional rights- Employee right- IPR Discrimination.

Module 5- Global Ethical Issues.

Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics -Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors-Moral leadership.

Text Book

1. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012.
2. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited ,New Delhi,2006.

Reference Books

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
2. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
3. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states,2005.
4. http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics**.**

Course Contents and Lecture Schedule

SL.No	Topic	No. of Lectures 25
1	**Module 1 – Human Values.**	
1.1	Morals, values and Ethics, Integrity, Academic Integrity,Work Ethics	1
1.2	Service Learning, Civic Virtue, Respect for others, Living peacefully	1
1.3	Caring and Sharing, Honesty, Courage, Co-operation commitment	2
1.4	Empathy, Self Confidence, Social Expectations	1
2	**Module 2- Engineering Ethics & Professionalism.**	
2.1	Senses of Engineering Ethics, Variety of moral issues, Types of inquiry	1
2.2	Moral dilemmas, Moral Autonomy, Kohlberg's theory	1
2.3	Gilligan's theory, Consensus and Controversy,Profession& Professionalism, Models of professional roles, Theories about right action	2
2.4	Self interest-Customs and Religion, Uses of Ethical Theories	1
3	**Module 3- Engineering as social Experimentation.**	
3.1	Engineering as Experimentation, Engineers as responsible Experimenters	1
3.2	Codes of Ethics,Plagiarism, A balanced outlook on law	2
3.3	Challenger case study, Bhopal gas tragedy	2
4	**Module 4- Responsibilities and Rights.**	
4.1	Collegiality and loyalty, Managing conflict, Respect for authority	1
4.2	Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest	2
4.3	Occupational crime, Professional rights, Employee right, IPR Discrimination	2
5	**Module 5- Global Ethical Issues.**	
5.1	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics	2
5.2	Role in Technological Development, Moral leadership	1
5.3	Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	2

SEMESTER -4

CODE MCN202	COURSE NAME CONSTITUTION OF INDIA	CATEGORY	L	T	P	CREDIT
			2	0	0	NIL

Preamble:

The study of their own country constitution and studying the importance environment as well as understanding their own human rights help the students to concentrate on their day to day discipline. It also gives the knowledge and strength to face the society and people.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the background of the present constitution of India and features.
CO 2	Utilize the fundamental rights and duties.
CO 3	Understand the working of the union executive, parliament and judiciary.
CO 4	Understand the working of the state executive, legislature and judiciary.
CO 5	Utilize the special provisions and statutory institutions.
CO 6	Show national and patriotic spirit as responsible citizens of the country

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1						2	2	2		2		
CO 2						3	3	3		3		
CO 3						3	2	3		3		
CO 4						3	2	3		3		
CO 5						3	2	3		3		
CO 6						3	3	3		2		

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	20	20	40
Understand	20	20	40
Apply	10	10	20
Analyse			

Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1 Discuss the historical background of the Indian constitution.

2 Explain the salient features of the Indian constitution.

3 Discuss the importance of preamble in the implementation of constitution.

Course Outcome 2 (CO2)

1 What are fundamental rights ? Examine each of them.

2 Examine the scope of freedom of speech and expression underlying the constitution.

3 The thumb impression of an accused is taken by the police against his will. He contends that this is a violation of his rights under Art 20(3) of the constitution. Decide.

Course Outcome 3(CO3):

1 Explain the powers of the President to suspend the fundamental rights during emergency.

2 Explain the salient features of appeal by special leave.

3. List the constitutional powers of President.

Course Outcome 4 (CO4):

1 Discuss the constitutional powers of Governor.

2 Examine the writ jurisdiction of High court.

3 Discuss the qualification and disqualification of membership of state legislature.

Course Outcome 5 (CO5):

1 Discuss the duties and powers of comptroller of auditor general.

2 Discuss the proclamation of emergency.

3 A state levies tax on motor vehicles used in the state, for the purpose of maintaining roads in the state. X challenges the levy of the tax on the ground that it violates the freedom of interstate commerce guaranteed under Art 301. Decide.

Course Outcome 6 (CO6):

1 Explain the advantages of citizenship.

2 List the important principles contained in the directive principles of state policy.

3 Discuss the various aspects contained in the preamble of the constitution

Model Question paper

PART A

(Answer all questions. Each question carries 3 marks)

1 Define and explain the term constitution.

2 Explain the need and importance of Preamble.

3 What is directive principle of state policy?

4 Define the State.

5 List the functions of Attorney general of India.

6 Explain the review power of Supreme court.

7 List the qualifications of Governor.

8 Explain the term and removal of Judges in High court.

9 Explain the powers of public service commission.

10 List three types of emergency under Indian constitution.

(10X3=30marks)

PART B

(Answer on question from each module. Each question carries 14 marks)

Module 1

11 Discuss the various methods of acquiring Indian citizenship.

12 Examine the salient features of the Indian constitution.

Module 2

13 A high court passes a judgement against X. X desires to file a writ petition in the supreme court under Art32, on the ground that the judgement violates his fundamental rights. Advise him whether he can do so.

14 What is meant by directive principles of State policy? List the directives.

Module3

15 Describe the procedure of election and removal of the President of India.

16 Supreme court may in its discretion grant special leave to appeal. Examine the situation.

Module 4

17 Discuss the powers of Governor.

18 X filed a writ petition under Art 226 which was dismissed. Subsequently, he filed a writ petition under Art 32 of the constitution, seeking the same remedy. The Government argued that the writ petition should be dismissed, on the ground of res judicata. Decide.

Module 5

19 Examine the scope of the financial relations between the union and the states.

20 Discuss the effects of proclamation of emergency.

(14X5=70marks)

Syllabus

Module 1 Definition, historical back ground, features, preamble, territory, citizenship.

Module 2 State, fundamental rights, directive principles, duties.

Module 3 The machinery of the union government.

Module 4 Government machinery in the states

Module 5 The federal system, Statutory Institutions, miscellaneous provisions.

Text Books

1 D D Basu, Introduction to the constitution of India, Lexis Nexis, New Delhi, 24e, 2019

2 PM Bhakshi, The constitution of India, Universal Law, 14e, 2017

Reference Books

1 Ministry of law and justice, The constitution of India, Govt of India, New Delhi, 2019.

2 JN Pandey, The constitutional law of India, Central Law agency, Allahabad, 51e, 2019

3 MV Pylee, India's Constitution, S Chand and company, New Delhi, 16e, 2016

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Definition of constitution, historical back ground, salient features of the constitution.	1
1.2	Preamble of the constitution, union and its territory.	1
1.3	Meaning of citizenship, types, termination of citizenship.	2
2	**Module 2**	
2.1	Definition of state, fundamental rights, general nature, classification, right to equality ,right to freedom , right against exploitation	2

2.2	Right to freedom of religion, cultural and educational rights, right to constitutional remedies. Protection in respect of conviction for offences.	2
2.3	Directive principles of state policy, classification of directives, fundamental duties.	2
3	**Module 3**	
3.1	The Union executive, the President, the vice President, the council of ministers, the Prime minister, Attorney-General, functions.	2
3.2	The parliament, composition, Rajya sabha, Lok sabha, qualification and disqualification of membership, functions of parliament.	2
3.3	Union judiciary, the supreme court, jurisdiction, appeal by special leave.	1
4	**Module 4**	
4.1	The State executive, the Governor, the council of ministers, the Chief minister, advocate general, union Territories.	2
4.2	The State Legislature, composition, qualification and disqualification of membership, functions.	2
4.3	The state judiciary, the high court, jurisdiction, writs jurisdiction.	1
5	**Module 5**	
5.1	Relations between the Union and the States, legislative relation, administrative relation, financial Relations, Inter State council, finance commission.	1
5.2	Emergency provision, freedom of trade commerce and inter course, comptroller and auditor general of India, public Services, public service commission, administrative Tribunals.	2
5.3	Official language, elections, special provisions relating to certain classes, amendment of the Constitution.	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
			2	0	0	2
EST 200	**DESIGN AND ENGINEERING**					

Preamble:

The purpose of this course is to

i) introduce the undergraduate engineering studentsthe fundamental principles of design engineering,

ii) make them understand the steps involved in the design process and

iii) familiarize them with the basic tools used and approaches in design.

Students are expected to apply design thinking in learning as well as while practicing engineering, which is very important and relevant for today. Case studies from various practical situations will help the students realize that design is not only concerned about the function but also many other factors like customer requirements, economics, reliability, etc. along with a variety of life cycle issues.

The course will help students to consider aesthetics, ergonomics and sustainability factors in designs and also to practice professional ethics while designing.

Prerequisite:

Nil. The course will be generic to all engineering disciplines and will not require specialized preparation or prerequisites in any of the individual engineering disciplines.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain the different concepts and principles involved in design engineering.
CO 2	Apply design thinking while learning and practicing engineering.
CO 3	Develop innovative, reliable, sustainable and economically viable designs incorporating knowledge in engineering.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	2	1					1			1		
CO 2		2				1		1				2
CO 3			2			1	1		2	2		1

Assessment Pattern

Continuous Internal Evaluation (CIE) Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination (ESE) Pattern: There will be two parts; Part A and Part B.
Part A : 30 marks
part B : 70 marks
Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.
Part B contains 2 case study questions from each module of which student should answer any one. Each question carry 14 marks and can have maximum 2 sub questions.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	35	35	70
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1): Appreciate the different concepts and principles involved in design engineering.

1. State how engineering design is different from other kinds of design

2. List the different stages in a design process.

3. Describedesign thinking.

4. State the function of prototyping and proofing in engineering design.

5. Write notes on the following concepts in connection with design engineering 1) Modular Design, 2) Life Cycle Design , 3) Value Engineering, 4) Concurrent Engineering, and 5) Reverse Engineering

6. State design rights.

Course Outcome 2 (CO2) Apply design thinking while learning and practicing engineering.

1. Construct the iterative process for design thinking in developing simple products like a pen, umbrella, bag, etc.

2. Show with an example how divergent-convergent thinking helps in generating alternative designs and then how to narrow down to the best design.

3. Describe how a problem-based learning helps in creating better design engineering solutions.

4. Discuss as an engineer, how ethics play a decisive role in your designs

Course Outcome 3(CO3): Develop innovative, reliable, sustainable and economically viable designs incorporating different segments of knowledge in engineering.

1. Illustratethe development of any simple product by passing through the different stages of design process

2. Show thegraphical design communication with the help of detailed 2D or 3D drawings for any simple product.

3. Describe how to develop new designs for simple products through bio-mimicry.

Model Question paper

Page 1 of 2

Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION
Course Code: EST 200
Course Name: DESIGN AND ENGINEERING
Max. Marks: 100Duration: 3 Hours

PART A

Answer all questions, each question carries 3 marks
Use only hand sketches

(1)Write aboutthe basic design process.

(2) Describe how to finalize the design objectives.

(3) State the role of divergent-convergent questioning in design thinking.

(4) Discuss how to perform design thinking in a team managing the conflicts.

(5) Show how engineering sketches and drawings convey designs.

(6)Explain the role of mathematics and physics in design engineering process.

(7) Distinguish between project-based learning and problem-based learning in design engineering.

(8) Describe how concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?

(9) Show how designs are varied based on the aspects of production methods, life span, reliability and environment?

(10) Explain how economics influence the engineering designs?

(10x3 marks =30 marks)

Part B

Answer any ONE question from each module. Each question carry 14 marks

Module 1

(11) Show the designing of a wrist watch going through the various stages of the design process. Use hand sketches to illustrate the processes.

or

(12)Find the customer requirements for designing a new car showroom. Show how the design objectives were finalized considering the design constraints?

Module 2

(13)Illustrate the design thinking approach for designing a bag for college students within a limited budget. Describe each stage of the process and the iterative procedure involved. Use hand sketches to support your arguments.

or

(14)Construct a number of possible designs and then refine them to narrow down to the best design for a drug trolley used in hospitals. Show how the divergent-convergent thinking helps in the process. Provide your rationale for each step by using hand sketches only.

Module 3

(15) Graphically communicate the design of a thermo flask used to keep hot coffee. Draw the detailed 2D drawings of the same with design detailing, material selection, scale drawings, dimensions, tolerances, etc. Use only hand sketches.

or

(16)Describe the role of mathematical modelling in design engineering. Show how mathematics and physics play a role in designing a lifting mechanism to raise 100 kg of weight to a floor at a height of 10 meters in a construction site.

Module 4

(17) Show the development of a nature inspired design for a solar poweredbus waiting shed beside a highway. Relate between natural and man-made designs. Use hand sketches to support your arguments.

or

(18)Show the design of a simple sofa and then depict how the design changes when considering 1) aesthetics and 2) ergonomics into consideration. Give hand sketches and explanations to justify the changes in designs.

Module 5

(19)Examine the changes in the design of a foot wear with constraints of 1) production methods, 2) life span requirement, 3) reliability issues and 4) environmental factors. Use hand sketches and give proper rationalization for the changes in design.

or

(20)Describe the how to estimate the cost of a particular design using ANY of the following: i) a website, ii) the layout of a plant, iii) the elevation of a building, iv) anelectrical or electronic system or device and v) a car.

Show how economics will influence the engineering designs. Use hand sketches to support your arguments.

(5x14 marks =70 marks)

Syllabus

Module 1

Design Process:- Introduction to Design and Engineering Design, Defining a Design Process-:Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.

Module 2

Design Thinking Approach:-Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Design Thinking in a Team Environment.

Module 3

Design Communication (Languages of Engineering Design):-Communicating Designs Graphically, Communicating Designs Orally and in Writing. Mathematical Modeling In Design, Prototyping and Proofing the Design.

Module 4

Design Engineering Concepts:-Project-based Learning and Problem-based Learning in Design.Modular Design and Life Cycle Design Approaches. Application of Bio-mimicry,Aesthetics and Ergonomics in Design. Value Engineering, Concurrent Engineering, and Reverse Engineering in Design.

Module 5

Expediency, Economics and Environment in Design Engineering:-Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design

Text Books

1) YousefHaik, SangarappillaiSivaloganathan, Tamer M. Shahin, Engineering Design Process, Cengage Learning 2003, Third Edition, ISBN-10: 9781305253285,

2) Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

Reference Books

1.Philip Kosky, Robert Balmer, William Keat, George Wise, Exploring Engineering, Fourth Edition: An Introduction to Engineering and Design, Academic Press 2015, 4th Edition, ISBN: 9780128012420.

2. Clive L. Dym, Engineering Design: A Project-Based Introduction, John Wiley & Sons, New York 2009, Fourth Edition, ISBN: 978-1-118-32458-5

3. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Berg Publishers 2011, First Edition, ISBN: 978-1847886361

4. Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., Engineering Design: A Systematic Approach, Springer 2007, Third Edition, ISBN 978-1-84628-319-2

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1: Design Process**	
1.1	Introduction to Design and Engineering Design. *What does it mean to design something? How Is engineering design different from other kinds of design? Where and when do engineers design? What are the basic vocabularyin engineering design? How to learn and do engineering design.*	1
1.2	*Defining a Design Process*-: Detailing Customer Requirements. *How to do engineering design? Illustrate the process with an example. How to identify the customer requirements of design?*	1
1.3	*Defining a Design Process*-: Setting Design Objectives, Identifying Constraints, Establishing Functions. *How to finalize the design objectives? How to identify the design constraints? How to express the functions a design in engineering terms?*	1
1.4	*Defining a Design Process*-: Generating Design Alternatives and Choosing a Design. *How to generate or create feasible design alternatives? How to identify the "best possible design"?*	1
1.5	Case Studies:- Stages of Design Process. *Conduct exercises for designing simple products going through the different stages of design process.*	1
2	**Module 2: Design Thinking Approach**	
2.1	Introduction to Design Thinking *How does the design thinking approach help engineers in creating innovative and efficient designs?*	1
2.2	Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. *How can the engineers arrive at better designs utilizing the iterative design thinking process (in which knowledge acquired in the later stages can be applied back to the earlier stages)?*	1
2.3	Design Thinking as Divergent-Convergent Questioning. *Describe how to create a number of possible designs and then how to refine and narrow down to the 'best design'.*	1
2.4	Design Thinking in a Team Environment. *How to perform design thinking as a team managing the conflicts ?*	1
2.5	Case Studies: Design Thinking Approach. *Conduct exercises using the design thinking approach for*	1

	designing any simple products within a limited time and budget	
3	**Module 3: Design Communication** **(Languages of Engineering Design)**	
3.1	Communicating Designs Graphically. *How do engineering sketches and drawings convey designs?*	1
3.2	Communicating Designs Orally and in Writing. *How can a design be communicated through oral presentation or technical reports efficiently?*	1
	First Series Examination	
3.3	Mathematical Modelling in Design. *How do mathematics and physics become a part of the design process?*	1
3.4	Prototyping and Proofing the Design. *How to predict whether the design will function well or not?*	1
3.5	Case Studies: Communicating Designs Graphically. *Conduct exercises for design communication through detailed 2D or 3D drawings of simple products with design detailing, material selection, scale drawings, dimensions, tolerances, etc.*	1
4	**Module 4: Design Engineering Concepts**	
4.1	Project-based Learning and Problem-based Learning in Design. *How engineering students can learn design engineering through projects?* *How students can take up problems to learn design engineering?*	1
4.2	Modular Design and Life Cycle Design Approaches. *What is modular approach in design engineering? How it helps?* *How the life cycle design approach influences design decisions?*	1
4.3	Application of Bio-mimicry, Aesthetics and Ergonomics in Design. *How do aesthetics and ergonomics change engineering designs?* *How do the intelligence in nature inspire engineering designs? What are the common examples of bio-mimicry in engineering?*	1
4.4	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design. *How do concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?*	1
4.5	Case Studies: Bio-mimicry based Designs. *Conduct exercises to develop new designs for simple*	1

	products using bio-mimicry and train students to bring out new nature inspired designs.	
5	**Module 5: Expediency, Economics and Environment in Design Engineering**	
5.1	Design for Production, Use, and Sustainability. *How designs are finalized based on the aspects of production methods, life span, reliability and environment?*	1
5.2	Engineering Economics in Design. *How to estimate the cost of a particular design and how will economics influence the engineering designs?*	1
5.3	Design Rights. *What are design rights and how can an engineer put it into practice?*	1
5.4	Ethics in Design. *How do ethics play a decisive role in engineering design?*	1
5.5	Case Studies: Design for Production, Use, and Sustainability. *Conduct exercises using simple products to show how designs change with constraints of production methods, life span requirement, reliability issues and environmental factors.*	1
Second Series Examination		

Code.	Course Name	L	T	P	Hrs	Credit
HUT 200	**Professional Ethics**	2	0	0	2	2

Preamble: To enable students to create awareness on ethics and human values.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the core values that shape the ethical behaviour of a professional.
CO 2	Adopt a good character and follow an ethical life.
CO 3	Explain the role and responsibility in technological development by keeping personal ethics and legal ethics.
CO 4	Solve moral and ethical problems through exploration and assessment by established experiments.
CO 5	Apply the knowledge of human values and social values to contemporary ethical values and global issues.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1								2			2	
CO 2								2			2	
CO 3								3			2	
CO 4								3			2	
CO 5								3			2	

Assessment Pattern

Bloom's category	Continuous Assessment Tests		End Semester Exam
	1	2	
Remember	15	15	30
Understood	20	20	40
Apply	15	15	30

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Tests (2 Nos) : 25 marks
Assignments/Quiz : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

<u>Course Level Assessment Questions</u>

Course Outcome 1 (CO1):

1. Define integrity and point out ethical values.
2. Describe the qualities required to live a peaceful life.
3. Explain the role of engineers in modern society.

Course Outcome 2 (CO2)

1. Derive the codes of ethics.
2. Differentiate consensus and controversy.
3. Discuss in detail about character and confidence.

Course Outcome 3(CO3):

1. Explain the role of professional’s ethics in technological development.
2. Distinguish between self interest and conflicts of interest.
3. Review on industrial standards and legal ethics.

Course Outcome 4 (CO4):

1. Illustrate the role of engineers as experimenters.
2. Interpret the terms safety and risk.
3. Show how the occupational crimes are resolved by keeping the rights of employees.

Course Outcome 5 (CO5):

1. Exemplify the engineers as managers.
2. Investigate the causes and effects of acid rain with a case study.
3. Explorate the need of environmental ethics in technological development.

Model Question paper

QP CODE: **Reg No:**_____________

PAGES:3 **Name :**_____________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: HUT 200
Course Name: PROFESSIONAL ETHICS

Max. Marks: 100 **Duration: 3 Hours**

(2019-Scheme)

PART A

(Answer all questions, each question carries 3 marks)

1. Define empathy and honesty.

2. Briefly explain about morals, values and ethics.

3. Interpret the two forms of self-respect.

4. List out the models of professional roles.

5. Indicate the advantages of using standards.

6. Point out the conditions required to define a valid consent?

7. Identify the conflicts of interests with an example?

8. Recall confidentiality.

9. Conclude the features of biometric ethics.

10. Name any three professional societies and their role relevant to engineers.

(10x3 = 30 marks)

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Classify the relationship between ethical values and law?

b) Compare between caring and sharing. (10+4 = 14 marks)

Or

12. a) Exemplify a comprehensive review about integrity and respect for others.

b) Discuss about co-operation and commitment. (8+6 = 14 marks)

MODULE II

13.a) Explain the three main levels of moral developments, deviced by Kohlberg.

b) Differentiate moral codes and optimal codes. (10+4 = 14 marks)

Or

14. a) Extrapolate the duty ethics and right ethics.

b) Discuss in detail the three types of inquiries in engineering ethics (8+6 = 14 marks)

MODULE III

15.a) Summarize the following features of morally responsible engineers.

(i) Moral autonomy **(ii)** Accountability

b)Explain the rights of employees (8+6 = 14 marks)

Or

16. a) Explain the reasons for Chernobyl mishap ?

b) Describe the methods to improve collegiality and loyalty. (8+6 = 14 marks)

MODULE IV

17.a) Execute collegiality with respect to commitment, respect and connectedness.

b) Identify conflicts of interests with an example. (8+6 = 14 marks)

Or

18. a) Explain in detail about professional rights and employee rights.

b) Exemplify engineers as managers.

MODULE V

19.a) Evaluate the technology transfer and appropriate technology.

b) Explain about computer and internet ethics. (8+6 = 14 marks)

Or

20. a) Investigate the causes and effects of acid rain with a case study.

b) Conclude the features of ecocentric and biocentric ethics. (8+6 = 14 marks)

Syllabus

Module 1 – Human Values.

Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue-Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment-Empathy-Self Confidence -Social Expectations.

Module 2 - Engineering Ethics & Professionalism.

Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas –Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy-Profession and Professionalism- Models of professional roles-Theories about right action –Self interest-Customs and Religion- Uses of Ethical Theories.

Module 3- Engineering as social Experimentation.

Engineering as Experimentation – Engineers as responsible Experimenters- Codes of Ethics- Plagiarism- A balanced outlook on law - Challenges case study- Bhopal gas tragedy.

Module 4- Responsibilities and Rights.

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining- Confidentiality- Role of confidentiality in moral integrity-Conflicts of interest- Occupational crime- Professional rights- Employee right- IPR Discrimination.

Module 5- Global Ethical Issues.

Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics -Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors-Moral leadership.

Text Book

1. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012.
2. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited ,New Delhi,2006.

Reference Books

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
2. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
3. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states,2005.
4. http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics**.**

Course Contents and Lecture Schedule

SL.No	Topic	No. of Lectures 25
1	**Module 1 – Human Values.**	
1.1	Morals, values and Ethics, Integrity, Academic Integrity,Work Ethics	1
1.2	Service Learning, Civic Virtue, Respect for others, Living peacefully	1
1.3	Caring and Sharing, Honesty, Courage, Co-operation commitment	2
1.4	Empathy, Self Confidence, Social Expectations	1
2	**Module 2- Engineering Ethics & Professionalism.**	
2.1	Senses of Engineering Ethics, Variety of moral issues, Types of inquiry	1
2.2	Moral dilemmas, Moral Autonomy, Kohlberg's theory	1
2.3	Gilligan's theory, Consensus and Controversy,Profession& Professionalism, Models of professional roles, Theories about right action	2
2.4	Self interest-Customs and Religion, Uses of Ethical Theories	1
3	**Module 3- Engineering as social Experimentation.**	
3.1	Engineering as Experimentation, Engineers as responsible Experimenters	1
3.2	Codes of Ethics,Plagiarism, A balanced outlook on law	2
3.3	Challenger case study, Bhopal gas tragedy	2
4	**Module 4- Responsibilities and Rights.**	
4.1	Collegiality and loyalty, Managing conflict, Respect for authority	1
4.2	Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest	2
4.3	Occupational crime, Professional rights, Employee right, IPR Discrimination	2
5	**Module 5- Global Ethical Issues.**	
5.1	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics	2
5.2	Role in Technological Development, Moral leadership	1
5.3	Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	2

SEMESTER -3

ECT201	SOLID STATE DEVICES	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to understand the physics and working of solid state devices.

Prerequisite: EST130 Basics of Electrical and Electronics Engineering

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply Fermi-Dirac Distribution function and Compute carrier concentration at equilibrium and the parameters associated with generation, recombination and transport mechanism
CO 2	Explain drift and diffusion currents in extrinsic semiconductors and Compute current density due to these effects.
CO 3	Define the current components and derive the current equation in a pn junction diode and bipolar junction transistor.
CO 4	Explain the basic MOS physics and derive the expressions for drain current in linear and saturation regions.
CO 5	Discuss scaling of MOSFETs and short channel effects.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										
CO 2	3	3										
CO 3	3	3										
CO 4	3	3										
CO 5	3											

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	25	25	50
Apply	15	15	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Compute carrier concentration at equilibrium and the parameters associated with generation, recombination and transport mechanism

1. Derive the expression for equilibrium electron and hole concentration.

2. Explain the different recombination mechanisms

3. Solve numerical problems related to carrier concentrations at equilibrium, energy band diagrams and excess carrier concentrations in semiconductors.

Course Outcome 2 (CO2) : Compute current density in extrinsic semiconductors in specified electric field and due to concentration gradient.

1. Derive the expression for the current density in a semiconductor in response to the applied electric field.

2. Derive the expression for diffusion current in semiconductors.

3. Show that diffusion length is the average distance a carrier can diffuse before recombining.

Course Outcome 3 (CO3): Define the current components and derive the current equation in a pn junction diode and bipolar junction transistor.

1. Derive ideal diode equation.

2. Derive the expression for minority carrier distribution and terminal currents in a BJT.

3. Solve numerical problems related to PN junction diode and BJT.

Course Outcome 4 (CO4): Explain the basic MOS physics with specific reference on MOSFET characteristics and current derivation.

1. Illustrate the working of a MOS capacitor in the three different regions of operation.

2. Explain the working of MOSFET and derive the expression for drain current.

3. Solve numerical problems related to currents and parameters associated with MOSFETs.

Course Outcome 5 (CO5): Discuss the concepts of scaling and short channel effects of MOSFET.

1. Explain the different MOSFET scaling techniques.

2. Explain the short channel effects associated with reduction in size of MOSFET.

SYLLABUS

MODULE I

Elemental and compound semiconductors, Intrinsic and Extrinsic semiconductors, concept of effective mass, Fermions-Fermi Dirac distribution, Fermi level, Doping & Energy band diagram, Equilibrium and steady state conditions, Density of states & Effective density of states, Equilibrium concentration of electrons and holes.

Excess carriers in semiconductors: Generation and recombination mechanisms of excess carriers, quasi Fermi levels.

MODULE II

Carrier transport in semiconductors, drift, conductivity and mobility, variation of mobility with temperature and doping, Hall Effect.
Diffusion, Einstein relations, Poisson equations, Continuity equations, Current flow equations, Diffusion length, Gradient of quasi Fermi level

MODULE III

PN junctions : Contact potential, Electrical Field, Potential and Charge distribution at the junction, Biasing and Energy band diagrams, Ideal diode equation.
Metal Semiconductor contacts, Electron affinity and work function, Ohmic and Rectifying Contacts, current voltage characteristics.
Bipolar junction transistor, current components, Transistor action, Base width modulation.

MODULE IV

Ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, threshold voltage, body effect, MOSFET-structure, types, Drain current equation (derive)-linear and saturation region, Drain characteristics, transfer characteristics.

MODULE V

MOSFET scaling – need for scaling, constant voltage scaling and constant field scaling.

Sub threshold conduction in MOS.
Short channel effects- Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects.
Non-Planar MOSFETs: Fin FET –Structure, operation and advantages

Text Books

1. Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, Pearson 6/e, 2010 (Modules I, II and III)

2. Sung Mo Kang, CMOS Digital Integrated Circuits: Analysis and Design, McGraw-Hill, Third Ed., 2002 (Modules IV and V)

Reference Books

1. Neamen, Semiconductor Physics and Devices, McGraw Hill, 4/e, 2012
2. Sze S.M., Semiconductor Devices: Physics and Technology, John Wiley, 3/e, 2005
3. Pierret, Semiconductor Devices Fundamentals, Pearson, 2006
4. Sze S.M., Physics of Semiconductor Devices, John Wiley, 3/e, 2005
5. Achuthan, K N Bhat, Fundamentals of Semiconductor Devices, 1e, McGraw Hill,2015
6. Yannis Tsividis, Operation and Modelling of the MOS Transistor, Oxford University Press.
7. Jan M.Rabaey, Anantha Chandrakasan, Borivoje Nikolic, Digital Integrated Circuits - A Design Perspective, PHI.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**MODULE 1**	
1.1	Elemental and compound semiconductors, Intrinsic and Extrinsic semiconductors, Effective mass	2
1.2	Fermions-Fermi Dirac distribution, Fermi level, Doping & Energy band diagram,	2
1.3	Equilibrium and steady state conditions, Density of states & Effective density of states	1
1.4	Equilibrium concentration of electrons and holes.	1
1.5	Excess carriers in semiconductors: Generation and recombination mechanisms of excess carriers, quasi Fermi levels.	2
1.6	TUTORIAL	2
2	**MODULE 2**	
2.1	Carrier transport in semiconductors, drift, conductivity and mobility,	2

	variation of mobility with temperature and doping.	
2.2	Diffusion equation	1
2.3	Einstein relations, Poisson equations	1
2.4	Poisson equations, Continuity equations, Current flow equations	1
2.5	Diffusion length, Gradient of quasi Fermi level	1
2.6	TUTORIAL	2
3	**MODULE 3**	
3.1	PN junctions : Contact potential, Electrical Field, Potential and Charge distribution at the junction, Biasing and Energy band diagrams,	2
3.2	Ideal diode equation	1
3.3	Metal Semiconductor contacts, Electron affinity and work function, Ohmic and Rectifying Contacts, current voltage characteristics.	3
3.4	Bipolar junction transistor – working,, current components, Transistor action, Base width modulation.	2
3.5	Derivation of terminal currents in BJT	2
3.6	TUTORIAL	1
4	**MODULE 4**	
4.1	Ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion	2
4.2	Threshold voltage, body effect	1
4.3	MOSFET-structure, working, types,	2
4.4	Drain current equation (derive)- linear and saturation region, Drain characteristics, transfer characteristics.	2
4.5	TUTORIAL	1
5	**MODULE 5**	
5.1	MOSFET scaling – need for scaling, constant voltage scaling and constant field scaling.	2
5.2	Sub threshold conduction in MOS.	1
5.3	Short channel effects- Channel length modulation, Drain Induced Barrier Lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects.	3
5.4	Non-Planar MOSFETs: Fin FET –Structure, operation and advantages	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

MODEL QUESTION PAPER

ECT 201 SOLID STATE DEVICES

Time: 3 hours **Max. Marks:100**

PART A

Answer ***all*** questions. Each question carries ***3 marks***.

1. Draw the energy band diagram of P type and N type semiconductor materials, clearly indicating the different energy levels.
2. Indirect recombination is a slow process. Justify
3. Explain how mobility of carriers vary with temperature.
4. Show that diffusion length is the average length a carrier moves before recombination.
5. Derive the expression for contact potential in a PN junction diode.
6. Explain Early effect? Mention its effect on terminal currents of a BJT.
7. Derive the expression for threshold voltage of a MOSFET.
8. Explain the transfer characteristics of a MOSFET in linear and saturation regions.
9. Explain Subthreshold conduction in a MOSFET. Write the expression for Subthreshold current.
10. Differentiate between constant voltage scaling and constant field scaling

PART B

Answer ***any one*** question from each module. Each question carries 14 marks.

MODULE I

11. (a) Derive law of mass action. (8 marks)

(b) An n-type Si sample with $N_d = 10^5$ cm^{-3} is steadily illuminated such that $g_{op} = 10^{21}$ EHP/cm^3 s. If $\tau_n = \tau_p = 1\mu s$ for this excitation. Calculate the separation in the Quasi-Fermi levels (F_n-F_p). Draw the Energy band diagram.. (6 marks)

12. (a) Draw and explain Fermi Dirac Distribution function and position of Fermi level in intrinsic and extrinsic semiconductors. (8 marks)

(b) The Fermi level in a Silicon sample at 300 K is located at 0.3 eV below the bottom of the conduction band. The effective densities of states N_C= 3.22 X 10^{19} cm^{-3} and N_V=1.83 x 10^{19} cm^{-3}. Determine (a) the electron and hole concentrations at 300K (b) the intrinsic carrier concentration at 400 K. (6 marks)

MODULE II

13. (a) Derive the expression for mobility, conductivity and Drift current density in a semiconductor. (8 marks)

(b) A Si bar 0.1 µm long and 100 µm^2 in cross-sectional area is doped with 10^{17} cm^{-3} phosphorus. Find the current at 300 K with 10 V applied. (b). How long will it take an average electron to drift 1 µm in pure Si at an electric field of 100 V/cm? (6 marks)

14. (a) A GaAs sample is doped so that the electron and hole drift current densities are equal in an applied electric field. Calculate the equilibrium concentration of electron and hole, the net doping and the sample resistivity at 300 K. Given μ_n = 8500 cm^2/Vs, μ_p = 400 cm^2/Vs, n_i = 1.79 x 10^6 cm^{-3}. (7 marks)

(b) Derive the steady-state diffusion equations in semiconductors. (6 marks)

MODULE III

15. (a) Derive the expression for ideal diode equation. State the assumptions used. (9 marks)

(b) Boron is implanted into an n-type Si sample (N_d = 10^{16}cm^{-3}), forming an abrupt junction of square cross section with area = 2 x 10^{-3} cm^2 . Assume that the acceptor concentration in the p-type region is N_a = 4 x 10^{18} cm^{-3} . Calculate V_0 , W, Q+, and E_0 for this junction at equilibrium (300 K). (5 marks)

16. With the aid of energy band diagrams, explain how a metal – N type Schottky contact function as rectifying and ohmic contacts. (14 marks)

MODULE IV

17. (a) Starting from the fundamentals, derive the expression for drain current of a MOSFET in the two regions of operation. (8 Marks)

(b) Find the maximum depletion width, minimum capacitance C_i, and threshold voltage for an ideal MOS capacitor with a 10-nm gate oxide ($Si0_2$) on p-type Si with N_a = 10^{16} cm^{-3}. (b) Include the effects of flat band voltage, assuming an n + polysilicon gate and fixed oxide charge of 5 x 10^{10} q (C/cm^2). (6 marks)

18. (a) Explain the CV characteristics of an ideal MOS capacitor (8 Marks)

(b) For a long channel n-MOSFET with W = 1V, calculate the V_G required for an $I_{D(sat.)}$ of 0.1 mA and $V_{D(sat.)}$ of 5V. Calculate the small-signal output conductance g and V the transconductance $g_{m(sat.)}$ at V_D = 10V. Recalculate the new I_D for (V_G - V_T) = 3 and V_D = 4V. (6 marks)

MODULE V

19. Explain Drain induced barrier lowering, Velocity Saturation, Threshold Voltage Variations and Hot Carrier Effects associated with scaling down of MOSFETs (14 marks)

20. With the aid of suitable diagrams explain the structure and working of a FINFET. List its advantages (14 marks)

ECT 203	**LOGIC CIRCUIT DESIGN**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		PCC	**3**	**1**	**0**	**4**

Preamble: This course aims to impart the basic knowledge of logic circuits and enable students to apply it to design a digital system.

Prerequisite: EST130 Basics of Electrical and Electronics Engineering

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the elements of digital system abstractions such as digital representations of information, digital logic and Boolean algebra
CO 2	Create an implementation of a combinational logic function described by a truth table using and/or/inv gates/ muxes
CO 3	Compare different types of logic families with respect to performance and efficiency
CO 4	Design a sequential logic circuit using the basic building blocks like flip-flops
CO 5	Design and analyze combinational and sequential logic circuits through gate level Verilog models.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										
CO 2	3	3	3									
CO 3	3	3										
CO 4	3	3	3									
CO 5	3	3	3		3							

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Course project : 15 marks

It is mandatory that a *course project* shall be undertaken by a student for this subject. The course project can be performed either as a hardware realization/simulation of a typical digital system using combinational or sequential logic. Instead of two assignments, two evaluations may be performed on the course project along with series tests, each carrying 5 marks. Upon successful completion of the project, a brief report shall be submitted by the student which shall be evaluated for 5 marks. The report has to be submitted for academic auditing. A few samples projects are given below:

Sample course projects:

1. M-Sequence Generator Psuedo random sequences are popularly used in wireless communication. A sequence generator is used to produce pseudo random codes that are useful in spread spectrum applications. Their generation relies on irreducible polynomials.A maximal length sequence generator that relies on the polynomial P (D) = $D^7 + D^3 + 1$, with each D represent delay of one clock cycle.

- An 8-bit shift register that is configured as a ring counter may be used realize the above equation.
- This circuit can be developed in verilog, simulated, synthesized and programmed into a tiny FPGA and tested in real time.
- Observe the M-sequnce from parallel outputs of shift register for one period . Count the number of 1s and zeros in one cycle.
- Count the number of runs of 1s in singles, pairs, quads etc. in the pattern.

2. BCD Subtractor

- Make 4 -bit parallel adder circuit in verilog.
- Make a one digit BCD subtracter in Verilog, synthesize and write into a tiny FPGA.
- Test the circuit with BCD inputs.

3. Digital Thermometer

- Develop a circuit with a temperature sensor and discrete components to measure and dispaly temperature.
- Solder the circuit on PCB and test it.

4. Electronic Display

- This display should receive the input from an alphanumeric keyboard and display it on an LCD diplay.
- The decoder and digital circuitry is to developed in Verilog and programmed into a tiny FPGA.

5. Electronic Roulette Wheel

- 32 LEDs are placed in a circle and numbered that resembles a roulette wheel.
- A 32-bit shift register generates a random bit pattern with a single 1 in it.
- When a push button is pressed the single 1 lights one LED randomly.
- Develop the shift register random pattern generator in verilog and implement on a tiny FPGA and test the circuit.

6. Three Bit Carry Look Ahead Adder

- Design the circuit of a three bit carry look ahead adder.
- Develop the verilog code for it and implement and test it on a tiny FPGA. item Compare the performance with a parallel adder.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. The questions on verlog modelling should not have a credit more than 25% of the whole mark.

Course Level Assessment Questions

Course Outcome 1 (CO1) : Number Systems and Codes

1. Consider the signed binary numbers A = 01000110 and B = 11010011 where B is in 2's complement form. Find the value of the following mathematical expression (i) A + B (ii) A – B
2. Perform the following operations (i)$D9CE_{16}$-$CFDA_{16}$ (ii) 6575_8-5732_8
3. Convert decimal 6,514 to both BCD and ASCII codes. For ASCII, an even parity bit is to be appended at the left.

Course Outcome 2 (CO2) : Boolean Postulates and combinational circuits

1. Design a magnitude comparator to compare two 2-bit numbers A = A_1A_0 and B = B_1B_0B
2. Simplify using K-map F(a,b,c,d) = Σ m (4,5,7,8,9,11,12,13,15)
3. Explain the operation of a 8x1 multiplexer and implement the following using an 8x1 multiplexer F(A, B, C, D) = Σ m (0, 1, 3, 5, 6, 7, 8, 9, 11, 13, 14)

Course Outcome 3 (CO3) : Logic families and its characteristics

1. Define the terms noise margin, propagation delay and power dissipation of logic families. Compare TTL and CMOS logic families showing the values of above mentioned terms.
2. Draw the circuit and explain the operation of a TTL NAND gate
3. Compare TTL, CMOS logic families in terms of fan-in, fan-out and supply voltage

Course Outcome 4 (CO4) : Sequential Logic Circuits

1. Realize a T flip-flop using NAND gates and explain the operation with truth table, excitation table and characteristic equation
2. Explain a MOD 6 asynchronous counter using JK Flip Flop
3. Draw the logic diagram of 3 bit PIPO shift register with LOAD/SHIFT control and explain its working

Course Outcome 5 (CO5) : Logic Circuit Design using HDL

1. Design a 4-to-1 mux using gate level Verilog model.
2. Design a verilog model for a hald adder circuit. Make a one bit full adder by connecting two half adder models.
3. Compare concurrent signal assignment versus sequential signal assignment.

Syllabus

Module 1: Number Systems and Codes:

Binary and hexadecimal number systems; Methods of base conversions; Binary and hexadecimal arithmetic; Representation of signed numbers; Fixed and floating point numbers; Binary coded decimal codes; Gray codes; Excess 3 code. Alphanumeric codes: ASCII. Basics of verilog -- basic language elements: identifiers, data objects, scalar data types, operators.

Module 2: Boolean Postulates and Fundamental Gates

Boolean postulates and laws – Logic Functions and Gates De-Morgan's Theorems, Principle of Duality, Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS), Canonical forms, Karnaugh map Minimization. Modeling in verilog, Implementation of gates with simple verilog codes.

Module 3: Combinatorial and Arithmetic Circuits

Combinatorial Logic Systems - Comparators, Multiplexers, Demultiplexers, Encoder, Decoder. Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder. Modeling and simulation of combinatorial circuits with verilog codes at the gate level.

Module 4: Sequential Logic Circuits:

Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Conversion of Flipflops, Excitation table and characteristic equation. Implementation with verilog codes. Ripple and Synchronous counters and implementation in verilog, Shift registers-SIPO, SISO, PISO, PIPO. Shift Registers with parallel Load/Shift, Ring counter and Johnsons counter. Asynchronous and Synchronous counter design, Mod N counter. Modeling and simulation of flipflops and counters in verilog.

Module 5: Logic families and its characteristics:

TTL, ECL, CMOS - Electrical characteristics of logic gates – logic levels and noise margins, fan-out, propagation delay, transition time, power consumption and power-delay product. TTL inverter - circuit description and operation; CMOS inverter - circuit description and operation; Structure and operations of TTL and CMOS gates; NAND in TTL and CMOS, NAND and NOR in CMOS.

Text Books

1. Mano M.M., Ciletti M.D., "Digital Design", Pearson India, 4th Edition. 2006
2. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989

3. S. Brown, Z. Vranesic, "Fundamentals of Digital Logic with Verilog Design", McGraw Hill
4. Samir Palnikar"Verilog HDL: A Guide to Digital Design and Syntheis", Sunsoft Press
5. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009

Reference Books

1. W.H. Gothmann, "Digital Electronics – An introduction to theory and practice", PHI, 2nd edition ,2006
2. Wakerly J.F., "Digital Design: Principles and Practices," Pearson India, 4th 2008

.

3. A. Ananthakumar ,"Fundamentals of Digital Circuits", Prentice Hall, 2nd edition, 2016
4. Fletcher, William I., An Engineering Approach to Digital Design, 1st Edition, Prentice Hall India, 1980

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Number Systems and Codes**:	
1.1	Binary, octal and hexadecimal number systems; Methods of base conversions;	2
1.2	Binary, octal and hexadecimal arithmetic;	1
1.3	Representation of signed numbers; Fixed and floating point numbers;	3
1.4	Binary coded decimal codes; Gray codes; Excess 3 code :	1
1.5	Error detection and correction codes - parity check codes and Hamming code-Alphanumeric codes:ASCII	3
1.6	Verilog basic language elements: identifiers, data objects, scalar data types, operators	2
2	**Boolean Postulates and Fundamental Gates:**	
2.1	Boolean postulates and laws – Logic Functions and Gates, De-Morgan's Theorems, Principle of Duality	2
2.2	Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS)	2
2.3	Canonical forms, Karnaugh map Minimization	1
2.4	Gate level modelling in Verilog: Basic gates, XOR using NAND and NOR	2
3	**Combinatorial and Arithmetic Circuits**	
3.1	Combinatorial Logic Systems - Comparators, Multiplexers, Demultiplexers	2
3.2	Encoder, Decoder, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder	3

3.3	Gate level modelling combinational logic circuits in Verilog: half adder, full adder, mux, demux, decoder, encoder	3
4	**Sequential Logic Circuits:**	
4.1	Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF	2
4.2	Conversion of Flipflops, Excitation table and characteristic equation.	1
4.3	Ripple and Synchronous counters, Shift registers-SIPO.SISO,PISO,PIPO	2
4.4	Ring counter and Johnsons counter, Asynchronous and Synchronous counter design	3
4.5	Mod N counter, Random Sequence generator	1
4.6	Modelling sequential logic circuits in Verilog: flipflops, counters	2
5	**Logic families and its characteristics**:	
5.1	TTL,ECL,CMOS- Electrical characteristics of logic gates – logic levels and noise margins, fan-out, propagation delay, transition time, power consumption and power-delay product.	3
5.2	TTL inverter - circuit description and operation	1
5.3	CMOS inverter - circuit description and operation	1
5.4	Structure and operations of TTL and CMOS gates; NAND in TTL, NAND and NOR in CMOS.	2

Simulation Assignments (ECT203)

The following simulations can be done in QUCS, KiCad or PSPICE.

BCD Adder

- Realize a one bit paraller adder, simulate and test it.
- Cascade four such adders to form a four bit parallel adder.
- Simulate it and make it into a subcircuit.
- Develop a one digit BCD adder, based on the subcircuit, simulate and test it

BCD Subtractor

- Use the above 4 -bit adder subcircuit, implement and simulate a one digit BCD subtractor.
- Test it with two BCD inputs

Logic Implementation with Multiplexer

- Develop an 8 : 1 multiplexer using gates, simulate, test and make it into a subcircuit.
- Use this subcircuit to implement the logic function $f(A, B, C) = \sum m(1, 3, 7)$
- Modify the truth table properly and implement the logic function $f(A, B, C, D) = \sum m(1, 4, 12, 14)$ using one 8 : 1 multiplexer.

BCD to Seven Segment Decoder

- Develop a BCD to seven segment decoder using gates and make it into a subcircuit.
- simulate this and test it

Ripple Counters

- Understand the internal circuit of 7490 IC and develop it in the simulator.
- Make it into a subcircuit and simulate it. Observe the truth table and timing diagrams for mod-5, mod-2 and mod-10 operation.
- Develop a mod-40 (mod-8 and mod-5) counter by cascading two such subcircuits.
- Simulate and observe the timing diagram and truth table.

Synchronous Counters

- Design and develop a 4-bit synchronous counter using J-K flip-flops.
- Perform digital simulation and observe the timing diagram and truth table.

Sequence Generator

- Connect D flip-flops to realize and 8-bit shift register and make it into a subcircuit.
- sequence generator that relies on the polynomial $P(D) = D_7 + D_3 + 1$, with each D represent delay of one clock cycle
- Simulate and observe this maximal length pseudo random sequence.

Transfer Characteristics of TTL and CMOS Inverters

- Develop a standard TTL circuit and perform sweep simulation and observe the transfer characteristics. Compute the threshold voltage and noise margns.
- Develop and simulate standard CMOS inverter circuit and perform sweep simulation and observe the transfer characteristics. Compute the threshold voltage and noise margins.

Model Question Paper

A P J Abdul Kalam Technological University

Third Semester B Tech Degree Examination

Branch: Electronics and Communication

Course: ECT 203 Logic Circuit Design

Time: 3 Hrs **Max. Marks: 100**

PART A

Answer All Questions

1	Convert 203.52_{10} to binary and hexadecimal.	(3)	K_1
2	Compare bitwise and logical verilog operators	(3)	K_1
3	Prove that NAND and NOR are not associative.	(3)	K_2
4	Convert the expression $\mathrm{ABCD}+\mathrm{AB}\overline{C}+\mathrm{ACD}$ to minterms.	(3)	K_2
5	Define expressions in Verilog with example.	(3)	K_2
6	Explain the working of a decoder.	(3)	K_1
7	What is race around condition?	(3)	K_1
8	Convert a T flip-flop to D flip-flop.	(3)	K_2
9	Define fan-in and fan-out of logic circuits.	(3)	K_2
10	Define noise margin and how can you calculate it?	(3)	K_2

PART B

Answer one question from each module. Each question carries 14 mark.

Module I

11(A)	Subtract 46_{10} from 100_{10} using 2's complement arithmetic.	(8)	K_2
11(B)	Give a brief description on keywords and identifiers in Verilog with example.	(6)	K_2

OR

12(A) Explain the floating and fixed point representation of numbers (8) K_2

12(A) Explain the differences between programming lanuguages and HDLs (6) K_2

Module II

13(A) Simplify using K-map (7) K_3

$$f(A,B,C,D)=\sum m(4,5,7,8,9,11,12,13,15)$$

using K-maps

13(B) Write a Verilog code for implementing above function (7) K_3

OR

14(A) Write a Verilog code to implement the basic gates. (7) K_3

14(B) Reduce the following Boolean function using K-Map and implement the simplified function using the logic gates (7) K_3

$$f(A,B,C,D)=\sum(0,1,4,5,6,8,9,10,12,13,14)$$

Module III

15(A) Design a 3-bit magnitude comparator circuit. (8) K_3

15(B) Write a Verilog description for a one bit full adder circuit. (6) K_3

OR

16(A) Write a verilog code to implement 4:1 multiplexer (6) K_3

16(B) Implement the logic function (8) K_3

$$f(A,B,C)=\sum m(0,1,4,7)$$

using 8 : 1 and 4 : 1 multiplexers.

Module IV

17	Design MOD 12 asynchronous counter using T flip-flop.	(14)	K_3

OR

18(A)	Explain the operation of Master Slave JK flipflop.	(7)	K_3
18(B)	Derive the ouput Q_{n+1} in Terms of J_n, K_n and Q_n	(7)	K_3

Module V

19(A)	Explain in detail about TTL with open collector output configuration.	(8)	K_2
19(B)	Draw an ECL basic gate and explain.	(6)	K_2

OR

20(A)	Demonstrate the CMOS logic circuit configuration and characteristics in detail.	(8)	K_2
20(B)	Compare the characteristics features of TTL and ECL digital logic families	(6)	K_2

ECT205	NETWORK THEORY	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to analyze the linear time invariant electronic circuits.

Prerequisite: EST130 Basics of Electrical and Electronics Engineering

MAT102 Vector Calculus, Differential Equations and Transforms (Laplace Transform)

Course Outcomes: After the completion of the course the student will be able to

CO 1 K3	Apply Mesh / Node analysis or Network Theorems to obtain steady state response of the linear time invariant networks.
CO 2 K3	Apply Laplace Transforms to determine the transient behaviour of RLC networks.
CO 3 K3	Apply Network functions and Network Parameters to analyse the single port and two port networks.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember K1	10	10	10
Understand K2	20	20	20
Apply K3	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Obtain steady state response of the network using Mesh / Node analysis. (K3)

1. Enumerate different types of sources in electronic networks.

2. Solve networks containing independent and dependent sources using Mesh / Node analysis.

3. Evolve the steady-state AC analysis of a given network using Mesh or Node analysis.

Course Outcome 1 (CO1) : Obtain steady state response of the network using Network Theorems. (K3)

1. Determine the branch current of the given network with dependent source using superposition theorem.

2. State and prove Maximum Power Transfer theorem.

3. Find the Thevenin's / Norton's equivalent circuit across the port of a given network having dependent source.

Course Outcome 2 (CO2): Determine the transient behaviour of network using Laplace Transforms (K3)

1. The switch is opened at t = 0 after steady state is achieved in given network. Find the expression for the transient output current.

2. Find the Laplace Transform of a given waveform.

3. In the given circuit, the switch is closed at $t = 0$, connecting an energy source to the R,C,L circuit. At time $t = 0$, it is observed that capacitor voltage has a initial value. For the element values given, determine expression for output voltage after converting the circuit into transformed domain.

Course Outcome 3 (CO3): Apply Network functions to analyse the single port and two port network. (K3)

1. What are the necessary conditions for a network Driving point function and Transfer functions?

2. Evaluate the Driving point function and Transfer function for the given network,

3. Plot the poles and zeros of the given network.

Course Outcome 3 (CO3): Apply Network Parameters to analyse the two port network. (K3)

1. Deduce the transmission parameters of two port network in terms of two port network parameters.

2. Define the condition for a two port network to be reciprocal.

3. Two identical sections of the given networks are connected in parallel. Obtain the two port network parameters of the combination.

SYLLABUS

Module 1 : Mesh and Node Analysis

Mesh and node analysis of network containing independent and dependent sources. Supermesh and Supernode analysis. Steady-state AC analysis using Mesh and Node analysis.

Module 2 : Network Theorems

Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, Maximum power transfer theorem. (applied to both dc and ac circuits having dependent source).

Module 3 : Application of Laplace Transforms

Review of Laplace Transforms and Inverse Laplace Transforms, Initial value theorem & Final value theorem, Transformation of basic signals and circuits into s-domain.
Transient analysis of RL, RC, and RLC networks with impulse, step and sinusoidal inputs (with and without initial conditions). Analysis of networks with transformed impedance and dependent sources.

Module 4 : Network functions

Network functions for the single port and two port network. Properties of driving point and transfer functions. Significance of Poles and Zeros of network functions, Time domain response from pole zero plot. Impulse Function & Response. Network functions in the sinusoidal steady state, Magnitude and Phase response.

Module 5 : Two port network Parameters

Impedance, Admittance, Transmission and Hybrid parameters of two port network. Interrelationship among parameter sets. Series and parallel connections of two port networks. Reciprocal and Symmetrical two port network. Characteristic impedance, Image impedance and propagation constant (derivation not required).

Text Books

1. Valkenburg V., “Network Analysis”, Pearson, 3/e, 2019.

2. Sudhakar A, Shyammohan S. P., “Circuits and Networks- Analysis and Synthesis”, McGraw Hill, 5/e, 2015.

Reference Books

1. Edminister, “Electric Circuits – Schaum’s Outline Series”, McGraw-Hill, 2009.

2. W. Hayt, J. Kemmerly, J. Phillips, S. Durbin, “Engineering Circuit Analysis,” McGraw Hill.

2. K. S. Suresh Kumar, “Electric Circuits and Networks”, Pearson, 2008.

3. William D. Stanley, “Network Analysis with Applications”, 4/e, Pearson, 2006.

4. Ravish R., “Network Analysis and Synthesis”, 2/e, McGraw-Hill, 2015.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Mesh and Node Analysis**	
1.1	Review of circuit elements and Kirchhoff’s Laws	2
1.2	Independent and dependent Sources, Source transformations	1
1.3	Mesh and node analysis of network containing independent and dependent sources	3
1.4	Supermesh and Supernode analysis	1
1.5	Steady-state AC analysis using Mesh and Node analysis	3
2	**Network Theorems (applied to both dc and ac circuits having dependent source)**	
2.1	Thevenin’s theorem	1
2.2	Norton’s theorem	1
2.3	Superposition theorem	2
2.4	Reciprocity theorem	1
2.5	Maximum power transfer theorem	2
3	**Application of Laplace Transforms**	
3.1	Review of Laplace Transforms	2
3.2	Initial value theorem & Final value theorem (Proof not necessary)	1
3.3	Transformation of basic signals and circuits into s-domain	2
3.4	Transient analysis of RL, RC, and RLC networks with impulse, step, pulse, exponential and sinusoidal inputs	3

3.5	Analysis of networks with transformed impedance and dependent sources	3
4	**Network functions**	
4.1	Network functions for the single port and two port network	2
4.2	Properties of driving point and transfer functions	1
4.3	Significance of Poles and Zeros of network functions, Time domain response from pole zero plot	1
4.4	Impulse Function & Response	1
4.5	Network functions in the sinusoidal steady state, Magnitude and Phase response	3
5	**Two port network Parameters**	
5.1	Impedance, Admittance, Transmission and Hybrid parameters of two port network	4
5.2	Interrelationship among parameter sets	1
5.3	Series and parallel connections of two port networks	2
5.4	Reciprocal and Symmetrical two port network	1
5.5	Characteristic impedance, Image impedance and propagation constant (derivation not required)	1

Simulation Assignments:

Atleast one assignment should be simulation of steady state and transient analysis of R, L, C circuits with different types of energy sources on any circuit simulation software. Samples of simulation assignments are listed below. The following simulations can be done in QUCS, KiCad or PSPICE.

1. Make an analytical solution of Problem 4.3 in page 113 of the book *Network Analysis* by M E Van Valkenberg. Realize this circuit in the simulator and observe *i(t)* and V_2 *(t)* using transient simulation.

2. Realize a series RLC circuit with

- R = 200Ω, L = 0.1H, C = 13.33µF
- R = 200Ω, L = 0.1H, C = 10µF and
- R = 200Ω, L = 0.1H, C = 1µF and no source respectively. The initial voltage across the capacitor is 200V Simulate the three circuits, and observe the current *i(t)* through them.

3. Repeat the above assignment for the three set of component values for a parallel RLC circuit.

4. Refer Problem 9.18 in page 208 in the book *Electric Circuits* by Nahvi and Edminister 4th Edition. See Fig. 9.28. Simulate this circuit to verify superposition theorem for the three current with individual sources and combination.

5. Refer Problem 9.22 in page 210 in the book *Electric Circuits* by Nahvi and Edminister 4th Edition. See Fig. 9.32. Implement the circuit on the simulator with V = 30< 30°. Verify the duality between the sources V and the current *I2* and *I3* using simulation.

6. See Fig. 12.40 in Chapter 12 (page 298) in the above book. Let R1 = R2 = 2kΩ, L = 10mH and C = 40nF. Implement this circuit in the simulator and perform the ac analysis to plot the frequency response.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, **(Model Question Paper)**

Course Code: ECT205

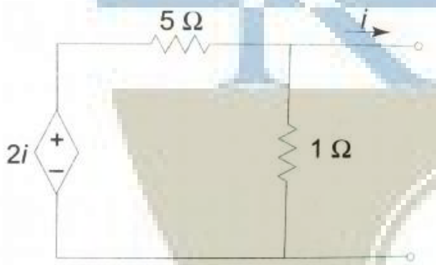
Course Name: NETWORK THEORY

Max. Marks: 100 Duration: 3 Hours

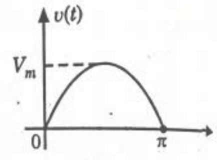
PART A

Answer ALL Questions. Each Carries 3 mark.

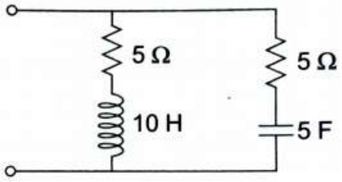
1	Illustrate the source-transformation techniques.	K2
2	Explain the concept of supernode.	K2
3	State and prove Maximum Power Transfer theorem	K1
4	Evaluate the Norton’s equivalent current in the following circuit.	K3



5	Evaluate the Laplace Transform of half-wave rectified sine pulse.	K3



6	Give the two forms of transformed impedance equivalent circuit of a capacitor with initial charge across it.	K2
7	Enumerate necessary condition for a Network Functions to be Transfer Functions.	K1
8	Obtain the pole zero configuration of the impedance function of the following circuit.	K3



9 Define the short-circuit admittance parameter with its equivalent circuit. K2

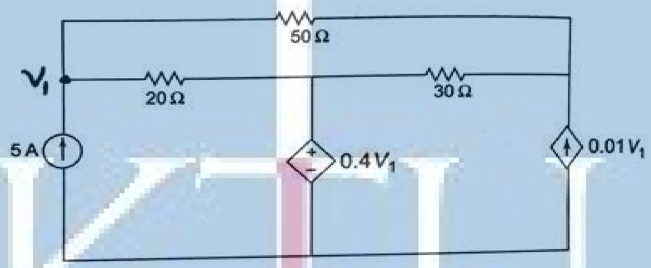
10 Deduce Z-parameter in terms of h-parameter. K2

PART – B

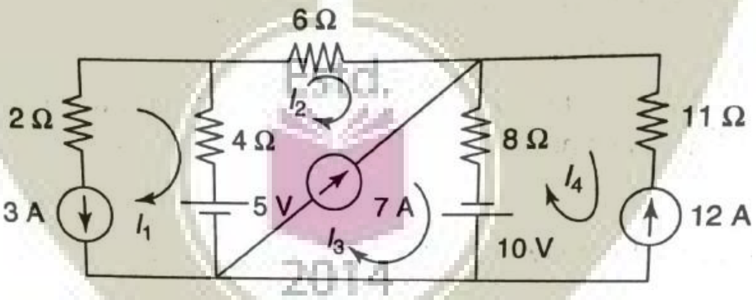
Answer one question from each module; each question carries 14 marks.

Module - I

11 a. Find the voltage V_1 using nodal analysis. 7 CO1 K3

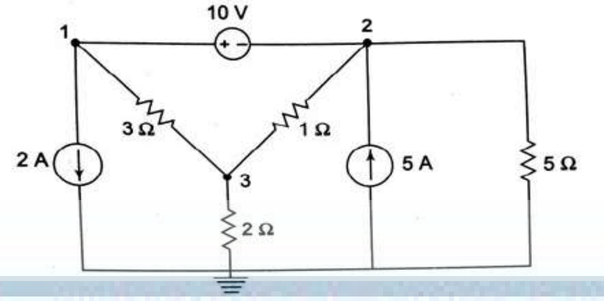


b. Find the current through 8 ohms resistor in the following circuit using mesh analysis. 7 CO1 K3

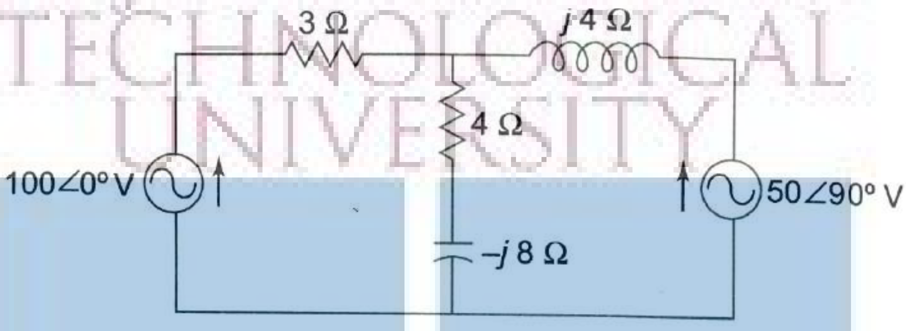


OR

12 Find the power delivered by the 5A current source using nodal analysis method. 7 CO1 K3



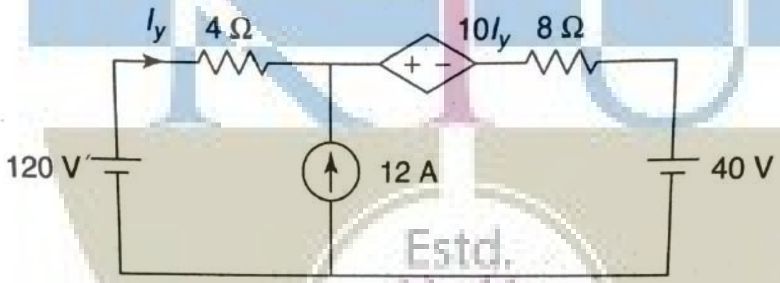
b. Determine the values of source currents using Mesh analysis 7



CO1
K3

Module - II

13 a. Find the current ***I**$_y$* by superposition principle. 7

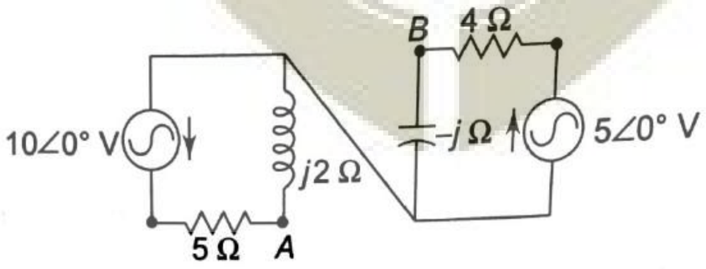


CO1
K3

b. Find the Norton’s equivalent circuit across the port **AB**. 7

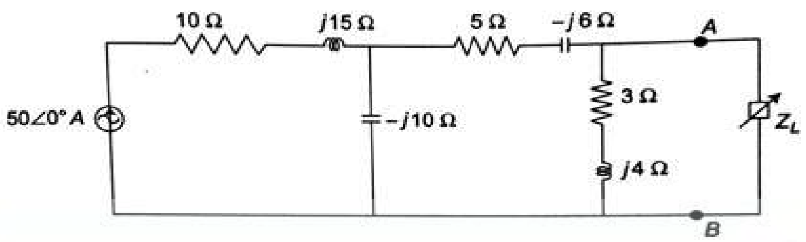
CO1

K3



OR

14 Determine the maximum power delivered to the load in the circuit. 14



CO1

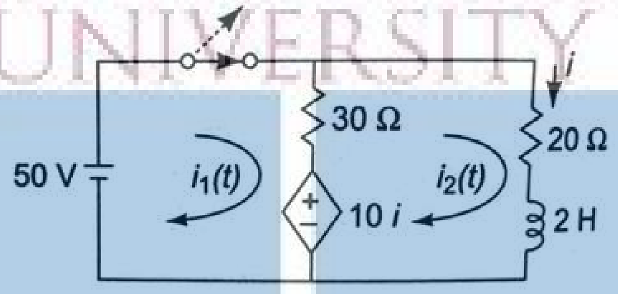
K3

Module - III

15 a. The switch is opened at t = 0 after steady state is achieved. Find the expression for the transient current ***i***. 8

CO2

K3



b. A voltage pulse of unit height and width ***' T '*** is applied to a low pass RC circuit at time t=0. Determine the expression for the voltage across the capacitor C as a function of time. 6

CO2

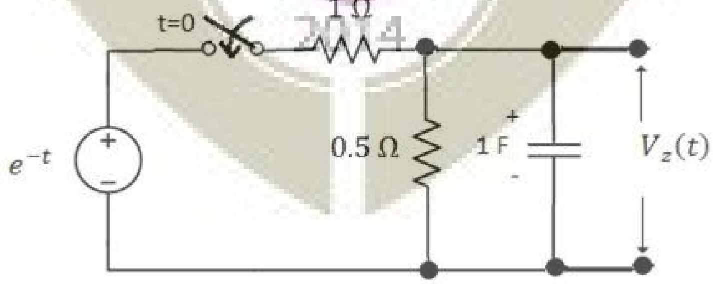
K3

OR

16 In the circuit, the switch is closed at $t = 0$, connecting a source e^{-t} to the RC circuit. At time $t = 0$, it is observed that capacitor voltage has the value $V_c(0) = 0.5V$. For the element values given, determine $V_z(t)$ after converting the circuit into transformed domain. 14

CO2

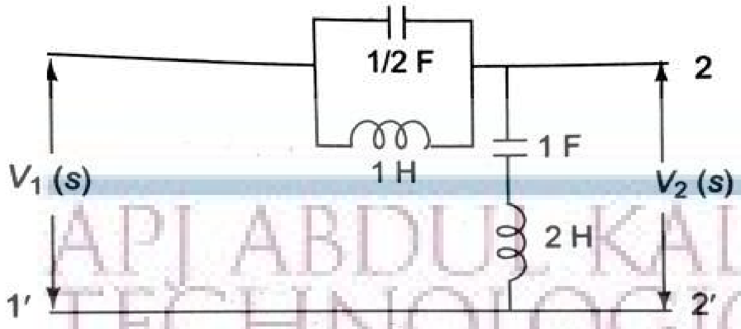
K3



Module - IV

17 For the network, determine Driving point impedance ***Z₁₁ (s)***, Voltage gain Transfer 14

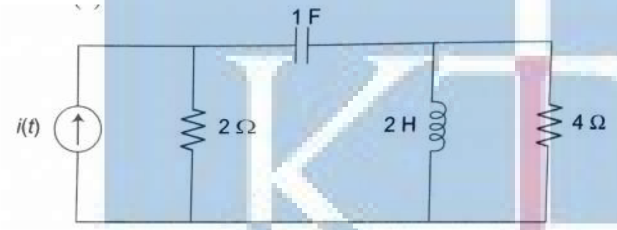
function ***G**$_{21}$ **(s)*** and Current gain Transfer function ***α**$_{21}$ **(s)***. CO3 K3



OR

18 a. Compare and contrast the necessary conditions for a network Driving point function and Transfer functions. 7 CO3 K2

b. For following network, evaluate the admittance function Y(s) as seen by the source i(t). Also pot the poles and zeros of Y(s). 7 CO3 K3



Module - V

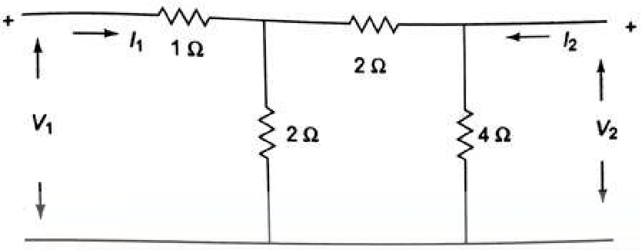
19 a. Deduce the transmission parameters of two port network in terms of 10 CO4 K2

(i) Z-parameters, (ii) Y-parameters and (iii) Hybrid parameters.

b. How to determine the given two port network is Symmetrical 4 K2

OR

20 Two identical sections of the following networks are connected in parallel. Obtain the Y-parameters of the combination. 14 K3


+
I_1
1 Ω
2 Ω
I_2
+
V_1
2 Ω
4 Ω
V_2

ECL 201	SCIENTIFIC COMPUTING LABORATORY	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble

- The following experiments are designed to translate the mathematical concepts into system design.
- The students shall use Python for realization of experiments. Other softwares such as R/MATLAB/SCILAB/LabVIEW can also be used.
- The experiments will lay the foundation for future labs such as DSP lab.
- The first two experiments are mandatory and any six of the rest should be done.

Prerequisites

- MAT 101 Linear Algebra and Calculus
- MAT 102 Vector Calculus, Differential Equations and Transforms

Course Outcomes The student will be able to

CO 1	Describe the needs and requirements of scientific computing and to familiarize one programming language for scientific computing and data visualization.
CO 2	Approximate an array/matrix with matrix decomposition.
CO 3	Implement numerical integration and differentiation.
CO 4	Solve ordinary differential equations for engineering applications
CO 5	Compute with exported data from instruments
CO 6	Realize how periodic functions are constituted by sinusoids
CO 7	Simulate random processes and understand their statistics.

Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	0	0	0	3	1	0	3
CO2	3	3	1	2	3	0	0	0	3	0	0	1
CO3	3	3	1	1	3	0	0	0	0	0	0	1
CO4	3	3	1	1	3	0	0	0	0	0	0	1
CO5	3	3	1	3	0	0	0	0	3	3	0	0
CO6	3	3	2	2	3	0	0	0	3	1	0	0
CO7	3	3	2	2	3	0	0	0	3	1	0	1

Assessment Pattern

Mark Distribution

Total Mark	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern

Attribute	Mark
Attendance	15
Continuous assessment	30
Internal Test (Immediately before the second series test)	30

End Semester Examination Pattern The following guidelines should be followed regarding award of marks.

Attribute	Mark
Preliminary work	15
Implementing the work/Conducting the experiment	10
Performance, result and inference (usage of equipments and trouble shooting)	25
Viva voce	20
Record	5

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

Course Level Assessment Questions

CO1-The needs and requirements of scientific computing and to familiarize one programming language for scientific computing and data visualization

1. Write a function to compute the first N Fibonacci numbers. Run this code and test it.
2. Write a function to compute the sum of N complex numbers. Run this code and test it.
3. Write a function to compute the factorial of an integer. Run this code and test it.

CO2-Approximation an array/matrix with matrix decomposition.

1. Write a function to compute the eigen values of a real valed valued matrix (say 5×5). Run this code. Plot the eigen values and understand their variation.
2. Write a function to approximate a 5×5 matrix using its first 3 eigen vales. Run the code and compute the absolute square error in the approximation.

CO3-Numerical Integration and Differentiation

1. Write and execute a function to return the first and second derivative of the function $f(t) = 3t^4 + 5$ for the vector $t = [-3, 3]$.
2. Write and execute a function to return the value of

$$\int_{-3}^{3} e^{-|t|}\, dt$$

CO4-Solution of ODE

1. Write and execute a function to return the numerical solution of

$$\frac{d^2x}{dt^2} + 4\frac{dx}{dt} + 2x = e^{-t}\cos(t)$$

.

2. Write and execute a function to solve for the current transient through an RL network (with $\frac{r}{L} = 1$) that is driven by the signal $5e^{-t}U(t)$

CO5-Data Analysis

1. Connect a signal generator toa DSO and display a $1\,V$, $3\,kHz$ signal. Store the trace in a usb device as a spreadsheet. Write and execute a function to load and dispaly signal from the spreadsheet. Compute the rms value of the signal.
2. Write and execute a program to display random data in two dimensions as continuous and discrete plots.

CO6-Convergence of Fourier Series

1. Write the Fourier series of a traingular signal. Compute this sum for 10 and 50 terms respectively. Plot both signals on the same GUI.

CO7-Simulation of Random Phenomena

1. Write and execute a function to toss three fair coins simultaneously. Compute the probability of getting exactly two heads for 100 and 1000 number of tosses

Experiments

Experiment 1. Familarization of the Computing Tool

1. Needs and requirements in scientific computing
2. Familiarization of a programming language like Python/R/ MATLAB/SCILAB/LabVIEW for scientific computing
3. Familiarization of data types in the language used.
4. Familiarization of the syntax of *while, for, if* statements.
5. Basic syntax and execution of small scripts.

Experiment 2. Familarization of Scientific Computing

1. Functions with examples
2. Basic arithmetic functions such as *abs*, *sine*, *real*, *imag*, *complex*, *sinc* etc. using bulit in modules.
3. Vectorized computing without loops for fast scientific applications.

Experiment 3. Realization of Arrays and Matrices

1. Realize one dimensional array of real and complex numbers
2. stem and continous plots of real arrays using *matplotlib*/GUIs/charts.
3. Realization of two dimensional arrays and matrices and their visualizations with *imshow/matshow/charts*
4. Inverse of a square matrix and the solution of the matrix equation

   $$[\mathbf{A}][\mathbf{X}] = [\mathbf{b}]$$

   where $\mathbf{A}$ is an $N \times N$ matrix and $\mathbf{X}$ and $\mathbf{b}$ are $N \times 1$ vectors.
5. Computation of the rank(ρ) and eigen values (λ_i) of $\mathbf{A}$
6. Approximate $\mathbf{A}$ for $N = 1000$ with the help of singular value decomposition of $\mathbf{A}$ as

   $$\tilde{\mathbf{A}} = \sum_{i=0}^{r} \lambda_i U_i V_i^T$$

   where U_i and V_i are the singular vectors and λ_i are the eigen values with $\lambda_i < \lambda_j$ for $i > j$. One may use the built-in functions for singular value decomposition.
7. Plot the absolute error(ζ) between $\mathbf{A}$ and $\tilde{\mathbf{A}}$ as $\zeta = \sum_{i=1}^{N} \sum_{j=1}^{N} |a_{i,j} - \tilde{a_{i,j}}|^2$ against r for $r = 10, 50, 75, 100, 250\ , 500, 750$ and appreciate the plot.

Experiment 4. Numerical Differentiation and Integration

1. Realize the functions $\sin t$, $\cos t$, *sinht* and *cosht* for the vector $t = [0, 10]$ with increment 0.01
2. Compute the first and second derivatives of these functions using built in tools such as *grad*.
3. Plot the derivatives over the respective functions and appreciate.
4. Familiarize the numerical integration tools in the language you use.
5. Realize the function

   $$f(t) = 4t^2 + 3$$

   and plot it for the vector $t = [-5, 5]$ with increment 0.01

6. Use general integration tool to compute

$$\int_{-2}^{2} f(t)\,dt$$

7. Repeat the above steps with trapezoidal and Simpson method and compare the results.

8. Compute

$$\frac{1}{\sqrt{2\pi}}\int_{0}^{\infty} e^{-\frac{x^2}{2}}\,dx$$

using the above three methods.

Experiment 5. Solution of Ordinary Differential Equations

1. Solve the first order differential equation

$$\frac{dx}{dt} + 2x = 0$$

with the initial condition $x(0) = 1$

2. Solve for the current transient through an RC network (with $RC = 3$) that is driven by
   - $5\,V$ DC
   - the signal $5e^{-t}U(t)$

   and plot the solutions.

3. Solve the second order differential equation

$$\frac{d^2x}{dt^2} + 2\frac{dx}{dt} + 2x = e^{-t}$$

4. Solve the current transient through a series RLC circuit with $R = 1\Omega$, $L = 1\,mH$ and $C = 1\,\mu F$ that is driven by
   - $5\,V$ DC
   - the signal $5e^{-t}U(t)$

Experiment 6. Simple Data Visualization

1. Draw stem plots, line plots, box plots, bar plots and scatter plots with random data.
2. plot the histogram of a random data.
3. create legends in plots.
4. Realize a vector $t = [-10, 10]$ with increment 0.01 as an array.
5. Implement and plot the functions
    - $f(t) = \cos t$
    - $f(t) = \cos t \cos 5t + \cos 5t$

Experiment 7. Simple Data Analysis with Spreadsheets

1. Display an electrical signal on DSO and export it as a *.csv* file.
2. Read this *.csv* or *.xls* file as an array and plot it.
3. Compute the mean and standard deviation of the signal. Plot its histogram with an appropriate bin size.

Experiment 8. Convergence of Fourier Series

1. The experiment aims to understand the lack of convergence of Fourier series
2. Realize the Fourier series
$$f(t) = \frac{4}{\pi}[1 - \frac{1}{3}\cos\frac{2\pi 3t}{T} + \frac{1}{5}\cos\frac{2\pi 5t}{T} - \frac{1}{7}\cos\frac{2\pi 7t}{T} + \cdots]$$
3. Realize the vector $t = [0, 100]$ with an increment of 0.01 and keep $T = 20$.
4. Plot the first 3 or 4 terms on the same graphic window and understand how the smooth sinusoids add up to a discontinous square function.
5. Compute and plot the series for the first 10, 20, 50 and 100 terms of the and understand the lack of convergence at the points of discontinuity.
6. With t made a zero vector, $f(0) = 1$, resulting in the *Madhava* series for π as
$$\pi = 4[1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots]$$
7. Use this to compute π for the first 10, 20, 50 and 100 terms.

Experiment 9: Coin Toss and the Level Crossing Problem

1. Simulate a coin toss that maps a head as 1 and tail as 0.
2. Toss the coin $N = 100$, 500,1000, 5000 and 500000 times and compute the probability (p) of head in each case.
3. Compute the absolute error $|0.5 - p|$ in each case and plot against N and understand the law of large numbers.
4. Create a uniform random vector with maximum magnitude 10, plot and observe.
5. Set a threshold ($V_T = 2$) and count how many times the random function has crossed V_T.
6. Count how many times the function has gone above and below the threshold.

Schedule of Experiments Every experiment should be completed in three hours.

ECL 203	**LOGIC DESIGN LAB**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		PCC	**0**	**0**	**3**	**2**

Preamble: This course aims to (i) familiarize students with the Digital Logic Design through the implementation of Logic Circuits using ICs of basic logic gates (ii) familiarize students with the HDL based Digital Design Flow.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Design and demonstrate the functioning of various combinational and sequential circuits using ICs
CO 2	Apply an industry compatible hardware description language to implement digital circuits
CO 3	Implement digital circuis on FPGA boards and connect external hardware to the boards
CO 4	Function effectively as an individual and in a team to accomplish the given task

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3	3						3			3
CO 2	3	1	1	3	3				3			3
CO 3	3	1	1	3	3				3	1		3
CO 4	3	3	3		3				3			3

Assessment

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks

Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work	: 15 Marks
(b) Implementing the work/Conducting the experiment	: 10 Marks
(c) Performance, result and inference (usage of equipments and trouble shooting)	: 25 Marks
(d) Viva voce	: 20 marks
(e) Record	: 5 Marks

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

Course Level Assessment Questions

Course Outcome 1 (CO1): Design and Development of combinational circuits

1. Design a one bit full adder using gates and implement and test it on board.

2. Implement and test the logic function $f(A,B,C)=\sum m(0,1,3,6)$ using an 8:1 Mux IC
3. Convert a D flip-flop to T flip-flop and implement and test on board.

Course Outcome 2 and 3 (CO2 and CO3): Implementation of logic circuits on tiny FPGA

1. Design and implement a one bit subtracter in Verilog and implement and test it on a tiny FPGA board.

2. Design and implement a J-K flip-flop in Verilog, implement and test it on a tiny FPGA board.

3. Design a 4:1 Multiplexer in Verilog and implement and test it on tiny FPGA board.

List of Experiments:

It is compulsory to conduct a minimum of 5 experiments from Part A and a minimum of 5 experiments from Part B.

Part A (Any 5)

The following experiements can be conducted on breadboard or trainer kits.

1. Realization of functions using basic and universal gates (SOP and POS forms).
2. Design and Realization of half /full adder and subtractor using basic gates and universal gates.
3. 4 bit adder/subtractor and BCD adder using 7483.
4. Study of Flip Flops: S-R, D, T, JK and Master Slave JK FF using NAND gates.
5. Asynchronous Counter:3 bit up/down counter

6. Asynchronous Counter:Realization of Mod N counter
7. Synchronous Counter: Realization of 4-bit up/down counter.
8. Synchronous Counter: Realization of Mod-N counters.
9. Ring counter and Johnson Counter. (using FF & 7495).
10. Realization of counters using IC’s (7490, 7492, 7493).
11. Multiplexers and De-multiplexers using gates and ICs. (74150, 74154)
12. Realization of combinational circuits using MUX & DEMUX.
13. Random Sequence generator using LFSR.

PART B (Any 5)

The following experiments aim at training the students in digital circuit design with verilog and implementation in small FPGAs. Small, low cost FPGAs, that can be driven by open tools for simulation, synthesis and place and route, such as *TinyFPGA* or *Lattice iCEstick* can be used. Open software tools such as *yosis* (for simulation and synthesis) and *arachne* (for place and route) may be used. The experiments will lay the foundation for digital design with FPGA with the objective of increased employability.

Experiment 1. Realization of Logic Gates and Familiarization of FPGAs
- (a) Familiarization of a small FPGA bboard and its ports and interface.
- (b) Create the .pcf files for your FPGA board.
- (c) Familiarization of the basic syntax of verilog
- (d) Development of verilog modules for basic gates, synthesis and implementation in the above FPGA to verify the truth tables.
- (e) Verify the universality and non associativity of NAND and NOR gates by uploading the corresponding verilog files to the FPGA boards.

Experiement 2: Adders in Verilog
- (a) Development of verilog modules for half adder in 3 modeling styles (dataflow/structural/ behavioural).
- (b) Development of verilog modules for full adder in structural modeling using half adder.

Experiement 3: Mux and Demux in Verilog
- (a) Development of verilog modules for a 4x1 MUX.
- (b) Development of verilog modules for a 1x4 DEMUX.

Experiement 4: Flipflops and coutners
- (a) Development of verilog modules for SR, JK and D flipflops.
- (b) Development of verilog modules for a binary decade/Johnson/Ring counters

Experiment 5. Multiplexer and Logic Implementation in FPGA
- (a) Make a gate level design of an 8 : 1 multiplexer, write to FPGA and test its functionality.
- (b) Use the above module to realize the logic function f (A, B, C) = ∑m(0, 1, 3, 7) and test it.
- (c) Use the same 8 : 1 multiplexer to realize the logic function f (A, B, C, D) = ∑m(0, 1, 3, 7, 10, 12) by partitioning the truth table properly and test it.

Experiment 6. Flip-Flops and their Conversion in FPGA
- (a) Make gate level designs of J-K, J-K master-slave, T and D flip-flops, implement and test them on the FPGA board.
- (b) Implement and test the conversions such as T to D, D to T, J-K to T and J-K to D

Experiment 7: Asynchronous and Synchronous Counters in FPGA

(a) Make a design of a 4-bit up down ripple counter using T-flip-lops in the previous experiment, implement and test them on the FPGA board.
(b) Make a design of a 4-bit up down synchronous counter using T-flip-lops in the previous experiment, implement and test them on the FPGAboard.

Experiment 8: Universal Shift Register in FPGA

(a) Make a design of a 4-bit universal shift register using D-flip-flops in the previous experiment, implement and test them on the FPGA board.
(b) Implement ring and Johnson counters with it.

Experiment 9. BCD to Seven Segment Decoder in FPGA

(a) Make a gate level design of a seven segment decoder, write to FPGA and test its functionality.
(b) Test it with switches and seven segment display. Use ouput ports for connection to the display.

SEMESTER -3

MINOR

ECT281	**ELECTRONIC CIRCUITS**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		Minor	3	1	0	4

Preamble: This course aims to develop the skill of the design of various analog circuits.

Prerequisite: EST130 Basics of Electrical and Electronics Engineering

Course Outcomes: After the completion of the course the student will be able to

CO 1	Realize simple circuits using diodes, resistors and capacitors
CO 2	Design amplifier and oscillator circuits
CO 3	Design Power supplies, D/A and A/D convertors for various applications
CO4	Design and analyze circuits using operational amplifiers

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2
CO 4	3	3										2

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
Analyse	K4			
Evaluate				
Create				

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Realize simple circuits using diodes, resistors and capacitors.

1. For the given specification design a differentiator and integrator circuit.
2. For the given input waveform and circuit, draw the output waveform and transfer characteristics.
3. Explain the working of RC differentiator and integrator circuits and sketch the output waveform for different time periods.

Course Outcome 2 (CO2): Design amplifier and oscillator circuits.

1. For the given transistor biasing circuit, determine the resistor values, biasing currents and voltages.
2. Explain the construction, principle of operation, and characteristics of MOSFETs.
3. Design a RC coupled amplifier for a given gain.
4. Design a Hartley oscillator to generate a given frequency.

Course Outcome 3 (CO3): Design Power supplies, D/A and A/D convertors for various applications.

1. Design a series voltage regulator.
2. For the regulator circuit, find the output voltage and current through the zener diode.
3. In a 10 bit DAC, for a given reference voltage, find the analog output for the given digital input.

Course Outcome 4 (CO4): Design circuits using operational amplifiers for various applications

1. For the given difference amplifier, find the output voltage.
2. Derive the expression for frequency of oscillation of Wien bridge oscillator using op-amp.
3. Realize a summing amplifier to obtain a given output voltage.

SYLLABUS

Module 1:

Wave shaping circuits: Sinusoidal and non-sinusoidal wave shapes, Principle and working of RC differentiating and integrating circuits, Clipping circuits - Positive, negative and biased clipper. Clamping circuits - Positive, negative and biased clamper.

Transistor biasing: Introduction, operating point, concept of load line, thermal stability (derivation not required), fixed bias, self bias, voltage divider bias.

Module 2:

MOSFET- Structure, Enhancement and Depletion types, principle of operation and characteristics.

Amplifiers: Classification of amplifiers, RC coupled amplifier – design and working, voltage gain and frequency response. Multistage amplifiers - effect of cascading on gain and bandwidth.

Feedback in amplifiers - Effect of negative feedback on amplifiers.

MOSFET Amplifier- Circuit diagram, design and working of common source MOSFET amplifier.

Module 3:

Oscillators: Classification, criterion for oscillation, Wien bridge oscillator, Hartley and Crystal oscillator. (design equations and working of the circuits; analysis not required).

Regulated power supplies: Review of simple zener voltage regulator, series voltage regulator, 3 pin regulators-78XX and 79XX, DC to DC conversion, Circuit/block diagram and working of SMPS.

Module 4 : Operational amplifiers: Characteristics of op-amps(gain, bandwidth, slew rate, CMRR, offset voltage, offset current), comparison of ideal and practical op-amp(IC741), applications of op-amps- scale changer, sign changer, adder/summing amplifier, subtractor, integrator, differentiator, Comparator, Instrumentation amplifier.

Module 5:

Integrated circuits: D/A and A/D convertors – important specifications, Sample and hold circuit, R-2R ladder type D/A convertors.

Flash and sigma-delta type A/D convertors.

Text Books

1. Robert Boylestad and L Nashelsky, Electronic Devices and Circuit Theory, Pearson, 2015.
2. Salivahanan S. and V. S. K. Bhaaskaran, Linear Integrated Circuits, Tata McGraw Hill, 2008.

Reference Books

1. David A Bell, Electronic Devices and Circuits, Oxford University Press, 2008.
2. Neamen D., Electronic Circuits, Analysis and Design, 3/e, TMH, 2007.
3. Millman J. and C. Halkias, Integrated Electronics, 2/e, McGraw-Hill, 2010.
4. Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, PHI, 2000.
5. K.Gopakumar, Design and Analysis of Electronic Circuits, Phasor Books, Kollam, 2013

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Wave shaping circuits**	
1.1	Sinusoidal and non-sinusoidal wave shapes	1
1.2	Principle and working of RC differentiating and integrating circuits	2
1.3	Clipping circuits - Positive, negative and biased clipper	1
1.4	Clamping circuits - Positive, negative and biased clamper	1
	Transistor biasing	
1.5	Introduction, operating point, concept of load line	1
	Thermal stability, fixed bias, self bias, voltage divider bias.	3
2	**Field effect transistors**	
2.2	MOSFET- Structure, Enhancement and Depletion types, principle of operation and characteristics	2
	Amplifiers	
2.3	Classification of amplifiers, RC coupled amplifier - design and working voltage gain and frequency response	3
2.4	Multistage amplifiers - effect of cascading on gain and bandwidth	1
2.5	Feedback in amplifiers - Effect of negative feedback on amplifiers	1
	MOSFET Amplifier- Circuit diagram, design and working of common source MOSFET amplifier	2
3	**Oscillators**	
3.1	Classification, criterion for oscillation	1
3.2	Wien bridge oscillator, Hartley and Crystal oscillator	3
	Regulated power supplies	
3.3	simple zener voltage regulator, series voltage regulator line and load regulation	3
3.4	3 pin regulators-78XX and 79XX	1
3.5	DC to DC conversion, Circuit/block diagram and working of SMPS	1
4	**Operational amplifiers**	
4.1	Differential amplifier	2
4.2	characteristics of op-amps(gain, bandwidth, slew rate, CMRR, offset voltage, offset current), comparison of ideal and practical op-amp(IC741)	2
4.3	applications of op-amps- scale changer, sign changer, adder/summing amplifier, subtractor, integrator, differentiator	3

4.4	Comparator, Schmitt trigger, Linear sweep generator	3
5	**Integrated circuits**	
5.1	D/A and A/D convertors – important specifications, Sample and hold circuit	1
5.2	R-2R ladder type D/A convertors	2
5.3	Flash and successive approximation type A/D convertors	2
5.4	Circuit diagram and working of Timer IC555, astable and monostable multivibrators using 555	3

Assignment:

Atleast one assignment should be simulation of transistor amplifiers and op-amps on any circuit simulation software.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT281

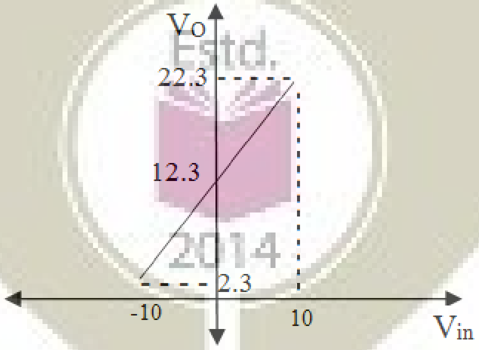
Course Name: ELECTRONIC CIRCUITS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1 Design a clamper circuit to get the following transfer characteristics, assuming voltage drop across the diode s 0.7V. K3



2 Give the importance of biasing in transistors? Mention significance of operating point. K2

3 What is line regulation and load regulation in the context of a voltage regulator? Explain with equation for percentage of regulation:- K2

4 Compare the features of FET with BJT:- K1

5 What is the effect of cascading in gain and bandwidth of amplifier? K1

6 Discuss about simple zener shunt voltage regulator:- K1

7 Realize a circuit to obtain Vo= $-2V_1+3V_2+4V_3$ using operational amplifier. Use minimum value of resistance as 10KΩ. K3

8 Design a monostable multivibrator using IC 555 timer for a pulse period of 1 ms. K3

9 Describe the working of a Flash type A/D Converter, with example. K2

10 Define: (1) Slew rate, (2) CMRR, (3) offset voltage and current:- K2

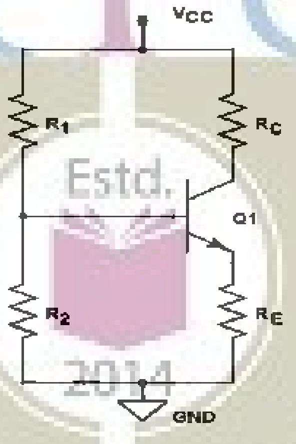
PART – B

Answer one question from each module; each question carries 14 marks.

Module - I

11 a. Design a differentiator circuit for a square wave signal with Vpp=10 and frequency 10KHz:- 5 CO1 K3

b. Consider a self-biasing circuit shown in figure below with Vcc=20V, R_c=1.5KΩ, which is operated at Q-point (Vce=8V, Ic=4mA), If h_{FE}=100, find R_1, R_2 and R_e. Assume V_{BE}=0.7V. 9 CO2 K3

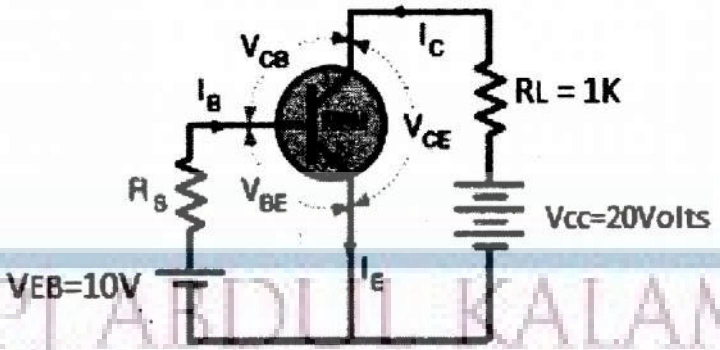


OR

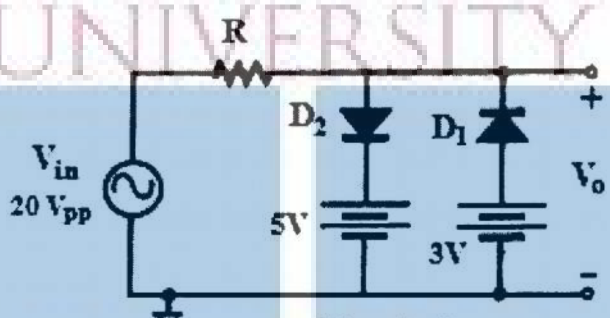
12 a. Explain the working of an RC differentiator circuit for a square wave input with period T.Sketchits output waveform for RC ≫ T ,RC ≪ T and RC = T. 5 CO1 K3

b. With reference to the following circuit, draw the load line and mark the Q point of a Silicon transistor operating in CE mode based on the following data (β=80, Rs=47KΩ, R_L=1KΩ, neglect I_{CBO}) 5 CO2

K3



c. Draw the output waveform and transfer characteristics of the given clipper circuit. 4 CO1 K3



Circuit diagram

Module - II

13 a. With neat sketches, explain the construction, principle of operation and characteristics of an N-channel enhancement MOSFET:- 9 CO2 K2

b. Draw the circuit of an RC coupled amplifier and explain the function of each element:- 5 CO2 K2

OR

14 a. Draw the circuit of a common source amplifier using MOSFET. Derive the expressions for voltage gain and input resistance:- 9 CO2 K2

b. Sketch the frequency response of an RC coupled amplifier and write the reasons for gain reduction in both ends. 5 CO2 K2

Module - III

15 a. Design a Hartley oscillator to generate a frequency of 150KHz. 5 CO2

K3

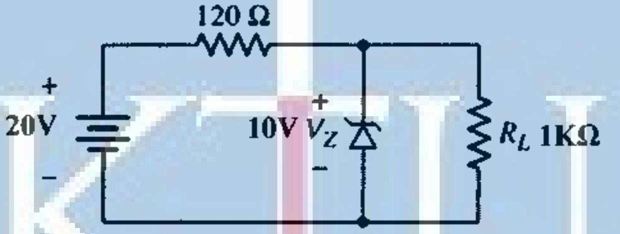
b. Draw the circuit of a series voltage regulator. Explain its working when the input voltage as well as load current varies. Design a circuit to deliver 5V, 100mA maximum load current:- 9 CO3 K3

OR

16 a. With neat diagram and relevant equations explain the working of wein bridge oscillator using BJT:- 7 CO2 K2

b. Derive the expression for the frequency of oscillation of Wien bridge oscillator using BJT 4 CO2 K2

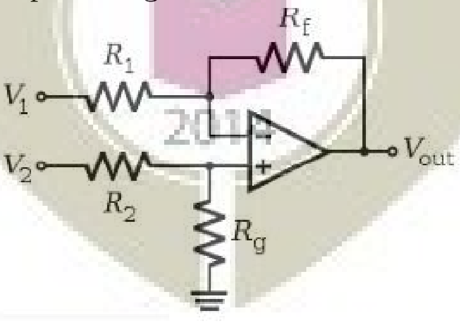
c. For the circuit shown below, find the ouput voltage across RL and current through the zener diode:- 3 CO3 K3



Module - IV

17 a. With circuit, relevant equations and waveforms explain the working of a Schmit trigger using op-amp:- 10 CO4 K2

b. The difference amplifier shown in the figure have R_1=R_2=5KΩ, R_F=10KΩ, R_g=1KΩ. Calculate the output voltage. 5 CO4 K3



OR

18 a. With circuits and equations show that an op-amp can act as integrator, differentiator, adder and subtractor. 9 CO4 K2

b.	What do you mean by differential amplifier? With neat sketches, explain the working of an open loop OP-AMP differential amplifier.	5 CO4 K2

Module - V

19 a.	Explain the working of R-2R ladder type DAC. In a 10 bit DAC, reference voltage is given as 15V. Find analog output for digital input of 1011011001.	10 CO3 K3
b.	With neat diagram explain the working of IC555 timer.	4 CO4 K3

OR

20 a.	A 4-bit R-2R ladder type DAC having R= 10 kΩ and V_R= 10 V. Find its resolution and output voltage for an input 1101.	4 CO4 K3
b.	Design an astable multivibrator using IC 555 timer for a frequency of 1KHz and a duty cycle of 70%.Assume c=0.1μF.	5 CO4 K3
c.	Draw the circuit diagram of a simple sample and hold circuit and explain the necessity of this circuit in A to D conversion.	5 CO4 K2

Simulation Assignments

The following simulations can be done in QUCS, KiCad or PSPICE.

1. Design and simulate RC coupled amplifer. Observe the input and output signals. Plot the AC frequency response and understand the variation of gain at high frequencies. Observe the effect of negative feedback by changing the capacitor across the emitter resistor.

2. Design and simulate Wien bridge oscillator for a frequency of $10\,kHz$. Run a transient simulation and observe the output waveform.

3. Design and simulate series voltage regulator for output voltage $V_O = 10V$ and output current $I_O = 100mA$ with and without short circuit protection and to test the line and load regulations.

4. Design and implement differential amplifier and measure its CMRR. Plot its transfer characteristics.

5. Design and simulate non-inverting amplifier for gain 5. Observe the input and output signals. Run the ac simulation and observe the frequency response and $3-$ db bandwidth.

6. Design and simulate a 3 bit flash type ADC. Observe the output bit patterns and transfer characteristics

7. Design and simulate $R-2R$ DAC ciruit.

8. Design and implement Schmitt trigger circuit for upper triggering point of $+8\,V$ and a lower triggering point of $-4\,V$ using op-amps.

ECT 283	ANALOG COMMUNICATION	CATEGORY	L	T	P	CREDIT
		Minor	3	1	0	4

Preamble: The course has two objectives: (1) to study two analog modulation schemes known as amplitude modulation and frequency modulation (2) to understand the implementations of transmitter and reciever systems used in AM and FM.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain various components of a communication system
CO 2	Discuss various sources of noise, and its the effect in a communication system
CO 3	Explain amplitude modulation and its variants for a sinusoidal message
CO 4	Explain frequency modulation and its variants for a sinusoidal message
CO 5	List and compare various transmitter and receiver systems of AM and FM

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										
CO 2	3	3										
CO 3	3	3										
CO 4	3	3										
CO 5	3	3										
CO 6	3	3										

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain various components of a communication system**.**

1. What is the need of a modulator in a radio communcation system?
2. What are the various frequency bands used in radio communication
3. Why base band communication is infeasible for terrestrial air transmission?

Course Outcome 2 (CO2): Discuss various sources of noise, and its the effect in a communication system**.**

1. What is thermal noise?
2. Describe the noise voltage generated across resistor?
3. Why is it that noise voltage can not be used as a source for power?

Course Outcome 3 (CO3): Explain amplitude modulation and its variants for a sinusoidal message**.**

1. Write down the equation for an AM wave for a sinusoidal message
2. What is the significance of modulation index?
3. Describe envelope detector

Course Outcome 4 (CO4): Explain frequency modulation and its variants for a sinusoidal message

4. How is practical bandwidth for an FM wave determined?
5. What are the value of frequency devaiation, bandwidth for a typical FM station?
6. What is PLL?

Course Outcome 5 (CO5): List and compare various transmitter and receiver systems of AM and FM

1. Draw the block diagram of a super heterodyne receiver.
2. How is adjasecent channel rejection achieved in superhet? How is image rejection achieved in a superhet?
3. Explain the working principle of one FM generator, and one FM demodulator.

Syllabus

Module I

Introduction, Elements of communication systems, Examples of analog communication systems, Frequency bands, Need for modulation.

Noise in communication system, Definitions of Thermal noise (white noise), Various types of noise -- Shot noise, Partition noise, Flicker noise, Burst noise, (No analysis required) Signal to noise ratio, Noise factor, Noise temperature, Narrow band noise.

Module II

Brief overview of signals and systems -- Signals, Classification of signals, Energy and power of signals, Basic signal operations, Impulse function, Properties of impulse function, Convolution, LTI system, Fourier Transform, Basic properties, Using Fourier transform to study LTI system.

Module III

Amplitude modulation (AM), Double-side band suppressed carrier (DSB-SC) modulation Single sideband modulation (SSB) – spectrum, power, efficiency of all the three variants. (Study of only tone modulation in DSB-SC, AM, and SSB.) Amplitude-modulator implementations – switching modulator, balanced modulator. AM demodulators -- Coherent demodulator. Envelope detector.

Module IV

Frequency modulation – modulation index, frequency deviation, average power, spectrum of tone modulated FM. Heuristics for bandwidth of FM. Narrow band FM and wide-band FM. FM generation: Varactor diode modulator, Armstrongs method. FM demodulation – slope detection, PLL demodulator.

Module V

Superheterodyne reciever, Principle of Carrier synchronization using PLL, NTSC Television broadcasting.

Text Books

1. Kennedy, Davis, “Electronic Communication Systems,” 4th Edition, Tata McGraw Hill

2. Wayne Tomasi, “Electronic Communication Systems – Fundamentals through Advanced,” 5th edition, Pearson.

3. B. P. Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, 4th edition, Oxford University Press.

Reference books

1. Leon W. Couch, Digital and Analog Communication Systems, 8th edition, Prentice Hall.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
I	Introduction, Elements of communication systems, Examples of analog communication systems, Frequency bands, Need for modulation	3
	Noise in communication system, Definitions of Thermal noise (white noise), Shot noise, Partition noise, Flicker noise, Burst noise, (No analysis required) Signal to noise ratio, Noise factor, Noise temperature, Narrow band noise.	5
II	**Brief Overview of Signals and Systems:** Signals, Classification of signals, Energy and power of signals, Basic signal operations,	4
	Impulse function, Properties of impulse function, Convolution,	2
	Definition of Linear time-invariant system. Input-output relation of LTI system	2
	Definition of Fourier Transforms, Some Properties of Fourier Transform – Linearity, Time-shift, Modulation theorem, Parsevals theorem. Using Fourier Transform to study LTI systems.	5
III	Amplitude modulation (AM) – modulation index, spectrum, power, efficiency.	2
	Double-side band suppressed carrier (DSB-SC) modulation – spectrum, power, efficiency.	1
	Single sideband modulation (SSB) – spectrum, power, efficiency. (Study of only tone modulation in DSB-SC, AM, and SSB.)	1
	Amplitude-modulator implementations – switching modulator, balanced modulator (at block diagram level).	2
	AM demodulators -- Coherent demodulator. Envelope detector.	3
IV	Frequency modulation – modulation index, frequency deviation, average power, spectrum of tone modulated FM	4
	Heuristics for bandwidth of FM. Narrow band FM and wide-band FM.	1
	FM generation: Varactor diode modulator, Armstrongs method. FM demodulation – slope detection, PLL demodulator.	4

V	Receivers for AM/FM: Super heterodyne receiver (block diagram), Adjacent channel selectivity, Image rejection, Double conversion.	3
	Carrier Synchronization using PLL	1
	NTSC Television broadcasting using AM, FM radio broadcasting.	2

Sample Assignments

1. Using the message signal m(t)=t /1+t^2. Determine and sketch the modulated wave for amplitude modulation whose percentage of modulation equal the following values – 50%, 100%, 120%
2. A standard AM transmission sinusoidally modulated to a depth of 30% produces sideband frequencies of 4.98MHz & 4.914 MHz. the amplitude of each sideband frequency is 75V. Determine the amplitude and frequency of the carrier?
3. Write the typical frequency ranges for the following classification of EM spectrum: MF, HF,VHF and UHF.
4. List the basic functions of a radio transmitter and corresponding functions of the receiever?
5. Discuss the types causes and effects of various forms of noise at a receiver.
6. What are the different frequency components in SSB & DSBSC signals?
7. Describe the AM generation using diode as a nonlinear resistor.
8. Define the following terms in the context of FM -- Frequency deviation, frequency sensitivity, instantaneous phase deviation.
9. The equation for FM wave is s(t)= 10 Cos $(2\pi * 10^6 t + 5 \sin\left(200\pi t + 10 \sin\left(3000\pi t\right)\right)$ Calculate frequency deviation, approximate transmission BW and power in the modulated signal.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH. DEGREE EXAMINATION

ECT 283: Analog Communication

Max. Marks: 60 Duration: 3 hours

PART A

Answer all questions. Each question carries 3 marks each.

1. Explain the need for modulation.
2. A receiver connected to an antenna whose resistance is 50 ohm has an equivalent noise resistance of 30 ohm .calculate receiver noise figure in decibels & its equivalent noise temperature?
3. Plot the signal x(t)=u(t+1)+2u(t)-u(t-3)
4. State Parseval’s theorem for DTFT. What is its signifance?
5. Define amplitude modulation? Give the frequency spectrum for AM wave?
6. Derive the expression for total power of AM wave?
7. Explain the following terms a)Modulation index b)Instantaneous frequency deviation
8. Compare AM & FM systems.
9. What are the advantages that the super heterodyne receiver has over the receivers? Are there any disadvantages?
10. Give the limitations of NTSC systems?

PART B

11. (a) Explain the following (i) Thermal noise (ii) Flicker noise (6 marks)
    (b) Explain the elements of communication systems in detail? (8 marks)

OR

12. (a) Define the signal to noise ratio and noise and noise figure of a receiver? How noise temperature related to noise figure? (8 marks)
    (b) List the basic functions of a radio transmitter & the corresponding functions of the receiver? (6 marks)
13. (a) Distinguish between energy & power signals. Give an example for each category? (6 marks)
    (b) State and prove the linearity and time shifting property of Fourier Transform? (8 marks)

OR

14. (a) Check whether the systems are linear & stable. (i) $y(t)=e^{x(t)}$ (ii) y[n]=x[n-1] (6 marks)

    (b) Find convolution of signal x[n] = [1,-1, 1, 1] with itself? (5 marks)
    (c)Distinguish between causal & non causal systems with suitable examples? (3 marks)

OR

15. (a) Derive the expression of total power in SSB wave? (7 marks)

(b) Describe the AM demodulation using envelope detector? (7 marks)

OR

16. (a) Describe the DSB SC wave generation process using balanced modulation (9 marks)

    (b) Give the spectrum of SSB & DSB SC waves? Make comparison of bandwidth requirements. (5 marks)

17. (a) Explain the direct method of generating FM signal using varactor diode? (6 marks)

    (b) Explain frequency modulation and it average power? (6 marks)

OR

18. (a) Explain with relevant mathematical expressions, the demodulation of FM signal using PLL? (10 marks)

    (b) Give the spectrum of tone modulated FM? (4 marks)

19. (a) Explain the super heterodyne receiver with a detailed block diagram? (10 marks)

    (b) Explain how the use of RF amplifier & improve the NR of a super heterodyne receiver? (4 marks)

OR

20. (a) Explain the TV broadcasting system using AM? (10 marks)

    (b) What is image frequency, how does it arise? (4 marks)

Simulation Assignments

The following simulations can be done in Python/SCILAB/MTLAB or LabVIEW.

Amplitude Modulation Schemes

- Create a sinusoidal carrier($x_c(t)$) and AF signal(x_t) with the frequency of carrier being 10 times that of the AF signal.
- Compute the AM signal as $mx_c(t)x(t) + x_c(t)$ for various values of the modulation index m ranging from 0 to 1.
- Observe the power spectral density of this AM signal.
- $mx_c(t)x(t)$ is the DSB-SC signal. Observe this signal and its power spectral density.
- Load a speech signal in say in *.wav* format into a vector and use it in place of the AF signal and repeat the above steps for a suitable carrier.

SSB Signal Generation

- Simulate an SSB transmitter and receiver using $-\frac{\pi}{2}$ shifters. This can be realized by the Hilbert Transform function in Python, MATLAB etc.
- Test the system with single tone and speech signal.
- Add channel noise to the signal and test for the robustness against noise.
- Slightly offset the receiver carrier phase and observe the effect at the reception.

FM Signal Generation

- Create a sinusoidal carrier($x_c(t)$) and a single tone signal ($x(t)$) with the frequency of carrier being 50 times that of the message tone.
- Compute the FM signal with a modulation index of 5.
- Observe the power spectral density of this FM signal for spectral width of 10 times that tone frequency.

AM Radio Receiver

- Procure a radio kit
- Assemble the kit by soldering all components and enjoy.

FM Radio Receiver

- Procure an FM radio kit
- Assemble the kit by soldering all components and enjoy.

Generation of Discrete Signals

- Generate the following discrete signals
  - Impulse signal
  - Pulse signal and
  - Triangular signal

ECT285	INTRODUCTION TO SIGNALS AND SYSTEMS	CATEGORY	L	T	P	CREDIT
		Minor	3	1	0	4

Preamble: This course aims to apply the concepts of electrical signals and systems

Prerequisite: None

Course Outcomes: After the completion of the course the student will be able to

CO 1	Define and classify continuous and discrete signals
CO 2	Explain and characterize a system and LTI system
CO 3	Explain the spectrum of a signal

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3			2							
CO 2	3	3		3	2							
CO 3	3	3		3	2							

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	10	10	20
Apply	30	30	60
Analyse			
Evaluate			
Create			

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Definition and classification of signals

1. Define a signal. Classify them to energy and power signals.
2. Determine whether the signal x(t)=cos(3t)+sin(5t) is periodic. If so what is the period?
3. Compare the frequency range of continuous time and discrete signals.

Course Outcome 2 (CO2): Explain and characterize a system

1. Check whether the system y[n]=cos{x[n]}is a. Stable b. Causal c. time invariant d. linear
2. Derive the ouptut of a continuous time LTI system
3. Give the meaning of impulse response of LTI systems

Course Outcome 2 (CO3): Spectra of Signals

1. State and prove Parsevals theorem
2. State and prove the modulation property of Fourier transform
3. Find the continuous tiime Fourier transform a pulse of width w and amplitude unity and centred about the origin.

Syllabus

Module 1 : Introduction to Continuous Time Signals

Definition of signal. Basic continous-time signals. Frequency and angular frequency of continous-time signals . Basic operation on signals. Classification of continous-time signals:Periodic and Non-periodic signals.Even and Odd signals, Energy and power signals. Noise and Vibration signals.

Module 2 : Discrete Time Signals

Basic discrete-time signals. Frequency and angular frequency of discrete-time signals.Classification of discrete-time signals:Periodic and Non-periodic signals.Even and Odd signals, Energy and power signals.

Module 3: Systems

System definition. Continuous-time and discrete-time systems. Properties – Linearity, Time invariance, Causality, Invertibility,Stability. Representation of systems using impulse response.

Module 4: Linear time invariant systems

LTI system definition. Response of a continous-time LTI system and the Convolutional Integral. Properties. Response of a discrete-time LTI system and the Convolutional Sum. Properties. Correlation of discrete-time signals

Module 5 : Frequency analysis of signals

Concept of frequency in continous-time and discrete-time signals. Fourier transform of continuous-time and discrete-time signals. Parsevals theorem. Interpretation of Spectra. Case study of a vibration signal.The sampling theorem.

Text Books

1. Simon Haykin, Barry Van Veen, Signals and systems, John Wiley
2. Hwei P.Hsu, Theory and problems of signals and systems, Schaum Outline Series, MGH.
3. Anders Brandt, Noise and Vibration Analysis,Wiley publication.
4. A Anand Kumar, Signals and systems, PHI learning
5. Sanjay Sharma, Signals and systems

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Continuous Time Signals**	
1.1	Definition of signal, Basic continous-time signals.	3
1.2	Frequency and angular frequency of continous-time signals	1
1.3	Basic operation on signals	1
1.4	Classification of continous-time signals	3
1.5	Noise and Vibration signals	1
2	**Discrete Time Signals**	
2.1	Basic discrete-time signals and its frequency	3
2.2	Classification of discrete-time signals	3

3	**Systems**	
3.1	System definition- CTS & DTS	1
3.2	Properties-Linearity, Time invariance	3
3.3	Causality, Invertibility, Stability	2
3.4	Representation of systems using impulse response	1
4	**Linear time invariant systems**	
4.1	LTI system definition.Properties.	1
4.2	Response of a continuous-time LTI system and the Convolutional Integral	3
4.3	Response of a discrete-time LTI system and the Convolutional Sum	3
4.4	Correlation of discrete-time signals	2
5	**Frequency analysis of signals**	
5.1	Concept of frequency in continuous-time and discrete-time signals	1
5.2	CTFT and spectra	3
5.3	DTFT and spectra	3
5.4	DFT	1
5.5	Parsevals theorem	1
5.6	Case study of a vibration signal	1
5.7	The sampling theorem	2

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B Tech Degree Examination

ECT 285 Introduction to Signals and Systems

Time: 3 Hrs **Max. Marks: 100**

PART A

Answer All Questions

1	Differentiate between energy and power signal with example.	(3)	K_2
2	Find the even and odd components of $x(t) = e^{jt}$.	(3)	K_2
3	Define discrete time signal and comment about its frequency range.	(3)	K_2
4	Sketch the sequence $x(n) = 2\delta(n-3) - \delta(n-1) + \delta(n) + \delta(n+2)$.	(3)	K_2
5	State and explain BIBO condition for system.	(3)	K_1
6	Distinguish between continuous time and discrete time systems.	(3)	K_2
7	Derive a relationship between input and output for a discrete LTI system	(3)	K_2
8	Compute the energy of the signal $x(n) = 0.8^n u(n)$	(3)	K_2
9	State and explain sampling theorem.	(3)	K_2
10	Comment about the input output characteristics of continuous time Fourier transform	(3)	K_2

PART B

Answer one question from each module. Each question carries 14 mark.

11(A)	Determine whether or not the signal $x(t) = \cos t + \sin \sqrt{2}t$ is periodic. If periodic determine its fundemental period.	(7)	K_2
11(B)	Define, sketch and list the properties of continuous time impulse function	(7)	K_2

OR

12(A) Determine whether the signal $x(t) = e^{-2t}u(t)$ is energy signal, power signal or neither. (7) K_2

12(B) Define unit step function and plot $u(t+2) - u(t-2)$. (7) K_2

13(A) Given the sequence $x(n) = \{1, 2, 1, 1, 3\}, -1 \leq n \leq 3$. Sketch (8) K_3

- $x(-n+2)$
- $x(n/2)$

13(B) Show that any signal $x(n)$ can be represented as the summation of an even and odd signal. (6) K_2

OR

14 Discuss briefly the basic discrete time signals. (14) K_2

15(A) Explain linear and nonlinear systems. (6) K_2

15(B) Apply the properties of system to check whether the following systems are linear or nonlinear (8) K_3

- $y(t) = tx(t)$
- $y(n) = x^2(n)$

OR

16(A) A sytem has an input-output relation given by $y(n) = T\{x(n)\} = nx(n)$. Determine whether the system is (14) K_3
a)Memoryless
b)Causal
c) Linear
d) Time invariant
e)Stable

17	The impulse response of a linear time invariant system is $h(n) = \{1, 2, 1, -1\}, -1 \leq n \leq 2$ Determine the response of the system for the input signal $x(n) = \{1, 2, 3, 1\}$	(14)	K_3

OR

18	A system is formed by connecting two systems in cascade. The impulse response of the system is given by $h_1(t)$ and $h_2(t)$ respectively where $h_1(t) = e^{-2t}u(t)$ and $h_2(t) = 2e^{-t}u(t)$ a)Find overall impulse response h(t) of the system. b) Determine the stability of the overall system	(14)	K_3
19(A)	Find the Nyquist rate of $x(t) = sin400\pi t + cos500\pi t.$	(7)	K_2
19(B)	State and prove modulation property of Fourier Transform	(7)	K_2

OR

20(A)	Find the CTFT of the signal $x(t) = te^{-at}u(t)$	(7)	K_2
20(B)	State and prove Parsevals theorem	(7)	K_2

Simulation Assignments

The following simulation assignments can be done with Python/MATLAB/ SCILAB/OCTAVE

1. Generate the following discrete signals
    - Impulse signal
    - Pulse signal and
    - Triangular signal
2. Write a function to compute the DTFT of a discrete energy signal. Test this function on a few signals and plot their magnitude and phase spectra.
3. - Compute the linear convolution between the sequences $x = [1, 3, 5, 3]$ with $h = [2, 3, 5, 6]$. Observe the stem plot of both signals and the convolution.
    - Now let $h = [1, 2, 1]$ and $x = [2, 3, 5, 6, 7]$. Compute the convolution between h and x.
    - Flip the signal x by 180° so that it becomes $[7, 6, 5, 3, 2]$. Convolve it with h. Compare the result with the previous result.
    - Repeat the above two steps with $h = [1, 2, 3, 2, 1]$ and $h = [1, 2, 3, 4, 5, 4, 3, 2, 1]$
    - Give your inference.
4. - Write a function to generate a unit pulse signal as a summation of shifted unit impulse signals
    - Write a function to generate a triangular signal as a convolution between two pulse signals.
5. - Relaize a continuous time LTI system with system response

      $$H(s) = \frac{5(s+1)}{(s+2)(s+3)}$$

      . One may use *scipy.signal.lti* package in Python.
    - Make it into a discrete system (possibly with *scipy.signal.cont2discrete*)
    - Observe the step response in both cases and compare.

SEMESTER -4

ECT202	ANALOG CIRCUITS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to develop the skill of analyse and design of different types of analog circuits using discrete electronic components.

Prerequisite: EST130 Basics of Electrical and Electronics Engineering

Course Outcomes: After the completion of the course the student will be able to

CO 1	Design analog signal processing circuits using diodes and first order RC circuit
CO 2	Analyse basic amplifiers using BJT and MOSFET
CO 3	Apply the principle of oscillator and regulated power supply circuits.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
Analyse	K4			
Evaluate				
Create				

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Design analog signal processing circuits using diodes and first order RC circuit.

1. For the given specification design a differentiator / integrator circuit.
2. For the given transfer characteristics design clipping / clamping circuit.
3. Design first order RC low-pass / high-pass circuit for the given specification.

Course Outcome 2 (CO2): Analyse basic amplifiers using BJT.

1. For the given transistor biasing circuit, determine the resistor values, biasing currents and voltages.
2. Design a RC coupled amplifier for a given gain.
3. Analyse the frequency response of BJT RC coupled amplifier using hybrid π model.

Course Outcome 2 (CO2): Analyse basic amplifiers using MOSFET.

1. Perform DC analysis of MOSFET circuits.
2. Design a common source amplifier.
3. Deduce the expression for voltage gain of CS stage with diode-connected load.

Course Outcome 2 (CO2): Analyse basic feedback amplifiers using BJT and MOSFET

1. Deduce the expression for voltage gain, input impedance and output impedance of the four feedback amplifier topologies.
2. Design practical discrete amplifiers for the four feedback amplifier topologies.

Course Outcome 3 (CO3): Apply the principle of oscillator and regulated power supply.

1. Design oscillator using BJT to generate sine wave for the given frequency.
2. Deduce the expression for maximum efficiency of class B power amplifiers.
3. Illustrate the DC and AC load line in transformer coupled class A power amplifiers.
4. Design voltage regulator for the given specifications.

SYLLABUS

Module 1:

Wave shaping circuits: First order RC differentiating and integrating circuits, First order RC low pass and high pass filters.

Diode Clipping circuits - Positive, negative and biased clipper. Diode Clamping circuits - Positive, negative and biased clamper.

Transistor biasing: Need, operating point, concept of DC load line, fixed bias, self bias, voltage divider bias, bias stabilization.

Module 2:

BJT Amplifiers: RC coupled amplifier (CE configuration) – need of various components and design, Concept of AC load lines, voltage gain and frequency response.

Small signal analysis of CE configuration using small signal hybrid-pi model for mid frequency and low frequency. (gain, input and output impedance).

High frequency equivalent circuits of BJT, Miller effect, Analysis of high frequency response of CE amplifier.

Module 3:

MOSFET amplifiers: MOSFET circuits at DC, MOSFET as an amplifier, Biasing of discrete MOSFET amplifier, small signal equivalent circuit. Small signal voltage and current gain, input and output impedance of CS configuration. CS stage with current source load, CS stage with diode-connected load.

Multistage amplifiers - effect of cascading on gain and bandwidth. Cascode amplifier.

Module 4 :

Feedback amplifiers: Effect of positive and negative feedback on gain, frequency response and distortion. The four basic feedback topologies, Analysis of discrete BJT circuits in voltage-series and voltage-shunt feedback topologies - voltage gain, input and output impedance.

Oscillators: Classification, criterion for oscillation, Wien bridge oscillator, Hartley and Crystal oscillator. (working principle and design equations of the circuits; analysis of Wien bridge oscillator only required).

Module 5:

Power amplifiers: Classification, Transformer coupled class A power amplifier, push pull class B and class AB power amplifiers, complementary-symmetry class B and Class AB power amplifiers, efficiency and distortion (no analysis required)

Regulated power supplies: Shunt voltage regulator, series voltage regulator, Short circuit protection and fold back protection, Output current boosting.

Text Books

1. Robert Boylestad and L Nashelsky, “Electronic Devices and Circuit Theory”, 11/e Pearson, 2015.
2. Sedra A. S. and K. C. Smith, “Microelectronic Circuits”, 6/e, Oxford University Press, 2013.

Reference Books

1. Razavi B., “Fundamentals of Microelectronics”, Wiley, 2015
2. Neamen D., “Electronic Circuits, Analysis and Design”, 3/e, TMH, 2007.
3. David A Bell, “Electronic Devices and Circuits”, Oxford University Press, 2008.
4. Rashid M. H., “Microelectronic Circuits - Analysis and Design”, Cengage Learning, 2/e,2011
5. Millman J. and C. Halkias, “Integrated Electronics”, 2/e, McGraw-Hill, 2010.

Course Contents and Lecture Schedule

No	Topic	No. of lectures
1	**Wave shaping circuits**	
1.1	Analysis and design of RC differentiating and integrating circuits	2
1.2	Analysis and design of First order RC low pass and high pass filters	2
1.3	Clipping circuits - Positive, negative and biased clipper	1
1.4	Clamping circuits - Positive, negative and biased clamper	1
	Transistor biasing	
1.5	Need of biasing, operating point, bias stabilization, concept of load line	1
	Design of fixed bias, self bias, voltage divider bias.	2
2	**BJT Amplifiers**	
2.1	Classification of amplifiers, RC coupled amplifier (CE configuration) – need of various components and design, Concept of AC load lines.	2
2.2	Small signal analysis of CE configuration using small signal hybrid π model for mid frequency. (gain, input and output impedance).	3
2.3	High frequency equivalent circuits of BJT, Miller effect, Analysis of high frequency response of CE amplifier. voltage gain and frequency response	4
3	**MOSFET amplifiers**	
3.1	MOSFET circuits at DC, MOSFET as an amplifier, Biasing of discrete MOSFET amplifier,	2
3.2	Small signal equivalent circuit. Small signal voltage and current gain, input and output impedances of CS configuration.	3

3.3	CS stage with current source load, CS stage with diode-connected load.	2
3.4	**Multistage amplifiers** - effect of cascading on gain and bandwidth. Cascode amplifier.	2
4	**Feedback amplifiers**	
4.1	Properties of positive and negative feedback on gain, frequency response and distortion.	1
4.2	Analysis of the four basic feedback topologies	2
4.3	Analysis of discrete circuits in each feedback topologies -voltage gain, input and output impedance	3
	Oscillators	
4.4	Classification, criterion for oscillation	1
	Wien bridge oscillator, Hartley and Crystal oscillator. (working principle and design equations of the circuits; analysis not required).	2
5	**Power amplifiers**	
5.1	Classification, Transformer coupled class A power amplifier	1
5.2	push pull class B and class AB power amplifiers, complementary-symmetry class B and Class AB power amplifiers, efficiency and distortion (no analysis required)	3
	Linear Regulated power supplies	
5.3	Principle of Linear Regulated power supplies, Shunt voltage regulator	1
5.4	Series voltage regulator, Short circuit protection and fold back protection, Output current boosting	2

Assignment:

Atleast one assignment should be simulation of different types of transistor amplifiers on any circuit simulation software.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT202

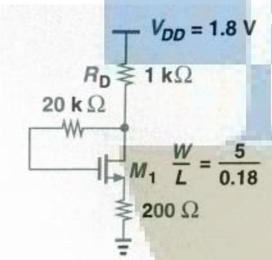
Course Name: ANALOG CIRCUITS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	Design the first order RC high pass filter with cut off frequency 2Kz.	3	K3
2	Describe about the double ended clipping.	3	K2
3	Differentiate between DC and AC load lines.	3	K2
4	What is the significance of Miller effect on high frequency amplifiers?	3	K1
5	What are the effects of cascading in gain and bandwidth of an amplifier?	3	K1
6	Calculate the drain current if $\mu_n C_{ox}$ = 100 $\mu A/V^2$, V_{TH} = 0.5V and λ = 0 in the following circuit.	3	K3



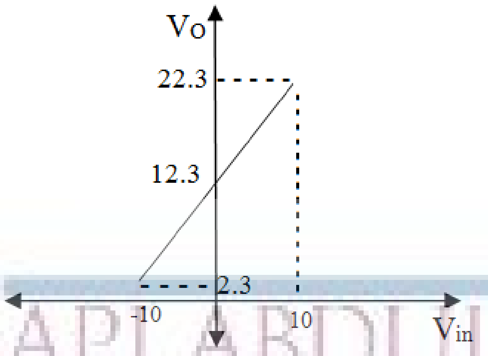
7	Illustrate the effect of negative feedback on bandwidth and gain of the amplifier.	3	K2
8	Explain the criteria for an oscillator to oscillate.	3	K1
9	How to eliminate cross over distortion in class-B power amplifier?	3	K2
10	What is line regulation and load regulation in the context of a voltage regulator?	3	K2

PART – B

Answer one question from each module; each question carries 14 marks.

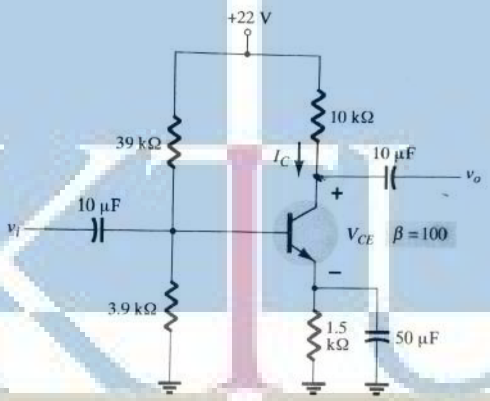
Module - I

11 a	Design a differentiator circuit for a square wave signal with Vpp=10 and frequency 10KHz.	6	CO1 K3
b.	Design a clamper circuit to get the following transfer characteristics, assuming voltage drop across the diodes 0.7V.	8	CO1 K3



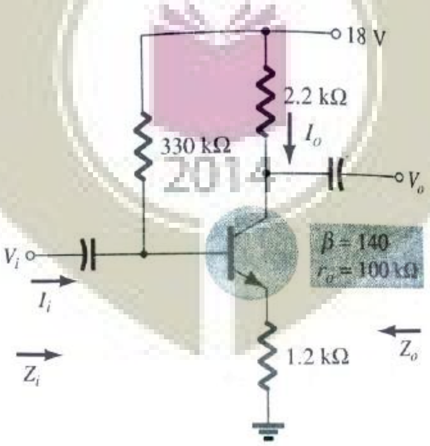
OR

12 a	Explain the working of an RC differentiator circuit for a square wave input with period T. Sketch its output waveform for RC ≫ T, RC ≪ T and RC = T.	5	K2 CO1
b.	With reference to the following circuit, draw the load line and mark the Q point of the Silicon BJT transistor.	9	K3 CO2



Module - II

13	For the following RC coupled amplifier determine r_e , Z_i , Z_o and A_v .	14	K3 CO2



OR

14 a	Draw the high frequency hybrid π model of BJT in CE configuration and explain the significance of each parameter.	6	K2 CO2
b	Analyse BJT RC coupled amplifier in CE configuration at high frequency using hybrid π model.	8	K2 CO2

Module - III

15 a	Draw the circuit of a common source amplifier using MOSFET. Derive the expressions for voltage gain and input resistance from small signal equivalent circuit.	7	K2 CO2
b.	How wide bandwidth is obtained in Cascode amplifier ?	7	K2 CO2

OR

16	Draw the CS stage with current source load and deduce the expression for voltage gain of the amplifier	14	K3 CO2

Module - IV

17	Give the block schematic of current-series feedback amplifier configuration and deduce the expression for gain, input impedance and output impedance with feedback. Design a practical circuit for this current-series feedback amplifier.	14	K3 CO2

OR

18 a	Design wein-bridge oscillator using BJT to generate 1KHz sine wave.	8	K3 CO3
b	Explain the working principle of crystal oscillator	6	K2 CO3

Module - V

19	Illustrate the working principle of complementary-symmetry class B power amplifiers and deduce the maximum efficiency of the circuit	14	K2 CO2

OR

20	Design a discrete series voltage regulator with short circuit protection for regulated output voltage 10V and maximum current 100mA.	14	K3 CO3

Simulation Assignments (ECT202)

The following simulations can be done in QUCS, KiCad or PSPICE.

1. Design and simulate a voltage series feedback amplifier based on BJT/ MOSFET. Observe the input and output signals. Plot the AC frequency response. Observe the Nyquits plot and understand its stability
2. Design and simulate a voltage shunt feedback amplifier based on BJT/ MOSFET. Observe the input and output signals. Plot the AC frequency response. Observe the Nyquits plot and understand its stability
3. Design and simulate series voltage regulator for output voltage $V_O = 10V$ and output current $I_O = 100mA$ with and without short circuit protection and to test the line and load regulations.
4. Design and simulate Wien bridge oscillator for a frequency of $5\,kHz$. Run a transient simulation and observe the output waveform.
5. Design and simulate Colpitts oscillator for a frequency of $455\,kHz$. Run a transient simulation and observe the output waveform.
6. Design and simulate a current series feedback amplifier based on BJT. Observe the input and output signals. Plot the AC frequency response. Observe the Nyquits plot and understand its stability
7. Design and simulate Hartley oscillator for a frequency of $455\,kHz$. Run a transient simulation and observe the output waveform.
8. Design and simulate clipping circuits that clips the $10\,V$ input sinusoid
   - at $+3.5\,V$ and at $-4.2\,V$
   - at $+2.5\,V$ and at $+4.2\,V$
   - at $-2.5\,V$ and at $-4.2\,V$

   with Si diodes

ECT 204	SIGNALS AND SYSTEMS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This couse aims to lay the foundational aspects of signals and systems in both continuous time and discrete time, in preparation for more advanced subjects in digital signal processing, image processing, communication theory and control systems.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply properties of signals and systems to classify them
CO 2	Represent signals with the help of series and transforms
CO 3	Describe orthogonality of signals and convolution integral.
CO 4	Apply transfer function to compute the LTI response to input signals.
CO 5	Apply sampling theorem to discretize continuous time signals

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										
CO 2	3	3	3									
CO 3	3	3	3									
CO 4	3	3										
CO 5	3	3	3									

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total	CIE	ESE	ESE Duration

Marks			
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1) : Apply properties of signals and systems to classify them

1. Check whether the following systems are stable, causal, linear, and time-invariant (a) y[n] = x[2n] (b) $y(t) = x^2(t) + 3$ (c) y[n] = nx[n]
2. Plot (a) u(t-1) + u(1-t) (b) u(t-1) – u(t+1) (c) sinc(t/T) (d) r(t) – r(t-2) – 2u(t-2)

Course Outcome 2 (CO2) : Represent signals with the help of series and transforms

1. Compute the Fourier transform of (a) x(t) = 1, -T/2 < t < T/2, and 0 elsewhere (b) x(t) = 1 - (|t|/T), -T < t < T, and 0 elsewhere
2. Show that a square wave has only odd harmonics.
3. State and prove Parsevals theorem

Course Outcome 3 (CO3) : Describe orthogonality of signals and convolution integral.

1. Show that δ(t-a) and δ(t-b), a ≠ b are orthogonal
2. Define convolution of x(t) and h(t)

Course Outcome 4 (CO4) : Apply transfer function to compute the LTI response to input signals.

1. Give the frequency response of a first-order low pass filter. What is the 3-dB cut off frequency?
2. What is the signficance of linear phase response?

Course Outcome 5 (CO5) : Apply sampling theorem to discretize continuous time signals

1. Derive the interpolation formula for finite-energy band-limited signals from its samples.

SYLLABUS

Elementary signals, Continuous time and Discrete time signals and systems, Signal operations, Differential equation representation, Difference equation representation, Continuous time LTI Systems, Discrete time LTI Systems, Correlation between signals, Orthogonality of signals, Frequency domain representation, Continuous time Fourier series, Continuous time Fourier transform, Using Laplace transform to characterize Transfer function, Stability and Causility using ROC of Transfer transform, Frequency response, Sampling, Aliasing, Z transform, Inverse Z transform, Unilateral Z-transform, Frequency domain representation of discrete time signals, Discrete time Fourier series and discrete time Fourier transform (DTFT), Analysis of discrete time LTI systems using the above transforms.

Text Books

1. Alan V. Oppenheim and Alan Willsky, Signals and Systems, PHI, 2/e, 2009

2. Simon Haykin, Signals & Systems, John Wiley, 2/e, 2003

Reference Books

1. Anand Kumar, Signals and Systems, PHI, 3/e, 2013.

2. B P. Lathi, Priciples of Signal Processing & Linear systems, Oxford University Press.

3. Gurung, Signals and System, PHI.

4. Mahmood Nahvi, Signals and System, Mc Graw Hill (India), 2015.

5. P Ramakrishna Rao, Shankar Prakriya, Signals and System, MC Graw Hill Edn 2013.

6. Rodger E. Ziemer, Signals & Systems - Continuous and Discrete, Pearson, 4/e, 2013

Course Contents and Lecture Schedule

Module	Topic	Number of lecture hours
I	Elementary Signals, Classification and representation of continuous time and discrete time signals, Signal operations	4
	Continuous time and discrete time systems – Classification, Properties.	3
	Representation of systems: Differential equation representation of continuous time systems. Difference equation representation of discrete systems.	2
	Continuous time LTI systems and convolution integral.	2

	Discrete time LTI systems and linear convolution.	2
	Stability and causality of LTI systems.	2
	Correlation between signals, Orthogonality of signals.	1
II	Frequency domain representation of continuous time signals - continuous time Fourier series and its properties.	4
	Continuous time Fourier transform and its properties. Convergence and Gibbs phenomenon	3
	Review of Laplace Transform, ROC of Transfer function, Properties of ROC, Stability and causality conditions.	3
	Relation between Fourier and Laplace transforms.	1
III	Analysis of LTI systems using Laplace and Fourier transforms. Concept of transfer function, Frequency response, Magnitude and phase response.	4
	Sampling of continuous time signals, Sampling theorem for lowpass signals, aliasing.	3
IV	Frequency domain representation of discrete time signals, Discrete time fourier series for discrete periodic signals. Properties of DTFS.	4
	Discrete time fourier transform (DTFT) and its properties. Analysis of discrete time LTI systems using DTFT. Magnitude and phase response.	5
V	Z transform, ROC , Inverse transform, properties, Unilateral Z transform.	3
	Relation between DTFT and Z-Transform, Analysis of discrete time LTI systems using Z transforms, Transfer function. Stability and causality using Z transform.	4

Simulation Assignments (ECT 204)

The following simulation assignments can be done with Python/MATLAB/ SCILAB/OCTAVE

1. Generate the following discrete signals
   - Impulse signal
   - Pulse signal and
   - Triangular signal
2. Write a function to compute the DTFT of a discrete energy signal. Test this function on a few signals and plot their magnitude and phase spectra.
3. - Compute the linear convolution between the sequences $x = [1, 3, 5, 3]$ with $h = [2, 3, 5, 6]$. Observe the stem plot of both signals and the convolution.
   - Now let $h = [1, 2, 1]$ and $x = [2, 3, 5, 6, 7]$. Compute the convolution between h and x.
   - Flip the signal x by 180° so that it becomes $[7, 6, 5, 3, 2]$. Convolve it with h. Compare the result with the previous result.
   - Repeat the above two steps with $h = [1, 2, 3, 2, 1]$ and $h = [1, 2, 3, 4, 5, 4, 3, 2, 1]$
   - Give your inference.
4. - Write a function to generate a unit pulse signal as a summation of shifted unit impulse signals
   - Write a function to generate a triangular signal as a convolution between two pulse signals.
5. - Relaize a continuous time LTI system with system response

     $$H(s) = \frac{5(s+1)}{(s+2)(s+3)}$$

     . One may use *scipy.signal.lti* package in Python.
   - Make it into a discrete system (possibly with *scipy.signal.cont2discrete*)
   - Observe the step response in both cases and compare.

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B Tech Degree Examination

Course: ECT 204 Signals and Systems

Time: 3 Hrs **Max. Marks: 100**

PART A

Answer All Questions

1	Differentiate between energy and power signal with example.	(3)	K_2
2	Test if the signals $x_1[n] = [1, -2, 3, 1]$ and $x_2[n] = [-1, 2, 1, 2]$ are orthogonal.	(3)	K_3
3	Compute the Fourier transform of $x(t) = \delta(t) + 0.5\delta(t-1)$	(3)	K_2
4	Write the Fourier series for $x(t) = A\cos 2\pi f_c t$ and use it to plot its line spectrum	(3)	K_2
5	Explain the transfer function of an LTI system in the s- domain.	(3)	K_1
6	What is the discrete frequency resulting when a $2\,kHz$ signal is sampled by an $8\,kHz$ sampling signals?	(3)	K_2
7	Give three properties of the ROC pertaining to Z-transform.	(3)	K_1
8	Compute the DTFT of $x[n] = \delta[n] - 2\delta[n-1] + 0.5\delta[n-3]$	(3)	K_3
9	Write the transfer function $H(z)$ of an LTI system described by $$y[n] = 0.3y[n-1] + 0.1y[n-2] + x[n] + 0.2x[n-1]$$	(3)	K_2
10	Give the relation between DTFT and Z transform	(3)	K_2

PART B

Answer one question from each module. Each question carries 14 mark.

Module I

11(A)	Test if the following systems are stable and time invariant i. $y[n] = \cos x[n]$ ii. $y[n] = x[n] - x[n-1]$	(8)	K_3
11(B)	Classify the following signals are energy and power signals i. $x[n] = 0.8^n U[n]$ ii. $x[n] = U[n] - U[n-10]$ iii. $x[n] = \cos 2\pi f_0 n$	(6)	K_3

OR

12(A)	Compute the convolution between $U[t] - U[t-5]$ with itself.	(7)	K_3
12(B)	Compute the output of the LTI system with input $x[n] = [1, -1, 2, -2]$ and impulse response $h[n] = [1, 2, 1]$	(7)	K_3

Module II

13(A)	Compute the Fourier transform of the triangular signal $x(t) = A[1 - \frac{\lvert t \rvert}{T}]$	(8)	K_3
13(B)	Compute the Fourier series of a half wave rectified sinusoid with period T and amplitude A	(6)	K_3

OR

14(A)	Compute the Laplace transforms of i. $x(t) = 2e^{-t}U[t] + 0.5e^{-3t}U[t]$ i. $x(t) = 2e^{-3t} \cos 4tU[t]$	(8)	K_3
14(B)	Compute the Fourier transform of a rectangukar pulse with unit amplitude and width T and centred around origin. Plot the Fourier tranform in the frequency domain.	(6)	K_3

Module III

15(A) Define sampling theorem. Determine the Nyquist rate and Nyquist interval for the signal (6) K_2

$$x(t) = \cos \pi t + 3 \sin 2\pi t + \sin 4\pi t$$

15(B) Analyze and characterize the LTI system $x(t)$ using Laplace Transform (8) K_2

$$x(t) = \frac{2}{3}e^{-t}u(t) + \frac{1}{3}e^{2t}u(t)$$

OR

16(A) Obtain the response of an LTI system with impulse response $h(t) = \delta(t)$ with input signal $x(t) = e^{-at}u(t)$ using Fourier transform (6) K_2

16(B) Explain spectral aliasing and the need for anti-aliasing filter with an example spectrum (8) K_2

Module IV

17(A) Describe the magnitude response and phase response of a discrete LTI system with the help of DTFTs. (7) K_2

17(B) Compute the magnitude response of an LTI system described by (7) K_2

$$y[n] = 0.1y[n-1]+0.1y[n-3]+x[n]+0.2x[n-1]+0.1x[n-2]$$

in terms of the DTFTs

OR

18 An LTI system has impulse response $h[n] = (\frac{1}{4})^n U[n]$. Use DTFT to compute the output for each of the following inputs: (i) $x[n] = (\frac{3}{4})^n U[n]$ (ii) $x[n] = (n+1)(\frac{1}{4})^n U[n]$ (iii) $x[n] = (-1)^n$. (14) K_2

Module V

19(A) Compute the inverse Z transform of (7) K_3

$$H(z) = \frac{1}{(1 - \frac{1}{2}z^{-1})(1 - \frac{1}{5}z^{-1})}$$

for all possible ROCs

19(B) Compute the inverse Z transform of (7) K_3

$$H(z) = cos(\alpha z^{-1})$$

for all possible ROCs

OR

20 Compute the Z-transform with ROC of

i. $x[n] = (\frac{1}{3})^n U[n]$ (4) K_3

ii. $x[n] = n(\frac{1}{3})^n U[n]$ (5) K_3

iii. $x[n] = \sum_{i=-\infty}^{n} (\frac{1}{3})^i U[i]$ (5) K_3

ECT 206	**COMPUTER ARCHITECTURE AND MICROCONTROLLERS***	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		PCC	**3**	**1**	**0**	**4**

Preamble: This course aims to impart knowledge of basic computer architecture and modern microcontrollers.

Prerequisite: ECT203 Logic Circuit Design

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the functional units, I/O and memory management w.r.t a typical computer architecture.
CO 2	Distinguish between microprocessor and microcontroller.
CO 3	Develop simple programs using assembly language programming.
CO 4	Interface 8051 microcontroller with peripheral devices using ALP/Embedded C
CO 5	Familiarize system software and Advanced RISC Machine Architecture.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3											3
CO 2	3											3
CO 3	3		3		3							3
CO 4	3	3	3		3							3
CO 5	3				3							3

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Course project : 15 marks

It is mandatory that a *course project* shall be undertaken by a student for this subject. The course project can be performed either as a hardware realization/simulation of a typical embedded system using Embedded C/ Assembly Language Programming. Instead of two assignments, two evaluations may be performed on the course project along with series tests, each carrying 5 marks. Upon successful completion of the project, a brief report shall be submitted by the student which shall be evaluated for 5 marks. The report has to be submitted for academic auditing. A few sample course projects are listed below:

Sample Course Projects

The below projects shall be done with the help of IDE for 8051/PIC/MSP/Arduino/Raspberry Pi-based interfacing boards/sensor modules.

1. Relay control
2. Distance measurement
3. Temperature measurement / Digital Thermometer
4. RF ID tags
5. Alphanumeric LCD display interface.
6. OLED display interfacing

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

SYLLABUS

Module 1: Computer Arithmetic and Processor Basics

Algorithms for binary multiplication and division. Fixed and floating-point number representation. Functional units of a computer, Von Neumann and Harvard computer architectures, CISC and RISC architectures. Processor Architecture – General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers. Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute, timing response, instruction sequencing and execution (basic concepts, datapath.

Module 2: 8051 Architecture

Microcontrollers and Embedded Processors. Architecture – Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts. Assembly Language Programming - Addressing Modes, Instruction set (Detailed study of 8051 instruction set is required).

Module 3: Programming and Interfacing of 8051

Simple programming examples in assembly language. Interfacing with 8051 using Assembly language programming: LED, Seven segment LED display. Programming in C - Declaring variables, Simple examples – delay generation, port programming, code conversion.

Interfacing of – LCD display, Keyboard, Stepper Motor, DAC and ADC -- with 8051 and its programming.

Module 4: Advanced Concepts

8051 Timers/Counters - Modes and Applications. Serial Data Transfer – SFRs of serial port, working, Programming the 8051 to transfer data serially. Introduction to ARM - ARM family, ARM 7 register architecture. ARM programmer's model. System software - Assembler, Interpreter, Compiler, Linker, Loader, Debugger.

Module 5: The Memory System

Types of memory - RAM, ROM. Memory Characteristics and Hierarchy. Cache memory – The basics of Caches, Mapping techniques, Improving Cache performance. Virtual memory – Overlay, Memory management, Address translation. Input/Output Organization – Introduction, Synchronous vs. asynchronous I/O, Programmed I/O, Interrupt driven I/O, Direct Memory Access.

Text Books

1. Muhammed Ali Mazidi & Janice Gilli Mazidi, R.D. Kinley, The 8051 microcontroller and Embedded System, Pearson Education, 2nd edition.
2. Subrata Ghoshal, Computer Architecture and Organization: From 8085 to Core2Duo and beyond, Pearson, 2011.
3. Steve Furber, ARM System - on-chip Architecture, Pearson Education

Reference Books

1. Mano M M, Computer System Architecture, 3rd Ed, Prentice Hall of India.
2. Computer organization and design: The Hardware/Software interface/David A. Patterson, John L. Hennessy. — 5th ed.
3. Computer Organisation V. Carl Hamacher, Zvonko G. Vranesic, Safwat G.Zaky.
4. John P Hayes, Computer Architecture and Organization, McGraw Hill.
5. Ramesh S Goankar, 8085 Microprocessor Architecture, Applications and Programming, Penram International, 5/e.
6. The 8051 Microcontrollers: Architecture Programming and Applications, K Uma Rao & Andhe Pallavi, Pearson, 2011.
7. Stallings W., Computer Organisation and Architecture, 5/e, Pearson Education.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures

1	**Computer Arithmetic and Processor Basics**	
1.1	Algorithms for binary multiplication and division	2
1.2	Fixed- and floating-point number representation in computers.	1
1.3	Functional units of a computer, Von Neumann and Harvard computer architectures, CISC and RISC architectures.	1
1.4	Processor Architecture – General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers.	2
1.5	Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute, timing response, instruction sequencing and execution (basic concepts), data path	3
	.	
2	**8051 Architecture**	
2.1	Microcontrollers and Embedded Processors and Applications	1
2.2	Architecture – Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts.	3
2.3	Addressing Modes of 8051	1
2.4	Instruction sets (Detailed study of 8051 instructions)	4
3	**Programming and Interfacing of 8051**	
3.1	Simple programming examples in assembly language.	2
3.2	Interfacing programming in Assembly language	2
3.3	Programming in C - Declaring variables, Simple examples – delay generation, port programming, code conversion.	3
3.4	Interfacing of 7 segment LCD display	1
3.5	Interfacing of Keyboard and stepper motor	2
3.6	Interfacing of DAC and ADC	2
4	**Advanced Concepts**	
4.1	8051 Timers/Counters - Modes and Applications	2
4.2	Serial Data Transfer – SFRs of serial port, working, Programming the 8051 to transfer data serially	2
4.3	Introduction to ARM - ARM family, ARM 7 register architecture. ARM programmer's model	2
4.4	System software - Assembler, Interpreter, Compiler, Linker, Loader, Debugger.	2
5	**Memory System**	
5.1	Types of memory - RAM, ROM. Memory Characteristics and Hierarchy	2
5.2	Cache memory – The basics of Caches, Mapping techniques, Improving Cache performance	2
5.3	Virtual memory – Overlay, Memory management, Address translation	2
5. 4	Input/Output Organization – Introduction, Synchronous vs. asynchronous I/O, Programmed I/O, Interrupt driven I/O, Direct Memory Access.	3

Simulation assignments

The following examples may be solved in C program

1. Program to convert the ASCII number into unpacked BCD.
2. Program to swap a number 0 x ab to 0 x ba, where a and b are hex digits.
3. Program to find the number of 1’s in an 8-bit data item.
4. Program to display ‘M’ and ‘E’ on the LCD connected to 8051 using the BUSY FLAG.
5. Program to rotate a stepper motor 50^0 in the clock wise direction.
6. Program to toggle pin P1.4 every second using interrupts for a frequency of 22 MHz. Use timer 1 in mode 1.
7. Program to generate a square wave of 1 kHz with duty cycle 33%. Use timer 1 in interrupt mode with a crystal frequency of 11.0592 MHz.

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B Tech Degree Examination

Branch: Electronics and Communication

Course: ECT 206 COMPUTER ARCHITECTURE AND MICROCONTROLLERS

Time: 3 Hrs Max. Marks: 100

Part – A

*Answer all questions. Questions carry **3 marks** each.*

1. Represent 4946.278941 as a 32 bit number in IEEE 754 format.

2. Which is more important for the functioning of a basic processor, Program Counter or Stack Pointer. Justify your answer.

3. List the components of 8051 microcontroller.

4. Write the operations happening in the following instructions:
ADD A, 56
XCHD A, @R1
DJNZ R6, LABEL
DIV AB
XRL A, #0FFh
JB P1.2 LABEL

5. Write an embedded C program for 8051 microcontroller to continously rotate a stepper motor clockwise.

6. Write an embedded C program for 8051 microcontroller to blink P2.5 every 2 seconds

7. List the different modes and give corresponding uses of timers in 8051 microcontroller

8. Which are the SFRs used for serial communication in 8051 microcontroller. Give there functions.

9. Illustrate the memory hierarchy in a computer system.

10. Is ROM a random access memory? Justify your answer.

Part – B

Answer one question each from all modules

Module – 1

11. a) With an example explain the “shift and add” algorithm for multiplying two binary numbers. (5 marks)
    b) With relevant diagrams illustrate the functioning of a basic (non – pipelined) processor. (9 marks)

OR

12. a) Differentiate RISC and CISC architectures. (4 marks)
    b) Explain Instruction Cycle with a sample timing diagram (10 marks)

Module – 2

13. a) Illustrate the complete memory organisation of 8051 microcontroller (10 marks)
    b) Differentiate microprocessors and microcontrollers. (4 marks)

OR

14. a) Explain about the Addressing Modes of 8051 microcontroller with examples. (7 marks)
    b) Describe the classification of the Instruction Set of 8051 microcontroller with examples. (7 marks)

Module – 3

15. a) Write an embedded C program for 8051 microcontroller to read an analogue signal from an ADC and reproduce the same using a DAC (9 marks)
    b) Write an assembly language program for 8051 microcontroller to sort N number in ascending order. Assume that the numbers are stored in continuous locations starting from 0x4321 onwards. (5 marks)

OR

16. a) Write an embedded C program for 8051 microcontroller to repeatedly display the sequence 1,5,8,0,2,6,4,9,3,7 using a 7 – segment display with a delay of 1.5 seconds between each number. (9 marks)
    b) Write an assembly language program for 8051 microcontroller to find the cube of an 8 – bit number (5 marks)

Module – 4

17. a) Assume a switch is connected to pin PL7. Write a embedded C program for 8051 microcontroller to monitor its status and
    send two messages to serial port continuously as follows:
    SW=0 send “NO”
    SW=1 send “YES”
    Assume XTAL = 11.0592 MHz, 9600 baud, 8-bit data, and 1 stop bit. (10 marks)
    b) Describe the ARM 7 register architecture (4 marks)

OR

18. a) Write a embedded C program for 8051 microcontroller to send the message "Hello World !" to serial port. Assume a SW is connected to pin P1.2. Monitor its status and set the baud rate as follows:
SW = 0 , 4800 baud rate
SW = 1 , 9600 baud rate
Assume XTAL = 11.0592 Mhz, 8 – bit data, and 1 stop bit (10 marks)
b) Explain how a HLL program is executed as machine language in a processor (4 marks)

Module – 5

19. a) Differentiate synchronous and asynchronous I/O.
Which is more efficient with respect to processor utilisation? Justify your answer (8 marks)
b) Explain direct mapping of cache memory with an example (6 marks)

OR

20. a) Differentiate interrupt driven and programmed I/O.
Which is more efficient with respect to processor utilisation? Justify your answer (8 marks)
b) Explain about memory management using virtual memory. (6 marks)

ECL 202	ANALOG CIRCUITS AND SIMULATION LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This course aims to

(i) familiarize students with the Analog Circuits Design through the implementation of basic Analog Circuits using discrete components.

(ii) familiarize students with simulation of basic Analog Circuits.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Design and demonstrate the functioning of basic analog circuits using discrete components.
CO 2	Design and simulate the functioning of basic analog circuits using simulation tools.
CO 3	Function effectively as an individual and in a team to accomplish the given task.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3						2			2
CO 2	3	3	3		3				2			2
CO 3	3	3	3						3			3

Assessment

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work	: 15 Marks
(b) Implementing the work/Conducting the experiment	: 10 Marks
(c) Performance, result and inference (usage of equipments and trouble shooting)	: 25 Marks
(d) Viva voce	: 20 marks
(e) Record	: 5 Marks

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

Part A : List of Experiments using discrete components [Any Six experiments mandatory]

1. RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
2. Clipping and clamping circuits (Transients and transfer characteristics)
3. RC coupled CE amplifier - frequency response characteristics
4. MOSFET amplifier (CS) - frequency response characteristics
5. Cascade amplifier – gain and frequency response
6. Cascode amplifier -frequency response
7. Feedback amplifiers (current series, voltage series) - gain and frequency response
8. Low frequency oscillators –RC phase shift or Wien bridge
9. Power amplifiers (transformer less) - Class B and Class AB
10. Transistor series voltage regulator (load and line regulation)

PART B: Simulation experiments [Any Six experiments mandatory]

The experiments shall be conducted using open tools such as QUCS, KiCad or variants of SPICE.

1. RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
2. Clipping and clamping circuits (Transients and transfer characteristics)
3. RC coupled CE amplifier - frequency response characteristics
4. MOSFET amplifier (CS) - frequency response characteristics
5. Cascade amplifier – gain and frequency response
6. Cascode amplifier – frequency response

7. Feedback amplifiers (current series, voltage series) - gain and frequency response
8. Low frequency oscillators – RC phase shift or Wien bridge
9. Power amplifiers (transformer less) - Class B and Class AB
10. Transistor series voltage regulator (load and line regulation)

ECL 204	MICROCONTROLLER LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This course aims to

(i) Familiarize the students with Assembly Language Programming of modern microcontrollers.

(ii) Impart the skills for interfacing the microcontroller with the help of Embedded C/Assembly Language Programming.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Write an Assembly language program/Embedded C program for performing data manipulation.
CO 2	Develop ALP/Embedded C Programs to interface microcontroller with peripherals
CO 3	Perform programming/interfacing experiments with IDE for modern microcontrollers.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3		3		3				3			3
CO 2	3		3	2	3				3			3
CO 3	3		3	3	3	3			3		3	3

Assessment

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work : 15 Marks
(b) Implementing the work/Conducting the experiment : 10 Marks
(c) Performance, result and inference (usage of equipments and trouble shooting) : 25 Marks
(d) Viva voce : 20 marks

(e) Record : 5 Marks

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

PART – A (At least 6 experiments are mandatory)

These experiments shall be performed using 8051 trainer kit. The programs shall be written either in embedded C or in assembly language.

1. Data transfer/exchange between specified memory locations.
2. Largest/smallest from a series.
3. Sorting (Ascending/Descending) of data.
4. Addition / subtraction / multiplication / division of 8/16 bit data.
5. Sum of a series of 8 bit data.
6. Multiplication by shift and add method.
7. Square / cube / square root of 8 bit data.
8. Matrix addition.
9. LCM and HCF of two 8 bit numbers.
10. Code conversion – Hex to Decimal/ASCII to Decimal and vice versa.

PART – B (At least 4 experiments are mandatory.)

Interfacing experiments shall be done using modern microcontrollers such as 8051 or ARM. The interfacing modules may be developed using Embedded C.

1. Time delay generation and relay interface.
2. Display (LED/Seven segments/LCD) and keyboard interface.
3. ADC interface.
4. DAC interface with wave form generation.
5. Stepper motor and DC motor interface.
6. Realization of Boolean expression through port.

SEMESTER -4
MINOR

ECT282	Microcontrollers	CATEGORY	L	T	P	CREDIT
		Minor	3	1	0	4

Preamble: This course aims to impart the overview of a microcontroller-based system design and interfacing techniques.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1 K2	Explain the building blocks of a typical microcomputer/microcontroller system
CO 2 K2	Familiarize the instruction set of 8051 and perform assembly language programming
CO 3 K3	Interface the various peripheral devices to the microcontroller using assembly/ C programming
CO4 K3	Realize external communication interface to the microcontroller
CO5 K2	Familiarize the building blocks of RISC Processors and ARM microcontrollers

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3											2
CO 2	3				3							2
CO 3	3	2	3		3							2
CO 4	3	2	3		3							2
CO5	3											2

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Syllabus

Module 1: Computer Arithmetic and Processor Basics

Functional units of a computer, Von Neumann and Harvard computer architectures. Processor Architecture – General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers. Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute.

Module 2: 8051 Architecture

Architecture – Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts. Addressing Modes, Instruction set (brief study of 8051 instruction set is sufficient).

Module 3: Programming and Interfacing of 8051

Simple programming examples in assembly language: Addition, Subtraction, Multiplication and Division. Interfacing of LCD display, Keyboard, Stepper Motor, DAC and ADC with 8051.

Module 4: Open Source Embedded Development Boards

Introduction. ATmega2560 microcontroller- Block diagram and pin description. Arduino Mega **256** board – Introduction and pin description. Simple Applications - Solar Tracker, 4-Digit 7-Segment LED Display, Tilt Sensor, Home Security Alarm System, Digital Thermometer, IoT applications.

Module 5: ARM Based System

Introduction - ARM family, ARM 7 register architecture, ARM programmer's model. Raspberry pi 4 board – Introduction and brief description. Applications - Portable Bluetooth speaker, Remote-controlled car, Photo Booth, IoT weather station, Home automation centre, Portable Digital eBook Library.

Text Books

1. Computer Architecture and Organization: From 8085 to Core2Duo and beyond, Subrata Ghoshal, Pearson, 2011.
2. The 8051 microcontroller and Embedded System, Muhammed Ali Mazidi & Janice Gilli Mazidi, R.D. Kinley, Pearson Education, 2nd edition.

Reference Books

1. The 8051 Microcontrollers: Architecture Programming and Applications, K Uma Rao & Andhe Pallavi, Pearson, 2011.
2. ARM System - on-chip Architecture, Steve Furber, Pearson Education

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Computer Arithmetic and Processor Basics**	
1.1	Functional units of a computer, Von Neumann and Harvard computer architectures	2
1.2	Processor Architecture – General internal architecture	1
1.3	Address bus, Data bus, control bus	1
1.4	Register set – status register, accumulator, program counter, stack pointer, general purpose registers.	2
1.5	Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute	3
2	**8051 Architecture**	
2.1	Architecture – Block diagram of 8051	1
2.2	Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts.	3
2.3	Addressing Modes of 8051	1
2.4	Instruction sets (brief study of 8051 instructions)	4
3	**Programming and Interfacing of 8051**	
3.1	Simple programming examples in assembly language	1
3.2	Addition, Subtraction, Multiplication and Division	2
3.3	Interfacing of 7 segment LCD display	1
3.4	Interfacing of Keyboard and stepper motor	2
3.5	Interfacing of DAC and ADC	3
4	**Open Source Embedded Development Boards**	
4.1	Introduction to open source boards	1
4.2	ATmega2560 microcontroller- Block diagram and pin description	3
4.3	Arduino Mega **256** board – Introduction and pin description	2
4.4	Simple Applications - Solar Tracker, 4-Digit 7-Segment LED Display, Tilt Sensor, Home Security Alarm System, Digital Thermometer, IoT applications	3
5	**ARM Based System**	

5.1	Introduction - ARM family, ARM 7 register architecture, ARM programmer's model	3
5.2	Raspberry pi 4 board – Introduction and brief description	2
5.3	Applications - Portable Bluetooth speaker, Remote-controlled car, Photo Booth, IoT weather station, Home automation centre, Portable Digital eBook Library	4

MODEL QUESTION PAPER

Total Pages: 2

Reg No.:_______________ Name:___________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, _____________ 20__

Course Code: ECT 282

Course Name: MICROCONTROLLERS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions; each question carries 3 marks.

		Marks
1	Distinguish between Harvard and Von-Neumann architecture.	(3)
2	Write down the control signal for a register transfer.	(3)
3	Explain the concept of memory banks in 8051.	(3)
4	Mention the difference between AJMP, LJMP and SJMP instructions.	(3)
5	Write a program to multiply two 8 bit numbers from external memory in 8051microcontroller	(3)
6	Explain the format of SCON special function register.	(3)
7	Discuss the features of ARM processor.	(3)
8	How do you interface an ADC with 8051?	(3)
9	List 5 main features of Atmega 2560 microcontroller	(3)
10	Give 5 features of ARM processors.	(3)

PART B

Answer one question from each module; each question carries 14 marks.

		Module 1	
1	a)	Explain the different stages of microprocessor operations.	(6)
	b)	Explain the role of different buses in a processor architecture.	(8)
		OR	
2	a)	Explain the data path for branch execution showing all control signals and sequences.	(6)
	b)	Explain the function of following registers: status register, accumulator, program counter, stack pointer, general purpose registers.	(8)
		Module 2	
3	a)	Draw the circuit diagram of port 1 and port 2 and describe their operation briefly.	(8)
	b)	Explain the internal architecture of 8051 microcontroller with a block diagram.	(6)
		OR	
4	a)	Briefly explain the following instructions of 8051: (i) MOV A, @Ri (ii) PUSH direct (iii) XCH A, Rn (iv) DAA	(8)
	b)	Explain the addressing modes of 8051.	(6)
		Module 3	
5	a)	Write an ALP to find the sum of an array of 8 bit numbers stored in the	(8)

		external memory of an 8051 microcontroller.	
	b)	How a DAC can be interfaced to 8051? Explain.	(6)
		OR	
6	a)	Write an ALP to add two 16 bit numbers, stored in consecutive locations in the external memory of an 8051 microcontrollers.	(8)
	b)	Explain the interfacing of LCD display with suitable schematic.	(6)
		Module 4	
7	a)	Explain the pin configuration of Arduino MEGA 256 board using a schematic diagram	(14)
		OR	
8	a)	Write short note on open source boards.	(5)
	b)	Explain the working of a four digit 7 segment LED display using an open source board.	(9)
		Module 5	
9	a)	Draw the ARM-7 register architecture and explain.	(7)
	b)	Draw and explain the programming model of an ARM processor.	(7)
		OR	
10	a)	Explain the features of a Raspberry pi -4 board.	(8)
	b)	Explain any one application using Raspberry pi -4 board and draw a schematic.	(6)
****			

ECT284	**DIGITAL COMMUNICATION**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		Minor	3	1	0	4

Preamble: This course aims to apply the concepts of probability and random processes in communication systems.

Prerequisite: ECT 253 Analog communication

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the main components in a digital communication system
CO 2	Explain the source coding schemes
CO 3	Explain codes for signaling
CO 4	Apply the knowledge of digital modulation schemes in digital transmission.
CO 5	Apply channel coding in digital transmission
CO 6	Explain digital receivers

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3										
CO 2	3	3		3								
CO 3	3	3		3								
CO 4	3	3			2							
CO 5	3	3		3								

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Main components in digital communication system
1. Draw the block diagram of a digital communication system and explain the blocks.
2. Compare and contrast analog communication system with a digital system. List the advantages of the latter.

Course Outcome 2 (CO2): Source Coding
1. Draw the block diagram of a linear PCM system and explain the functions of all blocks.
2. Explain the a-law and mu-law quantization
3. State sampling theorem and explain the reconstruction of signals

Course Outcome 3 (CO3): Signaling Code
1. Explain the principle of alternate mark inversion coding. Give an example with an arbitrary binary data pattern
2. Explain B3ZS code. Give an example with an arbitrary binary data pattern

Course Outcome 4 (CO4): Apply the knowledge of digital modulation schemes in digital transmission.
1. Explain the BPSK transmitter and receiver. Apply its principle to draw the output waveform of a BPSK transmitter that is fed with the bit pattern {1,0,0,1,1,00}.
2. Explain a baseband BPSK system. Give its probability of error. Draw the BER-SNR curve
3. Explain the QPSK transmitter and receiver. Apply its principle to draw the output waveform of a QPSK transmitter that is fed with the bit pattern {1,0,0,1,1,00}.

Course Outcome 5 (CO5): Digital Receivers
1. Explain encoding and decoding with (7,4) block codes
2. Explain the working of a matched filter receiver. Draw the BER-SNR curve at the output.
3. Explain Cyclic codes with an example.

SYLLABUS

Module 1: Linear Source Coding [1]

Elements of digital communication system. Sources, channels and receivers. Classification of communication channels. Discrete sources. Source coding techniques. Waveform coding methods. Sampling theorem. Sampling and reconstruction. Pulse code modulation. Sampling, quantization and encoding. Different quantizers. A-law and mu-law quantization. Practical 15 level mu and A law encoding.

Module 2: Nonlinear Source Coding [1,2]

Differential PCM, adaptive PCM, Delta modulator and adaptive delta modulator. Issues in delta modulation. Slope overload.

Module 3: Signaling Codes in Telephony [1]

Signalling codes in digital telephony. T1 signalling system. AMI and Manchester codes. Binary N-zero substitution, B3ZS code, B6ZS code.

Module 4: Digital Modulation Schemes [1,2]

Digital modulation schemes. Baseband BPSK system and the signal constellation. BPSK transmitter and receiver. Base band QPSK system and Signal constellations. Plots of BER Vs SNR (Analysis not required). QPSK transmitter and receiver. Quadrature amplitude modulation.

Module 5: Channel Coding and Receivers [1,2]

Transmission through AWGN Channel. Capacity of an AWGN channel. Receivers. Correlation and matched filter receiver. Channel coding schemes. Repetition code. Block codes Cyclic codes.

Text Books

1. John C. Bellamy, “Digital Telephony”,Wiley
2. Simon Haykin, “Communication Systems”, Wiley.
3. Sklar, “Digital Communications: Fundamentals and Applications”, Pearson.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Linear Source Coding**	
1.1	Block diagram of digital communication system, Sorces, channel and receivers. Classification of Channels	2
1.2	Source coding , waveform coding , sampling and reconstruction	2
1.3	PCM, Compression, 15 level A and mu-law coding	4
1.4	Uniform and Gaussian Pdf and correspoding CDF. Properties	1
2	**Nonlinear Source Coding**	
2.1	DPCM,Adaptive DPCM	4
2.2	Delta modulation, slope overload	3
3	**Signaling Codes**	
3.1	Overview of T1 signaling systems. Need for signaling codes, AMI and Manchestre codes	4
3.2	Binary N-zero substitution, B3ZS code, B6ZS code	3
3.5	Mutual information and channel capacity. Capacity of AWGN channel	2
4	**Digital Modulation**	
4.1	Need of digital modulation in modern communication.	1
4.2	Baseband BPSK system, signal constellation. Effect of AWGN, probability of error. BER-SNR curve, BPSK transmitter and receiver.	4
4.3	Baseband QPSK system, signal constellation. Effect of AWGN, probability of error. BER-SNR curve, QPSK transmitter and receiver.	4
4.4	QAM system	2
5	**Channel Coding and Receivers**	
5.1	Mutual information and channel capacity	2
5.2	Correlation and matched filter receiver, BER-SNR curve	2
5.3	Channel coding schemes. Repetition code. Block codes. Cyclic codes	5

Simulation Assignments

The following simulations can be done in MATLAB, Python,R or LabVIEW.

A-Law and μ-Law Characteristics

- Create a vector with say 1000 points that spans from -1 to 1.
- Apply A-Law companding on this vector get another vector. Plot it against the first vector for different A values and appreciate the transfer characteristics.
- Repeat the above steps for μ-law as well.

Practical A-Law compander

- Implement the 8-bit practical A-law coder and decoder in Appendix B 2 (pp 583–585) in *Digital Telephony by Bellamy*
- Test it with random numbers and speech signals. Observe the 15 levels of quantization.

Practical μ-Law compander

- Implement the 8-bit practical μ-law coder and decoder in Appendix B 1 (pp 579–581) in *Digital Telephony by Bellamy*
- Test it with random numbers and speech signals. Observe the 15 levels of quantization.

B3ZS Encoder and Decoder

- Implenet a B3ZS encoder and decoder.
- Test it with random bits.
- Decode and compare the result with the original bit pattern.

B6ZS Encoder and Decoder

- Implenet a B6ZS encoder and decoder.
- Test it with random binary vector.
- Decode and compare the result with the original bit pattern.

Base Band BPSK System

- Cretae a random binary sequence of 5000 bit. Convert it into a bipolar NRZ code.
- Create a BPSK mapper that maps bit 0 to zero phase and bit 1 to π phase.
- Plot the real part of the mapped signal against the imaginary part to observe the signal constellation
- Add AWGN of difference variances to the base band BPSK signal and observe the changes in constellation.
- Realize the BPSK transmitter and receiver in Fig. 6.4 in pager 352 in *Communication Systems by Simon Haykin* .
- Add AWGN of different variances and compute the bit error rate (BER) for different SNR values.
- Plot the BER Vs. SNR.
- Plot the theoretical BER-SNR curve, using Eq. 6.19 in pager 351 in *Communication Systems by Simon Haykin* .

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B Tech Degree Examination

Course: ECT 284 Digital Communication

Time: 3 Hrs **Max. Marks: 100**

PART A

Answer All Questions

1	State sampling theorem	(3)	K_2
2	Give the classification of communication channels	(3)	K_2
3	Explain the term slope overload	(3)	K_2
4	Why is a logarithmic quantizer preferred in DPCM?	(3)	K_2
5	Explain the needs for signalling codes	(3)	K_1
6	Draw the Manchester code for the bit pattern $\{1, 0, 1, 1, 0, 0\}$	(3)	K_3
7	Draw the BER-SNR curve for a BPSK system	(3)	K_2
8	Draw the signal constellation for a baseband QPSK system	(3)	K_2
9	Define mutual information and channel capacity	(3)	K_2
10	Explain a (7,4) block code.	(3)	K_2

PART B

Answer one question from each module. Each question carries 14 mark.

Module I

11(A)	Draw the block diagram of a linear PCM system and explain the blocks	(8)	K_2
11(B)	Explain μ-law companding	(6)	K_2

OR

12(A)	Explain how companding is achieved practically using different levels	(8)	K_2

12(B)	Explain mid-rise and mid-tread quantizers	(6)	K_2

Module II

13(A)	Explain the need for differential PCM. What is the advantage over linear PCM	(6)	K_2
13(B)	Draw the block diagram of a DPCM transmitter and receiver and explain the functions of ech block.	(8)	K_3

OR

14(A)	Draw the block diagram of a delta modulator and explain the functions of each block	(8)	K_2
14(B)	Explain the principle of adaptive delta modulation	(6)	K_2

Module III

15(A)	What is binary zero substitution? Explain the B3ZS line coding scheme	(8)	K_2
15(B)	Encode {101000010000000001} using B3ZS code	(6)	K_3

OR

16(A)	Explain the principle of alternate mark inversion coding. Give an example with an arbitrary binary data pattern	(8)	K_2
16(B)	Encode {101000010000000001} using B6ZS code	(6)	K_3

Module IV

17(A)	Draw the block diagram of BPSK transmitter and receiver and explain the functions of each block. Draw the BER-SNR curve.	(8)	K_2
17(B)	Draw the signal constellation of base band BPSK and indicate the effect of AWGN on it	(6)	K_2

OR

18(A) Draw the block diagram of QPSK transmitter and receiver and explain the functions of each block. Draw the BER-SNR curve. (8) K_2

18(B) Explain the QAM modulation and demodulation. (6) K_2

Module V

19(A) Explain how matched filter is used in digital reception? Draw the BER-SNR curve at the output. (8) K_3

19(B) Explain how correlation receiver is used in digital reception? (6) K_3

OR

20 Explain channel encoding and decoding with (7,4) block codes (14) K_3

ECT286	INTRODUCTION TO DIGITAL SIGNAL PROCESSING	CATEGORY	L	T	P	CREDIT
		Minor	3	1	0	4

Preamble: This course aims to give an introduction to digital signal processing

Prerequisite: ECT255 Introduction to Signals and Systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain how digital signals are obtained from continuous time signals.
CO 2	Apply Fourier transform in the analysis of signals
CO 3	Implement digital filters
CO 4	Explain the practical limitations in DSP implementations
CO 5	Explain the structure of a DSP processor.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1										
CO 2	3	3	2	2	3				3			1
CO 3	3	2	3	3	3				3			
CO 4	3	1										
CO 5	3	1			1							

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	25	25	50
Apply	15	15	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Discrete Signals and Sampling Theorem

1. Define a digital signal. Give the frequency range of digital signal. Explain the sampling theorem and show graphically how samples are generated from a continuous time signal.

2. What should be the minimum frequency to sample a 2.5kHz analog signal? Explain graphically how the continuous time signal is reconstructed from samples.

Course Outcome 2 (CO2): Application of Fourier Transform

1. Give the expression for DFT of an N-point sequence. Compute the 10 point DFT of a unit impulse sequence.

2. Derive the raddix-2 decimation in time algorithm for N=8.

Course Outcome 3 (CO3): Implementation of Digital Filters

1. Give the difference equation of an IIR filter. Give an example and draw its structure

2. Design an IIR Butterworth filter for passband frequency 5kHz and stopband frequency 10kHz. The stop band and passs band attenuations are 0.1 respectively.

Course Outcome 4 (CO4): Practical Limitations of Digital Filters

1(A). Explain the limit cycle oscillations in IIR filters

(B) Explain the effects of coefficient quantization in IIR filters

2. (A) Explain the effects of round of noise in digital filters
2(B) Explain the fixed and floating point arithmetic used in DSP processors.

Course Outcome 5 (CO5): Structure of Digital Signal Processors

1(A). Explain the function of the MAC unit in a DSP

(B) Explain the differences between Harvard and Von Neumann architecture.

2. Draw the internal structure of a floating point processor and explain its functional blocks

Syllabus

Module 1: Signal Processing Fundamentals
Discrete-time and digital signals. Basic elements of digital processing system- ADC, DAC and Nyquist rate. Frequency aliasing due to sampling. Need for anti-aliasing filters. Discrete Time Fourier Transforms – Properties. Computation of spectrum.

Module 2: Discrete Fourier Transform – Properties and Application
Discrete Fourier transform - DFT as a linear transformation, Properties - circular convolution. Filtering of long data sequences - FFT-Radix-2 DIT and DIF algorithms. Computational complexity of DFT and FFT -application.

Module 3: Digital Filters
Digital FIR Filter: Transfer function - Difference equation, Linear phase FIR filter, Concept of windowing, Direct form and cascade realization of FIR and IIR filters. Digital IIR Filters - Transfer function, Difference equation. Direct and parallel Structures. Design of analogue Butterworth filters, Analog frequency transformations, Impulse invariance method. Bilinear transformation, Analog prototype to digital transformations.

Module 5: Finite word length effects in digital filters and DSP Hardware
Fixed point arithmetic, Floating point arithmetic, Truncation and Rounding, Quantization error in ADC, Overflow error, Product round off error, Scaling , Limit cycle oscillation.

General and special purpose hardware for DSP: Computer architectures for DSP – Harvard, pipelining, MAC, special instruction, replication, on chip cache. General purpose digital signal processors (TMS 320 family) - Implementation of digital filtering on dsp processor. Special purpose DSP hardware

Text Books
1. Proakis, J.G. & Manolakis, D.G., “Digital Signal Processing: Principles, Algorithms,& Applications”, 3/e Prentice Hall of India, 1996.
2. Ifeachor, E.C., & Jervis, B.W., “Digital Signal Processing: A Practical Approach”,2/e, Pearson Education Asia, 2002.
3. Chen, C.T., “Digital Signal Processing: Spectral Computation & Filter Design”, Oxford Univ. Press, 2001.
4. Mitra, S.K., “Digital Signal Processing: A Computer-Based Approach”, McGraw Hill, NY, 1998
5. Monson H Hayes, Schaums outline: Digital Signal Processing.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Signal Processing Fundamentals**	
1.1	Overview of signals. Frequency elements of DSP sytems	2
1.2	Conversion of analog signals to digital signals, Sampling theorem, reconstruction ADC and DAC , spectra and antialiasing filter	3
1.3	DTFT properties, spectrum	3

2	**DFT**	
2.1	DFT from DTFT, DFT as a linear transformation. W matrix. Properties of DFT, Computational challenges.	3
2.2	FFT for comptational advantage, Radix -2 DIT and Dif algorith, in place computation. Bit reversal permutation. complexity	4
2.3	Filtering of long sequences	2
3	**Digital Filters**	
3.1	Model of FIR and IIR filters. Direct form I and II of FIR filter, simple FIR design	4
3.2	IIR filter, design of Butterworth filter, Direct and parallel realization	4
3.3	Analog to digital transformation, impulse invariance and bilinear transformation.	4
4	**Finite Word-length Effects**	
4.1	Number representation Truncation - Rounding - Quantization error in ADC - Overflow error- product round off error - Scaling - Limit cycle oscillation.	2
4.2	Truncation-Rounding - Quantization error in ADC - Overflow error - product round off error - Scaling - Limit cycle oscillation.	5
5	**DSP Architecture**	
5.1	Von Neumann and Harvard architecture, Comparison	1
5.2	Data paths of fixed and floating point DSP processors. Functions of various blocks Architecture of a typical DSP processor	5
5.3	Implementation of systems on DSP chip	2

Simulation Assignments

The following simulation assignments can be done with Python/MATLAB/ SCILAB/OCTAVE

1. Generate the following discrete signals
   - Impulse signal
   - Pulse signal and
   - Triangular signal
2. Write a function to compute the DFT of a discrete energy signal. Test this function on a few signals and plot their magnitude and phase spectra.
3. - Compute the linear convolution between the sequences $x = [1, 3, 5, 3]$ with $h = [2, 3, 5, 6]$. Observe the stem plot of both signals and the convolution.
   - Now let $h = [1, 2, 1]$ and $x = [2, 3, 5, 6, 7]$. Compute the convolution between h and x.
   - Flip the signal x by 180° so that it becomes $[7, 6, 5, 3, 2]$. Convolve it with h. Compare the result with the previous result.
   - Repeat the above two steps with $h = [1, 2, 3, 2, 1]$ and $h = [1, 2, 3, 4, 5, 4, 3, 2, 1]$
   - Give your inference.
4. - Compute the DFT matrix for $N = 8, 16, 64, 1024$ and 4098
   - Plot the first 10 rows in each case and appreciate these basis functions
   - Plot the real part of these matrices as images and appreciate the periodicities and half periodicities in the pattern
   - Normalize each matrix by dividing by $\sqrt{N}$. Compute the eigenvalues of every normalized matrix and observe that all eigenvalues belong to the set $\{1, j, -j, -1\}$.
5. - Realize a continuous time LTI system with system response

     $$H(s) = \frac{5(s+1)}{(s+2)(s+3)}$$

     . One may use *scipy.signal.lti* package in Python.
   - Make it into a discrete system (possibly with *scipy.signal.cont2discrete*)
   - Observe the step response in both cases and compare.
6. - Download a vibration signal in *.wav* format.
   - Load this signal into an array. One may use the *scipy.io.wavfile* module in Python.
   - understand the sampling rate of this signal.

- Plot and observe the vibration signal waveform.
- Compute the absolute squared value of the FFT of the vibration signal.
- Plot it and observe the spectral components in the discrete frequency domain.
- Multiply prominent discrete frequencies by the sampling rate and observe and appreciate the major frequency components in Hz.

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B. Tech. Degree Examination

Branch: Electronics and Communication

Course: ECT 286 Introduction to Digital Signal Processing

Time: 3 Hrs **Max. Marks: 100**

PART A

Answer All Questions

1	Define frequency of a discrete signal and identify its range.	(3)	K_1
2	State Nyquist sampling theorem for low pass signals and the formula for signal reconstruction.	(3)	K_3
3	Explain why DFT operation is a linear transformation.	(3)	K_2
4	Explain how FFT reduces the computational complexity of DFT.	(3)	K_2
5	Write the expresssion for the Hamming window and plot it.	(3)	K_1
6	Give the expression for bilinear tranformation and explain the term frequency warping.	(3)	K_2
7	Explain the quantization error in ADCs.	(3)	K_2
8	Explain the 1s and 2s complement representation of numbers in DSP processor.	(3)	K_2
9	Compare floating point and fixed point data paths in a DSP processor.	(3)	K_2
10	Explain function of a barrel shifter in a DSP processor.	(3)	K_2

PART B

Answer one question from each module. Each question carries 14 mark.

Module I

11(A)	Explain how analog signals are converted to digital signals.	(10)	K_2
11(B)	What all digital frequencies are obtained when a $1\,kHz$ signal is sampled by $4\,kHz$ and $8\,kHz$ impulse trains?	(4)	K_3

OR

12(A)	Give the expression for DTFT. Compute the DTFT of the signal $x[n] = [1, -1, 1, -1]$	(8)	K_3
12(B)	Explain how sampling affects the spectrum of the signal and the need of antialiasing filter	(6)	K_3

Module II

13(A)	Give the radix-2 decimation in time algorithm for 8-point FFT computation	(10)	K_3
13(B)	How is in place computation applied in FFT algorithms?	(4)	K_3

OR

14(A)	Find the DFT of the sequence $x(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$ using radix-2 DIF algorithm	(10)	K_3
14(B)	How is bit reverse addressing used in FFT computations?	(4)	K_3

Module III

15(A)	Write the difference equation representation of IIR filter and explain how its impulse response is infinite in duration	(7)	K_3

15(B) Convert the analog filter (7) K_3

$$H(s) = \frac{1}{(s+1)(s+2)}$$

into digital filter using impulse invariance method.

OR

16(A) Implement the FIR filter $h[n] = [1, 2, 4, 6, 4, 2, 1]$ with minimum multipliers in directform (6) K_3

16(B) Design an IIR Butterworth filter for passband frequency $5\,kHz$ and stopband frequency $10\,kHz$. The stop band and passs band attenuations are 0.1 respectively. (8) K_3

Module IV

17(A) Explain the limit cycle oscillations in IIR filters (6) K_3

17(B) Derive the quantization noise power in an ADC (8) K_3

OR

18(A) Find the output noise variance of a first order system with transfer function (8) K_3

$$H(z) = \frac{1}{1 - \alpha z^{-1}}$$

that is driven by a zero mean white Gaussian noise of variance σ_N^2

18(B) Explain the fixed and floating point arithmetic used in DSP processors. (6) K_3

Module V

19 Draw and explain the functional blocks in a floating point DSP processor. (14) K_2

OR

20(A)	Compare Von Neumann architecture with Harvard architecture	(7)	K_2
20(B)	Explain the significance and operation of the MAC unit in a DSP processor	(7)	K_2

SEMESTER -4
HONOURS

ECT292	NANOELECTRONICS	CATEGORY	L	T	P	CREDIT
		Honors	3	1	0	4

Preamble: This course aims to understand the physics behind mesoscopic systems and working of nanoelectronic devices.

Prerequisite: PHT100 Engineering Physics A, ECT201 Solid State Devices

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain quantum mechanical effects associated with low dimensional semiconductors.
CO 2	Explain the different processes involved in the fabrication of nanoparticles and nanolayers.
CO 3	Explain the different techniques for characterizing nano layers and particles
CO 4	Explain the different transport mechanisms in nano structures
CO 5	Illustrate the operating principle of nanoscale electronic devices like SET, Resonant tunnelling devices, Quantum lasers etc.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2											
CO 2	2											
CO 3	1											
CO 4	2											
CO 5	2											

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	35	35	70
Apply	5	5	10
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the quantum mechanical effects associated with low dimensional semiconductors.

1. Derive the expression for density of states in a 1D nanomaterial.

2. Compare and contrast triangular, square and parabolic quantum wells.

3. Solve numerical problems to find whether the given material is a nanometric one.

Course Outcome 2 (CO2) : Explain the different processes involved in the fabrication of nanoparticles and nanolayers.

1. Explain Sol-Gel process for synthesis of nanoparticles.
2. Explain the different steps involved in CVD process for fabricating nanolayers.
3. DC sputtering cannot be used for the coating of non- conducting materials. Justify.

Course Outcome 3 (CO3): Explain the different techniques for characterizing nano layers and particles.

1. Illustrate the working principle of an AFM.
2. Explain the different emission and interactions between electron beam and the specimen.
3. Explain the principle of operation of an XRD.

Course Outcome 4 (CO4): Explain the different transport mechanisms in nano structures.

1. Explain Kronig Penney model of a super lattice.

2. Explain modulation doping with an example.

3. Explain the different scattering events encountered by a carrier during parallel transport under the influence of electric field.

Course Outcome 5 (CO5): Illustrate the operating principle of nanoscale electronic devices like SET, Resonant tunnelling devices, Quantum lasers etc.

1. Explain Coulomb blockade effect. Illustrate the working of a single electron transistor.

2. Draw the schematic representation of the conduction band of a resonant tunnel diode for (a) no voltage applied (b) increasing applied voltages. Explain its I-V characteristics.

3. MODFETS are high electron mobility transistors. Justify.

Syllabus

Module I

Introduction to nanotechnology, Limitations of conventional microelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence.

Low dimensional structures - Quantum wells, wires and dots, Density of states of 1D and 2D nanostructures.

Basic properties of square quantum wells of finite depth, parabolic and triangular quantum wells

Module II

Introduction to methods of fabrication of nano-layers: physical vapour deposition- evaporation & Sputtering, Chemical vapour deposition, Molecular Beam Epitaxy, Ion Implantation, Formation of Silicon Dioxide- dry and wet oxidation methods.

Fabrication of nano particle- grinding with iron balls, laser ablation, reduction methods, sol gel, self assembly, precipitation of quantum dots.

Module III

Introduction to characterization of nanostructures: Principle of operation of Scanning Tunnelling Microscope, Atomic Force Microscope, Scanning Electron microscope - specimen interaction, X-Ray Diffraction analysis

Module IV

Quantum wells, multiple quantum wells, Modulation doped quantum wells, concept of super lattices Kronig - Penney model of super lattice.

Transport of charge in Nanostructures - Electron scattering mechanisms, Hot electrons, Resonant tunnelling transport, Coulomb blockade, Effect of magnetic field on a crystal. Aharonov-Bohm effect, the Shubnikov-de Hass effect.

Module V

Nanoelectonic devices - MODFETS, Single Electron Transistor, CNT transistors – Properties of graphene
Resonant tunnel effect, RTD, RTT, Hot electron transistors
Quantum well laser, quantum dot LED, quantum dot laser

Text Books

1. J.M. Martinez-Duart, R.J. Martin Palma, F. Agulle Rueda Nanotechnology for Microelectronics and optoelectronics , Elsevier, 2006
2. W.R. Fahrner, Nanotechnology and Nanoelctronics, Springer, 2005

Reference Books

1. Chattopadhyay, Banerjee, Introduction to Nanoscience & Technology, PHI 2012
2. Poole, Introduction to Nanotechnology, John Wiley 2006.
3. George W. Hanson, Fundamentals of Nanoelectronics, Pearson Education, 2009.
4. K. Goser, P. Glosekotter, J. Dienstuhl, Nanoelectronics and nanosystems, Springer 2004.
5. Supriyo Dutta, Quantum Transport- Atom to transistor, Cambridge, 2013.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**MODULE 1**	
1.1	Introduction to nanotechnology, Limitations of conventional microelectronics	1
1.2	Characteristic lengths in mesoscopic systems	1
1.3	Quantum mechanical coherence, Schrodinger’s equation, Low dimensional structures - Quantum wells, wires and dots	3
1.4	Density of states of 1D and 2D nanostructures	2
1.5	Basic properties of square quantum wells of finite depth, parabolic and triangular quantum wells	3
2	**MODULE 2**	
2.1	Introduction to methods of fabrication of nano-layers: physical vapour deposition- evaporation & Sputtering,	2
2.2	Chemical vapour deposition, Molecular Beam Epitaxy	2
2.3	Ion Implantation, Formation of Silicon Dioxide- dry and wet oxidation methods	2
2.4	Fabrication of nano particle- grinding with iron balls, laser ablation, reduction methods	2
2.5	Sol - Gel, self assembly, precipitation of quantum dots.	2
3	**MODULE 3**	
3.1	Introduction to characterization of nanostructures: Principle of operation	2

	of Scanning Tunnelling Microscope	
3.2	Atomic Force Microscope	1
3.3	Scanning Electron microscope - specimen interaction.	1
3.4	X-Ray Diffraction analysis	1
4	**MODULE 4**	
4.1	Quantum wells, multiple quantum wells, Modulation doped quantum wells, concept of super lattices	2
4.2	Kronig - Penney model of super lattice.	1
4.3	Transport of charge in Nanostructures - Electron scattering mechanisms, Hot electrons	1
4.4	Resonant tunnelling transport, Coulomb blockade	2
4.5	Quantum transport in nanostructures - Coulomb blockade	1
4.6	Effect of magnetic field on a crystal. Aharonov-Bohm effect	2
4.7	Shubnikov-de Hass effect	1
5	**MODULE 5**	
5.1	Nano electonic devices- MODFETS	2
5.2	Single Electron Transistor	1
5.3	CNT transistors , Properties of graphene	2
5.4	RTD, RTT, Hot electron transistors	3
5.5	Quantum well laser, quantum dot LED, quantum dot laser	2

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

MODEL QUESTION PAPER

ECT 292 NANOELECTRONICS

Time: 3 hours **Max. Marks:100**

PART A

Answer ***all*** questions. Each question carries ***3 marks***.

1. Explain any three characteristic lengths in mesoscopic systems.
2. Explain the terms (i) coherence length (ii) phase coherence.
3. Explain Laser ablation method for nanoparticle fabrication.
4. DC sputtering cannot be used for coating of non-conducting materials. Justify
5. Explain two different modes of operation of a STM.
6. Explain XRD method for characterizing nano materials.
7. Differentiate between the two types of multiple quantum wells.
8. Explain Aharonov-Bohm effect.
9. Explain why MODFETs are called high electron mobility transistors.
10. List any six properties of graphene.

PART B

Answer ***any one*** question from each module. Each question carries 14 marks.

MODULE I

11. (a) Show that DOS in a 2D material is independent of energy. (8 marks)
(b) Explain any three physical limitations in reducing the size of devices in Nano metric scale. (6 marks)

12. Compare and contrast square, parabolic and triangular quantum wells (14 marks)

MODULE III

13. (a) Illustrate the process of Molecular Beam Epitaxi for fabricating nano layers. (8 marks)
(b) Differentiate between dry oxidation and wet oxidation techniques (6 marks)

14. (a) Sketch and label a CVD reactor and explain the different steps involved in the CVD process. (8 marks)
(b) Explain the reduction method for nano particle fabrication (6 marks)

MODULE III

15. Explain the different specimen interactions of an electron beam and illustrate the working of a SEM (14 marks)

16. Explain the principle of operation of an AFM. Explain the different modes of operation. (14 marks)

MODULE IV

17. (a) Explain Kronig–Penney model of a super lattice. What is meant by Zone folding? (10 marks)

(b)Explain the concept of hot electrons in parallel transport (4 marks)

18. (a) Explain Coulomb Blockade effect (8 marks)

(b) Illustrate resonant tunneling effect. (6 marks)

MODULE V

19. (a)) Draw the schematic and explain the working of a single electron transistor (8 marks)

(b) Explain working of resonant tunneling diodes (6 marks)

20. (a) Illustrate the working of a quantum well laser (6 marks)

(b) Explain the different types of Carbon Nanotube transistors (8 marks)

ECT294	STOCHASTIC PROCESSES FOR COMMUNICATION	CATEGORY	L	T	P	CREDIT
		Honors	3	1	0	4

Preamble: This course aims to apply the concepts of probability and random processes in communication systems.

Prerequisite: None

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the concepts of probability, random variables and stochastic processes
CO 2	Apply the knowledge in probability to ststistically characterize communication channels.
CO 3	Apply probability to find the information and entropy
CO 4	Explain source coding and channel coding theorem.
CO 5	Apply stochastic processes in data transmission

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3										
CO 2	3	3		3	2							
CO 3	3	3		3	2							2
CO 4	3	3										
CO 5	3	3		3	2							

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	25	25	50
Apply	15	15	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Concepts in probability

1. Give frequentist and axiomatic definitions of probability. State the demerits of frequentist definition.

2. What is a random variable? Illustrate with an example how it becomes useful in studying engineering problems?

3. A six faced die with P(1)=P(3)=1/3, P(4)=P(5)=1/4 is thrown in a game with outcomes listed in the table.

Face	1	2	3	4	5	6
Payoff(Rs)	+50	-40	+60	-60	-20	+100

The + and - signs indicates gain and loss for the the player respectively.

1.Draw the CDF and PDF

2. Compute the expected value of gain/loss. Is it worthwhile to play the game?

3. Compute the entropy of the random variable.

Course Outcome 2 (CO2) : Review of random processes

1. Give the conditions for WSS and SSS.

2. Test if the sinusoid $X(t)=A\cos(2\pi ft+\theta)$ with θ variying uniformly in the interval $[-\pi,\pi]$ is WSS.

3. Define white Gussian noise.

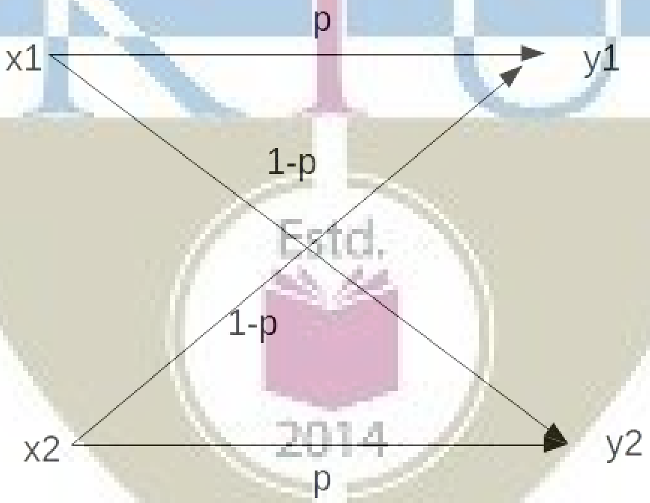
4. State central limit theorem. Why is Guassian model suitable in additive noise channels?

Course Outcome 3 (CO3): Entropy and Information

1. Define discrete memoryless source and discrete menoryless channel.

2. Define entropy and conditional entropy.

3. See the binary symmetric channel in the figure below.



Let p(x1)=1/3 and p =1/4. Compute the mutual information betweeen X and Y.

Course Outcome 4 (CO4): Source coding and Channel Coding

1. State the souce coding theorem.

2. Compute the mutual information between the input and output of an AWGN channel. What is its capacity.

3. Find the capacity of an AWGN channel with 4kHz bandwidth and the noise power spectral density 10^{-12}W/Hz. The signal power at the receiver is 0.1mW.

Course Outcome 5 (CO5): Stochastic processes in data transmission

1. Derive Chapman – Kolmogorov equation.

2. Explain the packet transmission in a slotted ALOHA network

3. Consider a Markov chain with three possible states 1,2,3 with transition probability matrix

$$\begin{pmatrix} \frac{1}{4} & \frac{1}{2} & \frac{1}{4} \\ \frac{1}{3} & 0 & \frac{2}{3} \\ \frac{1}{2} & 0 & \frac{1}{2} \end{pmatrix}$$

a) Draw the state transition diagram.
b) Find $P(X_4=3|X_3=2)$
c) If $P(X_0=1)=1/3$ Find $P(X_0=1,X_1=2)$

SYLLABUS

Module 1 : Review of Probability and Random Variables [1,2]

Review of probability. Relative frequency and Axiomatic definitions of probability, Significance of axiomatic definition. Bayes theorem and conditional probability. Independence. Discrete random variables. The cumulative distribution and density functions for discrete random variables. Joint distribution and conditional distribution. Statistical averages. Mean, Variance and standard deviation, Gaussian density function, Pdf of envelop of two gaussian variables – Rayleigh pdf.

Module 2 : Review of Random Processes [1-3]

Stochastic Processes. Stationarity and ergodicity. WSS and SSS processes. Gaussian Random process, Mean and autocorrelation and power spectral density functions. Weiner Kinchine theorem, Bandwidth of a random process, PSD of a Pulse Amplitude Modulated wave. White noise, Filtering of discrete WSS process by LTI systems. Noise-equivalent bandwidth, Signal to Noise Ratio, Matched Filter, Bandlimited and narrowband random process.

Sum of random variables, Markov Inequality, Chebyshev Inequality, Convergence, The central limit theorem (statement only). Gaussianity of thermal noise.

Module 3: Entropy and Information [1-3]

Basics of discrete communication system, Sources, channels and receivers. Discrete memoryless sources. Entropy. Source coding theorem (statement only). Mutual Information. Discrete memoryless channels. Matrix of channel transmission probabilities. Noiseless and noisy channels, binary symmetry channels. Channel coding theorem (statement only) Channel capacity for BSC (derivation reqruired), Differential entropy, Channel capacity of AWGN channel (statement only).

Module 4 : Markov Process and Queuing Theory [4,5]

Markov process. Definition and model. Markov chain. Transition probability matrix. State diagram and characteristics of a Markov chain. Chapman Kolmogorov equation. Poisson process.

Module 5 : Queues in Communication Networks [4,5]

Overview of queuing theory. M/M/1, M/M/∞, Application to packet transmission in a slotted ALOHA computer communication network.

Text Books

1. Papaulis and Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", MH
2. Analog and Digital Communication Systems, Hsu, Schaum Outline Series, MGH.
3. Digital Communication, John G Proakis, John Wiley
4. Probability and Random Processes, Miiller and Childers, Ed., 2, Academic Press
5. Data Networks, Bertsekas and Gallager, Ed. 2, PHI

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Review of probability. Relative frequency and Axiomatic definitions of probability, Significance of axiomatic definition.	1
1.2	Bayes theorem and conditional probability. Independence.	1
1.3	Discrete random variables.	1
1.4	The cumulative distribution and density functions for discrete random variables. Joint distribution and conditional distribution.	3
1.5	Statistical averages. Mean, Variance and standard deviation,	2
1.6	Gaussian density function, Pdf of envelop of two gaussian variables – Rayleigh pdf.	2
2	**MODULE 2**	
2.1	Stochastic Processes. Stationarity and ergodicity. WSS and SSS processes. Gaussian Random process	2
2.2	Mean and autocorrelation and power spectral density functions. Weiner Kinchine theorem, Bandwidth of a random process, PSD of a Pulse Amplitude Modulated wave.	3
2.3	White noise, Filtering of discrete WSS process by LTI systems. Noise-equivalent bandwidth, Signal to Noise Ratio, Matched Filter, Bandlimited and narrowband random process.	3
2.4	Sum of random variables, Markov Inequality, Chebyshev Inequality, Convergence, The central limit theorem (statement only). Gaussianity of thermal noise.	2
3	**MODULE 3**	
3.1	Basics of discrete communication system, Sources, channels and receivers.	1
3.2	Discrete memoryless sources. Entropy. Source coding theorem (statement only).	1

3.3	Mutual Information. Discrete memoryless channels. Matrix of channel transmission probabilities. Noiseless and noisy channels, binary symmetry channels.	2
3.4	Channel coding theorem (statement only) Channel capacity for BSC (derivation reqruired),	1
3.5	Differential entropy, Channel capacity of AWGN channel (statement only).	2
4	**MODULE 4**	
4.1	Markov process. Definition and model.	1
4.2	Markov chain. Transition probability matrix. State diagram and characteristics of a Markov chain. Chapman Kolmogorov equation.	4
4.3	Poisson process	3
5	**MODULE 5**	
5.1	Overview of queuing theory.	2
5.2	M/M/1, M/M/∞ systems	3
5.3	Application to packet transmission in a slotted ALOHA computer communication network.	3

Simulation Assignments

The following simulations can be done Python/R/MATLAB/SCILAB.

Generation of Discrete Stochastic Signals

1. Simulate stochastic signals of
    - Uniform
    - Binomial
    - Gaussian
    - Rayleigh
    - Ricean

   probability density functions and test their histograms.
2. Compute the statistical averages such as mean, variance, standard deviation etc.
3. To compute the autocorrelation matrix for each signals. Compare the autocorrelation of Gaussian signal with others.
4. To observe the spectrum of the signal and relate it with the autocorrelation function.

Central Limit Theorem–Gaussianity of Channels

- Simulate a coin toss experiment that generates a string of length N of 0s and 1s that are uniformly distributed.
- Toss the coin M times and sum up the string in every toss.
- Plot the normalized histogram of the sum values for $M = 100, 1000, 5000$.Observe that it is a Binomial distribution.
- Plot the function $q = \binom{M}{r} p^r (1-p)^{M-r}$ and compare with the histogram.
- Make M very large and observe that the histogram tends to become Gaussian, justifying the central limit theorem.

Frequency of Characters in English Text and the Entropy

1. It is required to understand the probabilities of occurrence of characters in English text say an English novel say with more than 300 pages(that contains text only) in .txt format(student may download one such file.).
2. Read the novel in *.txt* format into a single string or array and to identify the unique symbols(all letters, numbers, punctuation marks etc.) in the file and to plot their frequencies of occurrence.
3. Aprreciate the probabilities of occurrences of all symbols.
4. Compute the entropy and the information content in the book.

Simulation of a Point Process

1. It is required to simulate a point Poisson process, say the arrival of packets in a queue.
2. Let the rate of arrival of packets be say 100 per second.
3. Simulate the Poisson process using small time bins of say 1 millisecond.
4. Since Poisson process has no memory, the occurrence of an event is independent from one bin to another.
5. Binary random signals can be used to represent success or failure.
6. Simulate and dispaly each event with a vertical line using say *matplotlib*
7. Generate the couting process $N(t)$ which is the sum of the events until time t.
8. Plot $N(t)$ against t and appreciate it.

Simulation of a Discrete Markov Chain

1. It is required to simulate a birth death process as a discrete Markov chain.
2. Let us consider that the total population cannot exceed 1000 and the initial poulation is 100.
3. Set equal birth and death rates.
4. Iterate for say 10000 steps and plot the population against the iteration number.
5. Repeat the simulation for different rates and different population aand iteration sizes and appreciate the results.

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B Tech Degree Examination

Branch: Electronics and Communication

Course: ECT 294 Stochastic Processes for Communication

Time: 3 Hrs **Max. Marks: 100**

PART A

Answer All Questions

1	Give the three definitions of probability	(3)	K_2
2	In the toss of an unnfair coin, the probability of head is $\frac{1}{3}$.The player gets Rs. 100 if head turns up and loses Rs. 200 if tail turns up. Draw the CDF and PDF of this random variable	(3)	K_3
3	Write the conditions for strict sense and wide sense stationarity	(3)	K_2
4	Explain the Gaussian statistics of communication channels	(3)	K_2
5	State the two source coding theorems	(3)	K_1
6	Give channel matrix of a noiseless binary channel	(3)	K_2
7	With mathematical model, explain Markov process	(3)	K_2
8	Give an example of a Markov chain with its transition probability matrix	(3)	K_2
9	Explain an M/M/1 queue system in packet transmission	(3)	K_2
10	Explain the statistics of packet arrival in M/M/1 queue system	(3)	K_2

PART B

Answer one question from each module. Each question carries 14 mark.

Module I

11 A random variable **X** has the following pdf.

$$f_{\mathbf{X}}(\lambda) = \begin{cases} A[1 - \frac{|\lambda|}{3}]; & -3 \leq \lambda \leq 3 \\ 0; & \text{else} \end{cases}$$

Find the probability $P[|\lambda| < 1.5]$ (4) K_3

Find the probability $P[1.2 \leq \lambda \leq 2.3]$ (4) K_3

Find $E[\mathbf{X}]$ (6) K_3

OR

12. A six faced die with $P(1) = P(3) = \frac{1}{6}$, $P(4) = P(5) = \frac{1}{8}$, $P(2) = \frac{1}{12}$ is thrown in a game with outcomes listed in the table.

Face	1	2	3	4	5	6
Payoff	50	-40	60	-60	-20	100

The + and - signs indicates gain and loss for the player respectively.

A Draw the CDF and PDF of the Payoff random variable. (6) K_3

B Compute the expected value of gain/loss. Is it worthwhile to play the game? (5) K_3

C Compute the variance of Payoff. (3) K_3

Module II

13(A) Test if the random process (8) K_3

$$X(t) = A\cos\left(2\pi f_c t + \theta\right)$$

is WSS with θ a uniformly distributed random variable in the interval $[-\pi, \pi]$.

13(B)	If a random signal is applied as input to an LTI system, how is the power spectral density of the output related to that of the input? Explain.	(6)	K_2

OR

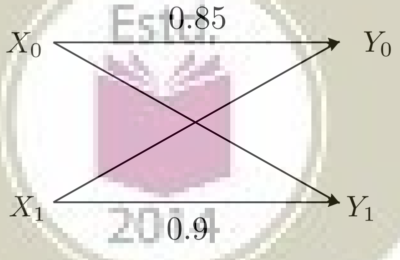
14(A)	State and prove Wiener Kinchine theorem .	(8)	K_3
14(B)	Justify the suitability of using white Gaussian model for noise in a communication system.	(6)	K_2

Module III

15(A)	State source coding theorem for a discrete memoryless source.	(6)	K_2
15(A)	Show that mutual information is always positive.	(3)	K_2
15(C)	What is channel capacity in terms of the conditional entropy? Write down the capacity of an AWGN channel.	(5)	K_3

OR

16(A)	Define entropy of a discrete memoryless source. If the alphabet is finite with size K, show that $H(X) \leq \log_2 K$	(6)	K_2
16(B)	For the binary channel below, compute the channel transition matrix and $P(Y_0)$ and $P(Y_1)$, given that $P(X_0) = P(X_1) = 0.5$	(8)	K_3



Module IV

17(A)	Explain a Poisson random process. Give two practical examples of a Poisson process	(7)	K_2
17(B)	Derive Chapman – Kolmogorov equation.	(7)	K_3

OR

18 Consider a Markov chain with three possible states 1,2,3 with transition probability matrix
(A) Draw the state transition diagram. (4) K_2
(B) Find $P(X4 = 3|X3 = 2)$ (5) K_3
(C) If $P(X0 = 1) = \frac{1}{3}$, find $P(X0 = 1, X1 = 2)$ (5) K_3

Module V

19 Explain the packet transmission in a slotted ALOHA network (14) K_2

OR

20 Explain the M/M/1 queue system pertaining to packet transmission (14) K_2

ECT296	STOCHASTIC SIGNAL PROCESSESING	CATEGORY	L	T	P	CREDIT
		Honours	3	1	0	4

Preamble: This course aims to study stochastic signals and their interactions with LTI systems

Prerequisite: None

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the concepts of probability, random variables and stochastic processes
CO 2	Apply the knowledge in probability to ststistically characterize communication channels.
CO 3	Use the properties of WSS for finding the LTI system response
CO 4	Model discrete signals using various methods
CO 5	Estimate the spectra of signals using various methods.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3										
CO 2	3	3		3	2							
CO 3	3	3		3	2							
CO 4	3	3										
CO 5	3	3		3	2							

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	15	15	30
Apply	25	25	50
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Concepts in probability

1. Give frequentist and axiomatic definitions of probability. State the demerits of frequentist definition.
2. What is a random variable? With an example, illustrate how it finds application in defining engineering problems?
3. A six faced die with P(1)=P(3)=1/3, P(4)=P(5)=1/4 is thrown in a game with outcomes listed in the table.

Face	1	2	3	4	5	6
Payoff(Rs)	+50	-40	+60	-60	-20	+100

The + and - signs indicates gain and loss for the the player respectively.

1.Draw the CDF and PDF
2. Compute the expected value of gain/loss. Is it worthwhile to play the game?
3. Compute the entropy of the random variable.

Course Outcome 2 (CO2) : Review of random processes

1. State central limit theorem. Explain the validity of using Gaussian model for additive communication channels.
2. Give the conditions for WSS and SSS.
3. Test if the sinusoid X(t)=Acos(2πft+θ) with θ variying uniformly in the interval [-π,π] is WSS.

Course Outcome 3 (CO3): WSS and LTI systems

1. Derive Wiener Hopf equations.
2. Solve Wiener-Hopf equation to get a third order discrete system for a an RV X whose autocorrelation is Rx=[0.89,0.75,0.7,0.6]
3. Prove that autocorretion and power spectral density are Fourier transform pairs

Course Outcome 4 (CO4): Signal modeling

1. Use Prony method to model a unit pulse x[n]=U[n]-U[n-N] as a system with one pole and one zero.
2. Use Pade apprimation to model the signal x whose fisrt six values are [1,1.2,0.9,0.5,0.6,0.25] using a second order all pole model (p=2 and q=0)

Course Outcome 5 (CO5): Stochastic processes in data transmission

1. Explain the periodogram method of spectrum estimation
2. Explain the need pf spectrum estimation
3. Use ARMA(p,q) model to estimate the spectrum

Syllabus

Module 1 : Review of Probability and Random Variables [1]

Review of probability. Relative frequency and Axiomatic definitions of probability, Significance of axiomatic definition. Bayes theorem and conditional probability. Independence. Discrete random variables. The cumulative distribution and density functions for random variables. Joint distribution and conditional distribution. Statistical averages. Mean, Variance and standard deviation, Functions of random variables. Multivariate Gaussian density function.

Module 2 : Review of Random Processes [1]

Stochastic Processes. Stationarity and ergodicity. WSS and SSS processes. Discrete Gaussian, Rayleigh and Ricean processes.

Sums of random variables, Convergence, Markov and Chebyshev inequality, The central limit theorem (statement only).

Module 3: The Autocorrelation Matrix and its Significance [2]

Statistical averages of discrete stationary stochastic processes. Mean and autocorrelation and power spectral density functions. Weiner Kinchine theorem, Filtering of discrete WSS process by LTI systems. The autocorrelation matrix and the significance of its eigen vectors. Whitening. Properties of autocorrelation matrix, its inversion and Levinson-Durbin Recursion. Wiener-Hopf equation. Brownian motion, its mathematical model and its autocorrelation and power spectral density

Module 4 : Signal Modeling - Deterministic and Stochastic [1]

The least square method of signal modeling. The Pade approximation. Prony's method. Stochastic models, AR, MA and ARMA models.

Module 5 : Spectrum Estimation [1,2]

Periodogram method of spectrum estimation. Parametric methods AR, MA and ARMA methods

Text Books

1. Monson Hayes, “Statistical Digital Signal Processing”, Wiley
2. A. Papaulis and Unnikrishna Pillai, “Probability, Random Variables and Stochastic Processes”, McGraw Hill

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Probability and Random Processes**	
1.1	The three definitions. Critique to classical definition. Probability as a function. The domain of probability function. Event and probability space	2
1.2	Conditional probability, Bayes theorem, Meaning and significance of prior. Random variable. Definition. Random variable as a function and its domain. Comparison with probability function.	2
1.3	Examples of RV. Discrete and continuous RV. CDF and PDF of RV(both discrete and continuous) Examples. Relation between the two and properties	1
1.4	Uniform and Gaussian Pdf and correspoding CDF. Properties	1
	Expectation, variance and standard deviation, Examples	2
1.5	Functions of random variables.	2
2	**Stochastic Processes**	
2.1	Stochastic process, Definition. Stationarity and ergodicity	2
2.2	WSS and SSS conditions. Example problems	2
2.3	Sums of random variables, Convergence, Markov and Chebyshev inequality	2
2.4	Gaussian Process. Envelope of Gaussian process. Rayleigh pdf. Example	2

2.5	Central limit theorem. Application in AWGN channel	1
3	**Autocorrelation Matrix**	
3.1	Expectation, variance, autocorrelation and power spectral density	2
3.2	Autocorrelation matrix, properties eigen values	2
3.3	Filtering of WSS, output auotocorrelation and PSD	2
3.4	Inversion of autocorrelation matrix. LD recursion	2
3.5	Whitening	1
3.6	Wiener Hopf equation, Brownian motion. Model and spectral density	3
4	**Signal Modeling**	
4.1	Least squares method	2
4.2	Pade method, Prony method	3
4.3	Stochastic models	3
5	**Spectrum Estimation**	
5.1	Periodogram	3
5.2	Parametric methods	4

Simulation Assignments

The following simulations can be done Python/R/MATLAB/SCILAB.

Generation of Discrete Stochastic Signals

1. Simulate stochastic signals of
   - Uniform
   - Binomial
   - Gaussian
   - Rayleigh
   - Ricean

   probability density functions and test their histograms.
2. Compute the statistical averages such as mean, variance, standard deviation etc.
3. To compute the autocorrelation matrix for each signals. Compare the autocorrelation of Gaussian signal with others.
4. To observe the spectrum of the signal and relate it with the autocorrelation function.

Gambler's Trouble

- It is observed by gamblers that although the number of triples of integers from 1 to 6 with sum 9 is the same as the number of such triples with sum 10, when three dice are rolled, a 9 seemed to come up less often than a 10.
- Simulate a die throwing experiment. One may use the *randint* command in Python.
- Roll three dice together N times.
- Compute the number of times the sum of outcomes is 9 and the corresponding probability.
- Repeat the experiment for the sum of outcomes equal to 10 and observe if the hypothesis is true.
- Compute the two probabilities for $N = 100; 1000; 10000; 50000; 100000$ and plot the two probabilities against N and appreciate.

Central Limit Theorem

- Simulate a coin toss experiment that generates a string of length N of 0s and 1s that are uniformly distributed.
- Toss the coin M times and sum up the string in every toss.
- Plot the normalized histogram of the sum values for $M = 100, 1000, 5000$.Observe that it is a Binomial distribution.
- Plot the function $q = \binom{M}{r} p^r (1-p)^{M-r}$ and compare with the histogram.
- Make M very large and observe that the histogram tends to become Gaussian, justifying the central limit theorem.

Labouchere system

- Labouchere system is a betting game in which a sequence of numbers is written and the player bets for an amount equal to the first and last number written.
- The game may be tossing a coin.
- If the player wins, the two numbers are removed from the list and the player is free to continue. If the list has only one number that becomes the stake amount.
- If he fails the amount at stake is appended to the list and the game continues until the list is completely crossed out, at which point the player has got the desired money or until he runs out of money
- Simulate this game and observe the outcomes for different sequences on the list

Levinson Durbin Recursion

1. It is required to invert large autocorrelation matrices with LD recursion.
2. Realize Gaussian and uniformly distributed random signals and compute their autocorrelation matrices.
3. Load a speech signal in say *.wav* format and compute its autocorrelation matrix.
4. Create a function to perform LD recursion on the above three matrices.

Simulation of Brownian Motion

1. The task is to realize the differential/difference equation for Brownian motion in two dimensions with and without gravity.
2. Observe the particle movement on the GUI and understand.
3. Compute the autocorrelation and power spectral density and appreciate.

Spectrum Estimation

1. Generate a cosinusoid of say 100 Hz frequency and bury it in AWGN of comparable variance.
2. Write functions for periodogram and ARMA method to estimate the spectrum of the cosinusoid.
3. The student may install the Python package *spectrum* and repeat the estimations steps using its modules and compare the plot of spectra with those resulted by your functions.

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B Tech Degree Examination

Branch: Electronics and Communication

Course: ECT 296 Stochastic Signal Processing

Time: 3 Hrs **Max. Marks: 100**

PART A

Answer All Questions

1	Give the three axioms of probability	(3)	K_2
2	You throw a coin and if head turns up you get Rs. 100 and loses Rs. 40 if tails turns up. The probability of a head is is 0.2. Draw the CDF and PDF of the random variable representing gain/loss.	(3)	K_3
3	State central limit theorem. Give its significance.	(3)	K_2
4	Draw the pdf of Rayleigh density function.	(3)	K_2
5	Write and explain the differential equation for Brownian motion	(3)	K_2
6	Give the output mean and autocorrelation of a an LTI system that is driven by a WSS process.	(3)	K_2
7	Explain the term signal modeling	(3)	K_2
8	Explain ARMA model of a signal	(3)	K_2
9	Explain the need for power spectrum estimation	(3)	K_2
10	List the various parametric spectrum estimation methods.	(3)	K_2

PART B

Answer one question from each module. Each question carries 14 mark.

Module I

11(A)	Derive mean and variance of a Gaussian distribution with parameters μ and σ^2	(8)	K_3
11(B)	Write down the probability density of a bivariate Gaussian random variable. What is the signifance of the correlation coefficient?	(6)	K_3

OR

12. A six faced die with $P(1) = P(5) = \frac{1}{6}$, $P(4) = P(3) = \frac{1}{8}$, $P(2) = \frac{1}{12}$ is thrown in a game with outcomes listed in the table.

Face	1	2	3	4	5	6
Payoff	50	-40	60	-60	-20	100

The + and - signs indicates gain and loss for the the player respectively.

A	Draw the CDF and PDF of Payoff random variable.	(6)	K_3
B	Compute the expected value of gain/loss. Is it worthwhile to play the game?	(6)	K_3
C	What is the variance of Payoff?	(3)	K_3

Module II

13(A) Test if the random process (7) K_3

$$X(t) = A\cos(2\pi f_c t + \theta)$$

is WSS with A a random variable in the interval $[-\pi, \pi]$.

13(B) If **X** and **Y** are zero mean Gaussian RVs, compute the pdf of $\mathbf{Z} = \sqrt{\mathbf{X^2} + \mathbf{Y^2}}$ (7) K_2

OR

14(A)	Express a Binomial random variable X as a sum of many Bernoulli random variables. Derive the mean of X using this connection.	(4)	K_3
14(B)	Derive Chebyshev inequality. How is it helpful in estimating tail probabilities?	(6)	K_3
14(B)	List the conditions for a stochastic process to be WSS.	(4)	K_3

Module III

15(A)	State and prove three properties of autocorrelation matrix.	(8)	K_3
15(B)	Prove that the power spectrum of a real process $\mathbf{X(t)}$ is real.	(6)	K_3

OR

16	Give the mathematical model and compute the autocorrelation of the Brownian motion	(14)	K_3

Module IV

17	Use Pade approximation to model the signal x whose fisrt six values are $[1, 1.6, 0.7, 0.4, 0.6, 0.25]$ using a second order all pole model ($p = 2$ and $q = 0$) and a second order MA model ($p = 0$ and $q = 2$)	(14)	K_3

OR

18	Use Prony method to model a unit pulse $x[n] = U[n] - U[n - N]$ as a system with one pole and one zero.	(14)	K_3

Module V

19	Explain the periodogram method of spectrum estimation	(14)	K_2

OR

20	Explain the three nonparametric methods of spectrum estimation	(14)	K_2

COMMON COURSES

(S5 & S6)

MCN 301	**DISASTER MANAGEMENT**	**Category**	**L**	**T**	**P**	**CREDIT**	**YEAR OF INTRODUCTION**
		Non - Credit	**2**	**0**	**0**	**Nil**	**2019**

Preamble: The objective of this course is to introduce the fundamental concepts of hazards and disaster management.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Define and use various terminologies in use in disaster management parlance and organise each of these terms in relation to the disaster management cycle (Cognitive knowledge level: **Understand**).
CO2	Distinguish between different hazard types and vulnerability types and do vulnerability assessment (Cognitive knowledge level: **Understand**).
CO3	Identify the components and describe the process of risk assessment, and apply appropriate methodologies to assess risk (Cognitive knowledge level: **Understand**).
CO4	Explain the core elements and phases of Disaster Risk Management and develop possible measures to reduce disaster risks across sector and community (Cognitive knowledge level: **Apply**)
CO5	Identify factors that determine the nature of disaster response and discuss the various disaster response actions (Cognitive knowledge level: **Understand**).
CO6	Explain the various legislations and best practices for disaster management and risk reduction at national and international level (Cognitive knowledge level: **Understand**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2				2				2		2
CO2	2	3	2		2	2	3			3		2
CO3	2	3	2	2	2	2	3			3		2
CO4	3	3	3		2	2	3					2
CO5	3	3			2	2	3					2
CO6	3					2	3	3				2

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	**10**	**10**	**20**
Understand	**25**	**25**	**50**
Apply	**15**	**15**	**30**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment - Test : 25 marks

Continuous Assessment - Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A.

Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

MCN 301 Disaster Management

Module 1

Systems of earth

Lithosphere- composition, rocks, soils; Atmosphere-layers, ozone layer, greenhouse effect, weather, cyclones, atmospheric circulations, Indian Monsoon; hydrosphere- Oceans, inland water bodies; biosphere

Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment.

Module 2

Hazard types and hazard mapping; Vulnerability types and their assessment- physical, social, economic and environmental vulnerability.

Disaster risk assessment –approaches, procedures

Module 3

Disaster risk management -Core elements and phases of Disaster Risk Management

Measures for Disaster Risk Reduction – prevention, mitigation, and preparedness.

Disaster response- objectives, requirements; response planning; types of responses.

Relief; international relief organizations.

Module 4

Participatory stakeholder engagement; Disaster communication- importance, methods, barriers; Crisis counselling

Capacity Building: Concept – Structural and Non-structural Measures, Capacity Assessment; Strengthening Capacity for Reducing Risk

Module 5

Common disaster types in India; Legislations in India on disaster management; National disaster management policy; Institutional arrangements for disaster management in India.

The Sendai Framework for Disaster Risk Reduction- targets, priorities for action, guiding principles

Reference Text Book

1. R. Subramanian, Disaster Management, Vikas Publishing House, 2018
2. M. M. Sulphey, Disaster Management, PHI Learning, 2016
3. UNDP, Disaster Risk Management Training Manual, 2016
4. United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster Risk Reduction 2015-2030, 2015

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is the mechanism by which stratospheric ozone protects earth from harmful UV rays?
2. What are disasters? What are their causes?
3. Explain the different types of cyclones and the mechanism of their formation
4. Explain with examples, the difference between hazard and risk in the context of disaster management
5. Explain the following terms in the context of disaster management (a) exposure (b) resilience (c) disaster risk management (d) early warning systems, (e) damage assessment (f) crisis counselling (g) needs assessment

Course Outcome 2 (CO2):

1. What is hazard mapping? What are its objectives?
2. What is participatory hazard mapping? How is it conducted? What are its advantages?
3. Explain the applications of hazard maps
4. Explain the types of vulnerabilities and the approaches to assess them

Course Outcome 3 (CO3):

1. Explain briefly the concept of ‘disaster risk’

2. List the strategies for disaster risk management 'before', 'during' and 'after' a disaster
3. What is disaster preparedness? Explain the components of a comprehensive disaster preparedness strategy

Course Outcome 4 (CO4):

1. What is disaster prevention? Distinguish it from disaster mitigation giving examples
2. What are the steps to effective disaster communication? What are the barriers to communication?
3. Explain capacity building in the context of disaster management

Course Outcome 5 (CO5):

1. Briefly explain the levels of stakeholder participation in the context of disaster risk reduction
2. Explain the importance of communication in disaster management
3. Explain the benefits and costs of stakeholder participation in disaster management
4. How are stakeholders in disaster management identified?

Course Outcome 6 (CO6):

1. Explain the salient features of the National Policy on Disaster Management in India
2. Explain the guiding principles and priorities of action according to the Sendai Framework for Disaster Risk Reduction
3. What are Tsunamis? How are they caused?
4. Explain the earthquake zonation of India

Model Question paper

QP CODE: **PAGES:3**

Reg No:______________ **Name :______________**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MCN 301

Course Name: Disaster Management

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. What is the mechanism by which stratospheric ozone protects earth from harmful UV rays?
2. What are disasters? What are their causes?
3. What is hazard mapping? What are its objectives?
4. Explain briefly the concept of 'disaster risk'
5. List the strategies for disaster risk management 'before', 'during' and 'after' a disaster
6. What is disaster prevention? Distinguish it from disaster mitigation giving examples
7. Briefly explain the levels of stakeholder participation in the context of disaster risk reduction
8. Explain the importance of communication in disaster management
9. What are Tsunamis? How are they caused?
10. Explain the earthquake zonation of India

Part B

Answer any one Question from each module. Each question carries 14 Marks

11. a. Explain the different types of cyclones and the mechanism of their formation [10]

b. Explain with examples, the difference between hazard and risk in the context of disaster management
[4]

OR

12. Explain the following terms in the context of disaster management [14]

(a) exposure (b) resilience (c) disaster risk management (d) early warning systems, (e) damage assessment (f) crisis counselling (g) needs assessment

13. a. What is participatory hazard mapping? How is it conducted? What are its advantages?
[8]

b. Explain the applications of hazard maps [6]

OR

14. Explain the types of vulnerabilities and the approaches to assess them [14]

15. a. Explain the core elements of disaster risk management [8]

b. Explain the factors that decide the nature of disaster response [6]

OR

16. a. What is disaster preparedness? Explain the components of a comprehensive disaster preparedness strategy [6]

b. Explain the different disaster response actions [8]

17. a. Explain the benefits and costs of stakeholder participation in disaster management [10]

b. How are stakeholders in disaster management identified? [4]

OR

18. a. What are the steps to effective disaster communication? What are the barriers to communication? [7]

b. Explain capacity building in the context of disaster management [7]

19. Explain the salient features of the National Policy on Disaster Management in India

[14]

OR

20. Explain the guiding principles and priorities of action according to the Sendai Framework for Disaster Risk Reduction [14]

Teaching Plan

	Module 1	**5 Hours**
1.1	Introduction about various Systems of earth, Lithosphere-composition, rocks, Soils; Atmosphere-layers, ozone layer, greenhouse effect, weather	1 Hour
1.2	Cyclones, atmospheric circulations, Indian Monsoon; hydrosphere-Oceans, inland water bodies; biosphere	1 Hour
1.3	Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard,	1 Hour
1.4	Exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, Disaster risk management, early warning systems	1 Hour
1.5	Disaster preparedness, disaster prevention, disaster, Mitigation, disaster response, damage assessment, crisis counselling, needs assessment.	1 Hour
	Module 2	**5 Hours**
2.1	Various Hazard types, Hazard mapping; Different types of Vulnerability types and their assessment	1 Hour
2.2	Vulnerability assessment and types, Physical and social vulnerability	1 Hour
2.3	Economic and environmental vulnerability, Core elements of disaster risk assessment	1 Hour
2.4	Components of a comprehensive disaster preparedness strategy approaches, procedures	1 Hour
2.5	Different disaster response actions	1 Hour
	Module 3	**5 Hours**
3.1	Introduction to Disaster risk management, Core elements of Disaster Risk Management	1 Hour
3.2	Phases of Disaster Risk Management, Measures for Disaster Risk Reduction	1 Hour
3.3	Measures for Disaster prevention, mitigation, and preparedness.	1 Hour

3.4	Disaster response- objectives, requirements. Disaster response planning; types of responses.	1 Hour
3.5	Introduction- Disaster Relief, Relief; international relief organizations.	1 Hour
	Module 4	**5 Hours**
4.1	Participatory stakeholder engagement	1 Hour
4.2	Importance of disaster communication.	1 Hour
4.3	Disaster communication- methods, barriers. Crisis counselling	1 Hour
4.4	Introduction to Capacity Building. Concept – Structural Measures, Non-structural Measures.	1 Hour
4.5	Introduction to Capacity Assessment, Capacity Assessment; Strengthening, Capacity for Reducing Risk	1 Hour
	Module 5	**5 Hours**
5.1	Introduction-Common disaster types in India.	1 Hour
5.2	Common disaster legislations in India on disaster management	1 Hour
5.3	National disaster management policy, Institutional arrangements for disaster management in India.	1 Hour
5.4	The Sendai Framework for Disaster Risk Reduction and targets	1 Hour
5.5	The Sendai Framework for Disaster Risk Reduction-priorities for action, guiding principles	1 Hour

HUT 300	**Industrial Economics & Foreign Trade**	**Category**	**L**	**T**	**P**	**CREDIT**
		HSMC	**3**	**0**	**0**	**3**

Preamble: To equip the students to take industrial decisions and to create awareness of economic environment.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the problem of scarcity of resources and consumer behaviour, and to evaluate the impact of government policies on the general economic welfare. (Cognitive knowledge level: **Understand**)
CO2	Take appropriate decisions regarding volume of output and to evaluate the social cost of production. (Cognitive knowledge level: **Apply**)
CO3	Determine the functional requirement of a firm under various competitive conditions. (Cognitive knowledge level: **Analyse**)
CO4	Examine the overall performance of the economy, and the regulation of economic fluctuations and its impact on various sections in the society. (Cognitive knowledge level: **Analyse**)
CO5	Determine the impact of changes in global economic policies on the business opportunities of a firm. (Cognitive knowledge level: **Analyse**)

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2										3	
CO2	2	2			2	2	3				3	
CO3	2	2	1								3	
CO4	2	2	1			1					3	
CO5	2	2	1								3	

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test 1 (Marks)	Test 2 (Marks)	
Remember	**15**	**15**	**30**
Understand	**20**	**20**	**40**
Apply	**15**	**15**	**30**

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment - Test (2 numbers) : 25 marks
Continuous Assessment - Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B.

Part A : 30 marks
Part B : 70 marks

Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 3 sub-divisions and carries 14 marks.

SYLLABUS

HUT 300 Industrial Economics & Foreign Trade

Module 1 (Basic Concepts and Demand and Supply Analysis)

Scarcity and choice - Basic economic problems- PPC – Firms and its objectives – types of firms – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.

Module 2 (Production and cost)

Production function – law of variable proportion – economies of scale – internal and external economies – Isoquants, isocost line and producer's equilibrium – Expansion path – Technical progress and its implications – Cobb-Douglas production function - Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point.

Module 3 (Market Structure)

Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly (meaning) – Non-price competition – Product pricing – Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming.

Module 4 (Macroeconomic concepts)

Circular flow of economic activities – Stock and flow – Final goods and intermediate goods - Gross Domestic Product - National Income – Three sectors of an economy- Methods of measuring national income – Inflation- causes and effects – Measures to control inflation- Monetary and fiscal policies – Business financing- Bonds and shares -Money market and Capital market – Stock market – Demat account and Trading account - SENSEX and NIFTY.

Module 5 (International Trade)

Advantages and disadvantages of international trade - Absolute and Comparative advantage theory - Heckscher - Ohlin theory - Balance of payments – Components – Balance of Payments deficit and devaluation – Trade policy – Free trade versus protection – Tariff and non-tariff barriers.

Reference Materials

1. Gregory N Mankiw, ‘Principles of Micro Economics’, Cengage Publications
2. Gregory N Mankiw, ‘Principles of Macro Economics’, Cengage Publications
3. Dwivedi D N, ‘Macro Economics’, Tata McGraw Hill, New Delhi.
4. Mithani D M, ‘Managerial Economics’, Himalaya Publishing House, Mumbai.
5. Francis Cherunilam, ‘International Economics’, McGraw Hill, New Delhi.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Why does the problem of choice arise?
2. What are the central problems?
3. How do we solve the basic economic problems?
4. What is the relation between price and demand?
5. Explain deadweight loss due to the imposition of a tax.

Course Outcome 2 (CO2):

1. What is shutdown point?
2. What do you mean by producer equilibrium?
3. Explain break-even point;
4. Suppose a chemical factory is functioning in a residential area. What are the external costs?

Course Outcome 3 (CO3):

1. Explain the equilibrium of a firm under monopolistic competition.
2. Why is a monopolist called price maker?
3. What are the methods of non-price competition under oligopoly?

4. What is collusive oligopoly?

Course Outcome 4 (CO4):

1. What is the significance of national income estimation?
2. How is GDP estimated?
3. What are the measures to control inflation?
4. How does inflation affect fixed income group and wage earners?

Course Outcome 5 (CO5):

1. What is devaluation?
2. Suppose a foreign country imposes a tariff on Indian goods. How does it affect India's exports?
3. What is free trade?
4. What are the arguments in favour of protection?

Model Question paper

QP CODE: **PAGES:3**

Reg No:______________ **Name :______________**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIFTH /SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: HUT 300

Course Name: Industrial Economics & Foreign Trade

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Why does an economic problem arise?

2. What should be the percentage change in price of a product if the sale is to be increased by 50 percent and its price elasticity of demand is 2?

3. In the production function Q= $2L^{1/2}K^{1/2}$ if L=36 how many units of capital are needed to produce 60 units of output?

4. Suppose in the short run AVC 4. Suppose in the short run AVC<P<AC. Will this firm produce or shut down? Give reason.

5. What is predatory pricing?

6. What do you mean by non- price competition under oligopoly?

7. What are the important economic activities under primary sector?

8. Distinguish between a bond and share?

9. What are the major components of balance of payments?

10. What is devaluation? **(10 x 3 = 30 marks)**

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Prepare a utility schedule showing units of consumption, total utility and marginal utility, and explain the law of diminishing marginal utility. Point out any three limitations of the law.

b) How is elasticity of demand measured according to the percentage method? How is the measurement of elasticity of demand useful for the government?

Or

12. a) Explain the concepts consumer surplus and producer surplus.

b) Suppose the government imposes a tax on a commodity where the tax burden met by the consumers. Draw a diagram and explain dead weight loss. Mark consumer surplus, producer surplus, tax revenue and dead weight loss in the diagram.

MODULE II

13. a) What are the advantages of large-scale production?

b) Explain Producer equilibrium with the help of isoquants and isocost line. What is expansion path?

Or

14. a) Explain break-even analysis with the help of a diagram.

b) Suppose the monthly fixed cost of a firm is Rs. 40000 and its monthly total variable cost is Rs. 60000.

i. If the monthly sales is Rs. 120000 estimate contribution and break-even sales.
ii. If the firm wants to get a monthly profit of Rs.40000, what should be the sales?

c) The total cost function of a firm is given as $TC=100+50Q - 11Q^2+Q^3$. Find marginal cost when output equals 5 units.

MODULE III

15. a) What are the features of monopolistic competition?

b) Explain the equilibrium of a firm earning supernormal profit under monopolistic competition.

Or

16. a) Make comparison between perfect competition and monopoly.

b) Explain price rigidity under oligopoly with the help of a kinked demand curve.

MODULE IV

17. a) How is national income estimated under product method and expenditure method?

b) Estimate GDPmp, GNPmp and National income

Private consumption expenditure = 2000 (in 000 cores)
Government Consumption = 500
NFIA = -(300)
Investment = 800
Net=exports =700
Depreciation = 400
Net-indirect tax = 300

Or

18. a) What are the monetary and fiscal policy measures to control inflation?

b) What is SENSEX?

MODULE V

19. a) What are the advantages of disadvantages of foreign trade?

b) Explain the comparative cost advantage.

Or

20. a) What are the arguments in favour protection?

b) Examine the tariff and non-tariff barriers to international trade.

(5 × 14 = 70 marks)

Teaching Plan

Module 1 (Basic concepts and Demand and Supply Analysis)		7 Hours
1.1	Scarcity and choice – Basic economic problems - PPC	1 Hour
1.2	Firms and its objectives – types of firms	1 Hour
1.3	Utility – Law of diminishing marginal utility – Demand – law of demand	1 Hour
1.4	Measurement of elasticity and its applications	1 Hour
1.5	Supply, law of supply and determinants of supply	1 Hour
1.6	Equilibrium – changes in demand and supply and its effects	1 Hour
1.7	Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.	1 Hour
Module 2 (Production and cost)		**7 Hours**
2.1	Productions function – law of variable proportion	1 Hour
2.2	Economies of scale – internal and external economies	1 Hour
2.3	producers equilibrium – Expansion path	1 Hour
2.4	Technical progress and its implications – cob Douglas Production function	1 Hour
2.5	Cost concepts – social cost: private cost and external cost – Explicit and implicit cost – sunk cost	1 Hour
2.6	Short run cost curves & Long run cost curves	1 Hour
2.7	Revenue (concepts) – shutdown point – Break-even point.	1 Hour
Module 3 (Market Structure)		**6 hours**
3.1	Equilibrium of a firm, MC – MR approach and TC – TR approach	1 Hour
3.2	Perfect competition & Imperfect competition	1 Hour
3.3	Monopoly – Regulation of monopoly – Monopolistic competition	1 Hour
3.4	Oligopoly – kinked demand curve	1 Hour
3.5	Collusive oligopoly (meaning) – Non price competition	1 Hour
3.6	Cost plus pricing – Target return pricing – Penetration, Predatory pricing – Going rate pricing – price skimming	1 Hour

Module 4 (Macroeconomic concepts)		**7 Hours**
4.1	Circular flow of economic activities	1 Hour
4.2	Stock and flow – Final goods and intermediate goods – Gross Domestic Product - National income – Three sectors of an economy	1 Hour
4.3	Methods of measuring national income	1 Hour
4.4	Inflation – Demand pull and cost push – Causes and effects	1 Hour
4.5	Measures to control inflation – Monetary and fiscal policies	1 Hour
4.6	Business financing – Bonds and shares – Money market and capital market	1 Hour
4.7	Stock market – Demat account and Trading account – SENSEX and NIFTY	1 Hour
Module 5 (International Trade)		**8 Hours**
5.1	Advantages and disadvantages of international trade	1 Hour
5.2	Absolute and comparative advantage theory	2 Hour
5.3	Heckscher – Ohlin theory	1 Hour
5.4	Balance of payments - components	1 Hour
5.5	Balance of payments deficit and devaluation	1 Hour
5.6	Trade policy – Free trade versus protection	1 Hour
5.7	Tariff and non tariff barriers.	1 Hour

HUT 310	**Management for Engineers**	**Category**	**L**	**T**	**P**	**Credit**
		HMC	**3**	**0**	**0**	**3**

Preamble: This course is intended to help the students to learn the basic concepts and functions of management and its role in the performance of an organization and to understand various decision-making approaches available for managers to achieve excellence. Learners shall have a broad view of different functional areas of management like operations, human resource, finance and marketing.

Prerequisite: Nil

Course Outcomes After the completion of the course the student will be able to

CO1	Explain the characteristics of management in the contemporary context (Cognitive Knowledge level: **Understand**).
CO2	Describe the functions of management (Cognitive Knowledge level: **Understand**).
CO3	Demonstrate ability in decision making process and productivity analysis (Cognitive Knowledge level: **Understand**).
CO4	Illustrate project management technique and develop a project schedule (Cognitive Knowledge level: **Apply**).
CO5	Summarize the functional areas of management (Cognitive Knowledge level: **Understand**).
CO6	Comprehend the concept of entrepreneurship and create business plans (Cognitive Knowledge level: **Understand**).

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**				**1**	**2**	**2**	**2**		**2**	**1**	**1**
CO2	**2**				**1**	**1**		**2**	**1**	**2**	**1**	**1**
CO3	**2**	**2**	**2**	**2**	**1**							
CO4	**2**	**2**	**2**	**2**	**1**						**2**	**1**
CO5	**2**					**1**	**1**		**1**	**2**	**1**	
CO6		**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Abstract POs defined by National Board of Accreditation			
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	**Test 1 (Marks in percentage)**	**Test 2 (Marks in percentage)**	**End Semester Examination (Marks in percentage)**
Remember	15	15	30
Understand	15	15	30
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment - Test : 25 marks

Continuous Assessment - Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

HUT 310 Management for Engineers (35 hrs)

Module 1 (Introduction to management Theory- 7 Hours)

Introduction to management theory, Management Defined, Characteristic of Management, Management as an art-profession, System approaches to Management, Task and Responsibilities of a professional Manager, Levels of Manager and Skill required.

Module 2 (management and organization- 5 hours)

Management Process, Planning types , Mission, Goals, Strategy, Programmes, Procedures, Organising, Principles of Organisation, Delegation, Span of Control, Organisation Structures, Directing, Leadership, Motivation, Controlling..

Module 3 (productivity and decision making- 7 hours)

Concept of productivity and its measurement; Competitiveness; Decision making process; decision making under certainty, risk and uncertainty; Decision trees; Models of decision making.

. Module 4 (project management- 8 hours)

Project Management, Network construction, Arrow diagram, Redundancy. CPM and PERT Networks, Scheduling computations, PERT time estimates, Probability of completion of project, Introduction to crashing.

Module 5 (functional areas of management- 8 hours)

Introduction to functional areas of management, Operations management, Human resources management, Marketing management, Financial management, Entrepreneurship, Business plans, Corporate social responsibility, Patents and Intellectual property rights.

References:

1. H. Koontz, and H. Weihrich, Essentials of Management: An International Perspective. 8th ed., McGraw-Hill, 2009.
2. P C Tripathi and P N Reddy, Principles of management, TMH, 4th edition, 2008.
3. P. Kotler, K. L. Keller, A. Koshy, and M. Jha, Marketing Management: A South Asian Perspective. 14th ed., Pearson, 2012.
4. M. Y. Khan, and P. K. Jain, Financial Management, Tata-McGraw Hill, 2008.
5. R. D. Hisrich, and M. P. Peters, Entrepreneurship: Strategy, Developing, and Managing a New Enterprise, 4th ed., McGraw-Hill Education, 1997.
6. D. J. Sumanth, Productivity Engineering and Management, McGraw-Hill Education, 1985.
7. K.Ashwathappa, 'Human Resources and Personnel Management', TMH, 3 rd edition, 2005.
8. R. B. Chase, Ravi Shankar and F. R. Jacobs, Operations and Supply Chain Management, 14th ed. McGraw Hill Education (India), 2015.

Sample Course Level Assessment Questions

Course Outcome1 (CO1): Explain the systems approach to management?

Course Outcome 2 (CO2): Explain the following terms with a suitable example Goal, Objective, and Strategy.

Course Outcome 3 (CO3): Mr. Shyam is the author of what promises to be a successful novel. He has the option to either publish the novel himself or through a publisher. The publisher is offering Mr. Shyam Rs. 20,000 for signing the contract. If the novel is successful, it will sell 200,000 copies. Else, it will sell 10,000 copies only. The publisher pays a Re. 1 royalty per copy. A market survey indicates that there is a 70% chance that the novel will be successful. If Mr. Shyam undertakes publishing, he will incur an initial cost of Rs. 90,000 for printing and marketing., but each copy sold will net him Rs. 2. Based on the given information and the decision analysis method, determine whether Mr. Shyam should accept the publisher's offer or publish the novel himself.

Course Outcome 4 (CO4): Explain the concepts of crashing and dummy activity in project management.

Course Outcome 5 (CO5): Derive the expression for the Economic order quantity (EOQ)?

Course Outcome 6 (CO6): Briefly explain the theories of Entrepreneurial motivation.?

Model Question Paper

QP CODE: PAGES: 4

Reg No:_______________ Name:_________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: HUT 310

Course name: Management for Engineers

Max Marks: 100 **Duration: 3 Hours**

PART-A (Answer All Questions. Each question carries 3 marks)

1. “Management is getting things done through other.” Elaborate.

2. Comment on the true nature of management. Is it a science or an art?

3. Planning is looking ahead and controlling is looking back. Comment with suitable examples

4. Explain the process of communication?

5. Explain the hierarchy of objectives?

6. Explain the types of decisions?

7. Describe the Economic man model?

8. Explain the concepts of crashing and dummy activity in project management.

9. Differentiate the quantitative and qualitative methods in forecasting.

10. What are the key metrics for sustainability measurement? What makes the measurement and reporting of sustainability challenging?

PART-B (Answer any one question from each module)

11. a) Explain the systems approach to management. **(10)**

b) Describe the roles of a manager **(4)**

OR

12. a) Explain the 14 principles of administrative management? **(10)**

b) Explain the different managerial skills (**4)**

13. a) What are planning premises, explain the classification of planning premises. **(10)**

b) Distinguish between strategy and policy. How can policies be made effective. **(4)**

OR

14 a) Explain three motivational theories. **(9)**

b) Describe the managerial grid. **(5)**

15. a) Modern forest management uses controlled fires to reduce fire hazards and to stimulate new forest growth. Management has the option to postpone or plan a burning. In a specific forest tract, if burning is postponed, a general administrative cost of Rs. 300 is incurred. If a controlled burning is planned, there is a 50% chance that good weather will prevail and burning will cost Rs. 3200. The results of the burning may be either successful with probability 0.6 or marginal with probability 0.4. Successful execution will result in an estimated benefit of Rs. 6000, and marginal execution will provide only Rs. 3000 in benefits. If the weather is poor, burning will be cancelled incurring a cost of Rs. 1200 and no benefit. i) Develop a decision tree for the problem. (ii) Analyse the decision tree and determine the optimal course of action. **(8)**

b) Student tuition at ABC University is \$100 per semester credit hour. The Education department supplements the university revenue by matching student tuition, dollars per dollars. Average class size for typical three credit course is 50 students. Labour costs are \$4000 per class, material costs are \$20 per student, and overhead cost are \$25,000 per class. (a) Determine the total factor productivity. (b) If instructors deliver lecture 14 hours per week and the semester lasts for 16 weeks, what is the labour productivity? **(6)**

OR

16. a) An ice-cream retailer buys ice cream at a cost of Rs. 13 per cup and sells it for Rs. 20 per cup; any remaining unsold at the end of the day, can be disposed at a salvage price of Rs. 2.5 per cup. Past sales have ranged between 13 and 17 cups per day; there is no reason to believe that

sales volume will take on any other magnitude in future. Find the expected monetary value and EOL, if the sales history has the following probabilities: **(9)**

Market Size	13	14	15	16	17
Probability	0.10	0.15	0.15	0.25	0.35

b) At Modem Lumber Company, Kishore the president and a producer of an apple crates sold to growers, has been able, with his current equipment, to produce 240 crates per 100 logs. He currently purchases 100 logs per day, and each log required 3 labour hours to process. He believes that he can hire a professional buyer who can buy a better quality log at the same cost. If this is the case, he increases his production to 260 crates per 100 logs. His labour hours will increase by 8 hours per day. What will be the impact on productivity (measured in crates per labour-hour) if the buyer is hired? What is the growth in productivity in this case? **(5)**

17. a) A project has the following list of activities and time estimates:

Activity	**Time (Days)**	**Immediate Predecessors**
A	1	-
B	4	A
C	3	A
D	7	A
E	6	B
F	2	C, D
G	7	E, F
H	9	D
I	4	G, H

(a) Draw the network. (b) Show the early start and early finish times. (c) Show the critical path. **(10)**

b) An opinion survey involves designing and printing questionnaires, hiring and training personnel, selecting participants, mailing questionnaires and analysing data. Develop the precedence relationships and construct the project network. **(4)**

OR

18. a) The following table shows the precedence requirements, normal and crash times, and normal and crash costs for a construction project:

Activity	**Immediate Predecessors**	**Required Time (Weeks)**		**Cost (Rs.)**	
		Normal	**Crash**	**Normal**	**Crash**
A	-	4	2	10,000	11,000
B	A	3	2	6,000	9,000
C	A	2	1	4,000	6,000
D	B	5	3	14,000	18,000
E	B, C	1	1	9,000	9,000
F	C	3	2	7,000	8,000
G	E, F	4	2	13,000	25,000
H	D, E	4	1	11,000	18,000
I	H, G	6	5	20,000	29,000

Draw the network. (b) Determine the critical path. (c) Determine the optimal duration and the associated cost. **(10)**

b) Differentiate between CPM and PERT. **(4)**

19. a) What is meant by market segmentation and explain the process of market segmentation **(8)**

b) The Honda Co. in India has a division that manufactures two-wheel motorcycles. Its budgeted sales for Model G in 2019 are 80,00,000 units. Honda's target ending inventory is 10,00, 000 units and its beginning inventory is 12, 00, 000 units. The company's budgeted selling price to its distributors and dealers is Rs. 40, 000 per motorcycle. Honda procures all its wheels from an outside supplier. No defective wheels are accepted. Honda's needs for extra wheels for replacement parts are ordered by a separate division of the company. The company's target ending inventory is 3,00,000 wheels and its beginning inventory is 2,00,000 wheels. The budgeted purchase price is Rs. 1,600 per wheel.

(a) Compute the budgeted revenue in rupees.

(b) Compute the number of motorcycles to be produced.

Compute the budgeted purchases of wheels in units and in rupees.? **(6)**

OR

20. a) a) "Human Resource Management policies and principles contribute to effectiveness, continuity and stability of the organization". Discuss. (b) What is a budget? Explain how sales budget and production budgets are prepared? **(10)**

b) Distinguish between the following: (a) Assets and Liabilities (b) Production concept and Marketing concept (c) Needs and Wants (d) Design functions and Operational control functions in operations **(4)**

Teaching Plan

Sl.No	TOPIC	SESSION
	Module I	
1.1	Introduction to management	1
1.2	Levels of managers and skill required	2
1.3	Classical management theories	3
1.4	neo-classical management theories	4
1.5	modern management theories	5
1.6	System approaches to Management,	6
1.7	Task and Responsibilities of a professional Manager	7
	Module 2	
2.1	Management process – planning	8
2.2	Mission – objectives – goals – strategy – policies – programmes – procedures	9
2.3	Organizing, principles of organizing, organization structures	10
2.4	Directing, Leadership	11
2.5	Motivation, Controlling	12
	Module III	
3.1	Concept of productivity and its measurement Competitiveness	13
3.2	Decision making process;	14
3.3	Models in decision making	15
3.4	Decision making under certainty and risk	16
3.5	Decision making under uncertainty	17
3.6	Decision trees	18
3.7	Models of decision making.	19
	Module IV	
4.1	Project Management	20

Sl.No	TOPIC	SESSION
	Module I	
4.2	Network construction	21
4.3	Arrow diagram, Redundancy	22
4.4	CPM and PERT Networks	23
4.5	Scheduling computations	24
4.6	PERT time estimates	25
4.7	Probability of completion of project	26
4.8	Introduction to crashing	
	Module V	
5.1	Introduction to functional areas of management,	28
5.2	Operations management	29
5.3	Human resources management ,	30
5.4	Marketing management	31
5.5	Financial management	32
5.6	Entrepreneurship,	33
5.7	Business plans	34
5.8	Corporate social responsibility, Patents and Intellectual property rights	35

SEMESTER V

ECT301	**LINEAR INTEGRATED CIRCUITS**	**CATEGORY**	**L**	**T**	**P**	**CREDITS**
		PCC	**3**	**1**	**0**	**4**

Preamble: This course aims to develop the skill to design circuits using operational amplifiers and other linear ICs for various applications.

Prerequisite: EC202 Analog Circuits

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand Op Amp fundamentals and differential amplifier configurations
CO 2	Design operational amplifier circuits for various applications
CO 3	Design Oscillators and active filters using opamps
CO4	Explain the working and applications of timer, VCO and PLL ICs
CO5	Outline the working of Voltage regulator IC's and Data converters

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3	1	2								1
CO 2	3	3	2	2	2							1
CO 3	3	3	2	2	2							1
CO 4	3	3	1	2	2							1
CO 5	3	3	2	2	2							1

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyse	K4			
Evaluate				
Create				

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Analyze differential amplifier configurations.

1. Explain the working of BJT differential amplifiers.
2. Calculate the input resistance, output resistance, voltage gain and CMRR of differential amplifiers.
3. Explain the non-ideal parameters of differential amplifiers.
4. Derive CMRR, input resistance and output resistance of a dual input balanced output differential amplifier configuration.

Course Outcome 2 (CO2): Design operational amplifier circuits for various applications.

1. Design an opamp circuit to obtain an output voltage $V_0=-(2V_1+4V_2 + 3V_3)$
2. A 741C op-amp is used as an inverting amplifier with a gain of 50. The voltage gain vs frequency curve of 741C is flat upto 20kHz.What maximum peak to peak input signal can be applied without distorting the output?
3. With the help of a neat circuit diagram, derive the equation for the output voltage of an Instrumentation amplifier.
4. With the help of circuit diagrams and graphs, explain the working of a Full wave Precision rectifier.

Course Outcome 3 (CO3): Design active filters using opamps

1. Derive the design equations for a second order Butterworth active low pass filter.
2. Design a Notch filter to eliminate power supply hum (50 Hz).
3. Design a first order low pass filter at a cut-off frequency of 2kHz with a pass band gain of 3

Course Outcome 4 (CO4): Explain the working and applications of specialized ICs

1. With the help of internal diagram explain the monostable operation of timer IC 555. Draw the input and different output waveforms. Derive the equation for pulse width.

2. Explain the operation of Phase Locked Loop. What is lock range and capture range? Realize a summing amplifier to obtain a given output voltage.

3. Design a circuit to multiply the incoming frequency by a factor of 5 using 565 PLL.

Course Outcome 5 (CO5): Outline the working of Voltage regulator IC's and Data converters

1. What is the principle of operation of Dual slope ADC. Deduce the relationship between analogue input and digital output of the ADC.
2. Explain how current boosting is achieved using I.C 723
3. Explain the working of successive approximation ADC

SYLLABUS

Module 1:

Operational amplifiers(Op Amps): The 741 Op Amp, Block diagram, Ideal op-amp parameters, typical parameter values for 741, Equivalent circuit, Open loop configurations, Voltage transfer curve, Frequency response curve.

Differential Amplifiers: Differential amplifier configurations using BJT, DC Analysis- transfer characteristics; AC analysis- differential and common mode gains, CMRR, input and output resistance, Voltage gain. Constant current bias, constant current source; Concept of current mirror-the two transistor current mirror, Wilson and Widlar current mirrors.

Module 2:

Op-amp with negative feedback: General concept of Voltage Series, Voltage Shunt, current series and current shunt negative feedback, Op Amp circuits with voltage series and voltage shunt feedback, Virtual ground Concept; analysis of practical inverting and non-inverting amplifiers for closed loop gain, Input Resistance and Output Resistance.
Op-amp applications: Summer, Voltage Follower-loading effects, Differential and Instrumentation Amplifiers, Voltage to current and Current to voltage converters, Integrator, Differentiator, Precision rectifiers, Comparators, Schmitt Triggers, Log and antilogamplifiers.

Module 3:

Op-amp Oscillators and Multivibrators: Phase Shift and Wien-bridge Oscillators, Triangular and Sawtooth waveform generators, Astable and monostable multivibrators.
Active filters: Comparison with passive filters, First and second order low pass, High pass, Band pass and band reject active filters, state variable filters.

Module 4 :

Timer and VCO: Timer IC 555- Functional diagram, Astable and monostable operations;. Basic concepts of Voltage Controlled Oscillator and application of VCO IC LM566,
Phase Locked Loop – Operation, Closed loop analysis, Lock and capture range, Basic building blocks, PLL IC 565, Applications of PLL.

Module 5:

Voltage Regulators: Fixed and Adjustable voltage regulators, IC 723 – Low voltage and high voltage configurations, Current boosting, Current limiting, Short circuit and Fold-back protection.
Data Converters: Digital to Analog converters, Specifications, Weighted resistor type and R-2R Ladder type.
Analog to Digital Converters: Specifications, Flash type and Successive approximation type.

Text Books

1. Roy D. C. and S. B. Jain, Linear Integrated Circuits, New Age International, 3/e, 2010

Reference Books

1. DFranco S., Design with Operational Amplifiers and Analog Integrated Circuits, 3/e, Tata McGraw Hill, 2008
2. Gayakwad R. A., Op-Amps and Linear Integrated Circuits, Prentice Hall, 4/e, 2010
3. Salivahanan S. and V. S. K. Bhaaskaran, Linear Integrated Circuits, Tata McGraw Hill, 2008.
4. Botkar K. R., Integrated Circuits, 10/e, Khanna Publishers, 2010
5. C.G. Clayton, Operational Amplifiers, Butterworth & Company Publ. Ltd. Elsevier, 1971
6. David A. Bell, Operational Amplifiers & Linear ICs, Oxford University Press, 2nd edition, 2010
7. R.F. Coughlin & Fredrick Driscoll, Operational Amplifiers & Linear Integrated Circuits, 6th Edition, PHI, 2001
8. Sedra A. S. and K. C. Smith, Microelectronic Circuits, 6/e, Oxford University Press, 2013.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Operational amplifiers**	**(9)**
1.1	The 741 Op Amp, Block diagram, Ideal op-amp parameters, typical parameter values for 741	1
1.2	Equivalent circuit, Open loop configurations, Voltage transfer curve, Frequency response curve.	1
1.3	Differential amplifier configurations using BJT, DC Analysis- transfer characteristics	2
1.4	AC analysis- differential and common mode gains, CMRR, input and output resistance, Voltage gain	2
1.5	Constant current bias and constant current source	1
1.6	Concept of current mirror, the two transistor current mirror Wilson and Widlar current mirrors.	2
2	**Op-amp with negative feedback and Op-amp applications**	**(11)**

2.1	General concept of Voltage Series, Voltage Shunt, current series and current shunt negative feedback	1
2.2	Op Amp circuits with voltage series and voltage shunt feedback, Virtual ground Concept	1
2.3	Analysis of practical inverting and non-inverting amplifier	2
2.4	Summer, Voltage Follower-loading effect	1
2.5	Differential and Instrumentation Amplifiers	1
2.6	Voltage to current and Current to voltage converters	1
2.7	Integrator, Differentiator	1
2.8	Precision rectifiers-half wave and full wave	1
2.9	Comparators, Schmitt Triggers	1
2.10	Log and antilog amplifier	1
3	**Op-amp Oscillators and Multivibrators**	**(10)**
3.1	Phase Shift and Wien-bridge Oscillators,	2
3.2	Triangular and Sawtooth waveform generators, Astable and monostable multivibrators	2
3.3	Comparison, design of First and second order low pass and High pass active filters	2
3.4	Design of Second Order Band pass and band reject filters	2
3.5	State variable filters	2
4	**Timer, VCO and PLL**	**(9)**
4.1	Timer IC 555- Functional diagram, Astable and monostable operations.	2
4.2	Basic concepts of Voltage Controlled Oscillator	1
4.3	Application of VCO IC LM566	2
4.4	PLL Operation, Closed loop analysis Lock and capture range.	2
4.5	Basic building blocks, PLL IC 565, Applications of PLL	2
5	**Voltage regulators and Data converters**	**(9)**
5.1	Fixed and Adjustable voltage regulators	1
5.2	IC 723 – Low voltage and high voltage configurations,	2
5.3	Current boosting, Current limiting, Short circuit and Fold-back protection.	2
5.4	Digital to Analog converters, Specifications, Weighted resistor type and R-2R Ladder type.	2
5.5	Analog to Digital Converters: Specifications, Flash type and Successive approximation type.	2

Assignment:

Assignment may be given on related innovative topics on linear IC, like Analog multiplier- Gilbert multiplier cell, variable trans-conductance technique, application of analog multiplier IC AD633., sigma delta or other types of ADC etc. At least one assignment should be simulation of opamp circuits on any circuit simulation software. The following simulations can be done in QUCS, KiCad or PSPICE.(The course instructor is free to add or modify the list)

1. Design and simulate a BJT differential amplifier. Observe the input and output signals. Plot the AC frequency response
2. Design and simulate Wien bridge oscillator for a frequency of 10 kHz. Run a transient simulation and observe the output waveform.
3. Design and implement differential amplifier and measure its CMRR. Plot its transfer characteristics.
4. Design and simulate non-inverting amplifier for gain 5. Observe the input and output signals. Run the ac simulation and observe the frequency response and 3− db bandwidth.
5. Design and simulate a 3 bit flash type ADC. Observe the output bit patterns and transfer characteristics
6. Design and simulate R − 2R DAC circuit.
7. Design and implement Schmitt trigger circuit for upper triggering point of +8 V and a lower triggering point of −4 V using op-amps.

Model Question

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT301

Program: Electronics and Communication Engineering
Course Name: Linear Integrated Circuits
Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1. Draw and list the functions of 741 IC pins K1
2. Define slew rate with its unit. What is its effect at the output signal? K2
3. How the virtual ground is different from actual ground? K2
4. A differential amplifier has a common mode gain of 0.05 and difference mode gain of 1000.Calculate the output voltage for two signals V1 = 1mV and V2 = 0.9Mv K3
5. Design a non-inverting amplifier for a gain of 11 K3
6. Design a second order Butterworth Low Pass Filter with f_H= 2KHz K3
7. Draw the circuit of monostable multivibrator using opamp. K1
8. What is the principle of VCO?. K1
9. Mention 3 applications of PLL. K2
10. Define the following terms with respect to DAC (i)Resolution (ii)Linearity (iii) Full scale output voltage K2

Differentiate between line and load regulations. K3

PART – B

Answer one question from each module; each question carries 14 marks.

	Module I			
11. a)	Derive CMRR, input resistance and output resistance of a dual input balanced output differential amplifier configuration.	7	CO1	K3
11. b)	What is the principle of operation of Wilson current mirror and its advantages? Deduce the expression for its current gain.	7	CO1	K2
	OR			
12.a)	Draw the equivalent circuit of an operational amplifier. Explain voltage transfer characteristics of an operational amplifier.	6	CO1	K3
12.b)	Explain the following properties of a practical opamp (i) Bandwidth (ii) Slew rate (iii) Input offset voltage (iv) Input offset current	8	CO1	K2
	Module II			

13. a)	Design a fullwave rectifier to rectify an ac signal of 0.2V peak-to-peak. Explain its principle of operation.	7	CO2	K3
13. b)	Draw the circuit diagram of a differential instrumentation amplifier with a transducer bridge and show that the output voltage is proportional to the change in resistance.	7	CO2	K2
	OR			
14.a)	Derive the following characteristics of voltage shunt amplifier: i) Closed loop voltage gain ii)Input resistance iii) Output resistance iv)Bandwidth	7	CO2	K3
14.b)	Explain the working of an inverting Schmitt trigger and draw its transfer characteristics.	7	CO2	K2
	Moduel III			
15 a)	Derive the equation for frequency of oscillation (f0) of a Wein Bridge oscillator. Design a Wein Bridge oscillator for f0 = 1KHz.	7	CO3	K3
15 b)	Derive the equation for the transfer function of a first order wide Band Pass filter.	7	CO3	K3
	OR			
16a	Derive the design equations for a second order Butterworth active low pass filter.	7	CO3	K3
16b	Design a circuit to generate 1KHz triangular wave with 5V peak.	7	CO3	K3
	Module IV			
17 a)	Design a circuit to multiply the incoming frequency by a factor of 5 using 565 PLL.	8	CO4	K3
17 b)	With the help of internal diagram explain the monostable operation of timer IC 555. Draw the input and output waveforms. Derive the equation for pulse width.	6	CO4	K2
	OR			
18 a)	Design a monostable multi-vibrator for a pulse duration of 1ms using IC555.	7	CO4	K3
18 b)	Explain the operation of Phase Locked Loop. What is lock range and capture range?	7	CO4	K2
	Module V			
19 a)	Explain the working of R-2R ladder type DAC. In a 10 bit DAC, reference voltage is given as 15V. Find analog output for digital input of 1011011001.	7	CO5	K2
19 b)	Explain how short circuit, fold back protection and current boosting are done using IC723 voltage regulator.	7	CO5	K2
	OR			
20 a)	With a functional diagram, explain the principle of operation of Successive approximation type ADC.	7	CO5	K2
20 b)	With a neat circuit diagram, explain the operation of a 3-bit flash converter.	7	CO5	K2

ECT303	DIGITAL SIGNAL PROCESSING	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to provide an understanding of the principles, algorithms and applications of DSP.

Prerequisite: ECT 204 Signals and systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	State and prove the fundamental properties and relations relevant to DFT and solve basic problems involving DFT based filtering methods
CO 2	Compute DFT and IDFT using DIT and DIF radix-2 FFT algorithms
CO 3	Design linear phase FIR filters and IIR filters for a given specification
CO 4	Illustrate the various FIR and IIR filter structures for the realization of the given system function
CO5	Explain the basic multi-rate DSP operations decimation and interpolation in both time and frequency domains using supported mathematical equations
CO6	Explain the architecture of DSP processor (TMS320C67xx) and the finite word length effects

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2		2							2
CO 2	3	3	3		3							2
CO 3	3	3	3		3							2
CO 4	3	3	2		3							2
CO5	2	2	2		2							2
CO6	2	2	-		-							2

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	30
Apply	K3	20	20	60
Analyse	K4			
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

CO1: State and prove the fundamental properties and relations relevant to DFT and solve basic problems involving DFT based filtering methods

1. Determine the N-point DFT X(k) of the N point sequences given by (i) $x_1(n)=\sin(2\pi n/N)$ n/N) (ii) $x_2(n)=\cos^2(2\pi n/N)$ n/N)
2. Show that if x(n) is a real valued sequence, then its DFT X(k) is also real and even

CO2: Compute DFT and IDFT using DIT and DIF radix-2 FFT algorithms

1. Find the 8 point DFT of a real sequence x(n)={1,2,2,2,1,0,0,0,0} using Decimation in frequency algorithm?
2. Find out the number of complex multiplications require to perform an 1024 point DFT using(i)direct computation and (ii) using radix 2 FFT algorithm?

CO3: Design linear phase FIR filters and IIR filters for a given specification

1. Design a linear phase FIR filter with order M=15 and cut-off frequency πn/N) /6 .Use a Hanning Window.
2. Design a low pass digital butter-worth filter using bilinear transformation for the given specifications. Passband ripple $\leq$1dB, Passband edge:4kHz, Stopband Attenuation:$\geq$40 dB, Stopband edge:6kHz, Sampling requency:24 kHz

CO4: Illustrate the various FIR and IIR filter structures for the realization of the given system function

1. Obtain the direct form II and transpose structure of the filter whose transfer function is given below.

$$H(z)=\frac{0.44\,z^2+0.362\,z+0.02}{z^3+.4\,z^2+.18\,z-0.2}$$

2. Realize an FIR system with the given difference equation y(n)=x(n)-0.5x(n-1)+0.25x(n-2)+0.5x(n-3)-0.4x(n-4)+0.2x(n-5)

CO5: Explain the basic multi-rate DSP operations decimation and interpolation in both time and frequency domains using supported mathematical equations

1. Derive the frequency domain expression of the factor of 2 up-sampler whose input is given by x(n) and transform by X(k)?
2. Bring out the role of an anti-imaging filter in a sampling rate converter?

CO6: Explain the architecture of DSP processor TMS320C67xx and the finite word length effects

1. Derive the variance of quantization noise in an ADC with step size Δ, assuming uniformly distributed quantization noise with zero mean ?
2. Bring out the architectural features of TMS320C67xx digital signal processor?

SYLLABUS

Module 1

Basic Elements of a DSP system, Typical DSP applications, Finite-length discrete transforms, Orthogonal transforms – The Discrete Fourier Transform: DFT as a linear transformation (Matrix relations), Relationship of the DFT to other transforms, IDFT, Properties of DFT and examples. Circular convolution, Linear Filtering methods based on the DFT, linear convolution using circular convolution, Filtering of long data sequences, overlap save and overlap add methods, Frequency Analysis of Signals using the DFT (concept only required)

Module 2

Efficient Computation of DFT: Fast Fourier Transform Algorithms-Radix-2 Decimation in Time and Decimation in Frequency FFT Algorithms, IDFT computation using Radix-2 FFT Algorithms, Application of FFT Algorithms, Efficient computation of DFT of Two Real Sequences and a 2N-Point Real Sequence

Module 3

Design of FIR Filters - Symmetric and Anti-symmetric FIR Filters, Design of linear phase FIR filters using Window methods, (rectangular, Hamming and Hanning) and frequency sampling method, Comparison of design methods for Linear Phase FIR Filters. Design of IIRDigital Filters from Analog Filters (Butterworth), IIR Filter Design by Impulse Invariance, and Bilinear Transformation, Frequency Transformations in the Analog and Digital Domain.

Module 4

Structures for the realization of Discrete Time Systems - Block diagram and signal flow graph representations of filters, FIR Filter Structures: Linear structures, Direct Form, CascadeForm, IIR Filter Structures: Direct Form, Transposed Form, Cascade Form and Parallel Form, Computational Complexity of Digital filter structures. Multi-rate Digital Signal Processing:

Decimation and Interpolation (Time domain and Frequency Domain Interpretation),
Anti- aliasing and anti-imaging filter.

Module 5

Computer architecture for signal processing: Harvard Architecture, pipelining, MAC, Introduction to TMS320C67xx digital signal processor, Functional Block Diagram.
Finite word length effects in DSP systems: Introduction (analysis not required), fixed-point and floating-point DSP arithmetic, ADC quantization noise, Finite word length effects in IIRdigital filters: coefficient quantization errors. Finite word length effects in FFT algorithms: Round off errors

Text Books

1. Proakis J. G. and Manolakis D. G., Digital Signal Processing, 4/e, Pearson Education, 2007
2. Alan V Oppenheim, Ronald W. Schafer ,Discrete-Time Signal Processing, 3rd Edition , Pearson ,2010

3. Mitra S. K., Digital Signal Processing: A Computer Based Approach, 4/e McGraw Hill (India) 2014

Reference Books

4. Ifeachor E.C. and Jervis B. W., Digital Signal Processing: A Practical Approach, 2/e Pearson Education, 2009.
5. Lyons, Richard G., Understanding Digital Signal Processing, 3/e. Pearson Education India, 2004.
6. Salivahanan S, Digital Signal Processing,4e, Mc Graw –Hill Education New Delhi, 2019
7. Chassaing, Rulph., DSP applications using C and the TMS320C6x DSK. Vol. 13. John Wiley & Sons, 2003.
8. Vinay.K.Ingle, John.G.Proakis, Digital Signal Processing: Bookware Companion Series,Thomson,2004
9. Chen, C.T., “Digital Signal Processing: Spectral Computation & Filter Design”, Oxford Univ. Press, 2001.
10. Monson H Hayes, “Schaums outline: Digital Signal Processing”, McGraw HillProfessional, 1999

Course Contents and Lecture Schedule

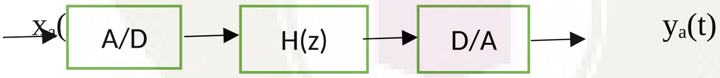
No.	Topic	No. of Lectures
1	**Module 1**	
1.1	Basic Elements of a DSP system, Typical DSP applications, Finite length Discrete transforms, Orthogonal transforms	1
1.2	The Discrete Fourier Transform: DFT as a linear transformation(Matrix relations),	1
1.3	Relationship of the DFT to other transforms, IDFT	1
1.4	Properties of DFT and examples ,Circular convolution	2
1.5	Linear Filtering methods based on the DFT- linear convolution using circular convolution, Filtering of long data sequences, overlap save and overlap add methods,	3
1.6	Frequency Analysis of Signals using the DFT(concept only required)	1
2	**Module 2**	
2.1	Efficient Computation of DFT: Fast Fourier Transform Algorithms	1
2.2	Radix-2 Decimation in Time and Decimation in Frequency FFT Algorithms	4
2.3	IDFT computation using Radix-2 FFT Algorithms	2
2.4	Application of FFT Algorithms-Efficient computation of DFT of Two Real Sequences and a 2N-Point Real Sequence	1
3	**Module 3**	

3.1	Design of FIR Filters- Symmetric and Anti-symmetric FIR Filters, Design of linear phase FIR filters using Window methods, (rectangular, Hamming and Hanning)	4
3.2	Design of linear phase FIR filters using frequency sampling Method, Comparison of Design Methods for Linear Phase FIR Filters	2
3.3	Design of IIR Digital Filters from Analog Filters, (Butterworth), IIR Filter Design by Impulse Invariance	3
3.4	IIR Filter Design by Bilinear Transformation	2
3.5	Frequency Transformations in the Analog and Digital Domain.	1
4	**Module 4**	
4.1	Structures for the realization of Discrete Time Systems- Block diagram and signal flow graph representations of filters	2
4.2	FIR Filter Structures: (Linear structures), Direct Form Cascade Form	,2
4.3	IIR Filter Structures: Direct Form, Cascade Form and Parallel Form	3
4.3	Computational Complexity of Digital filter structures.	1
4.4	Multi-rate Digital Signal Processing: Decimation and Interpolation (Time domain and Frequency Domain Interpretation), Anti-aliasing and anti-imaging filter.	3
5	**Module 5**	
5.1	Computer architecture for signal processing : Harvard Architecture, pipelining, MAC, Introduction to TMS320C67xx digital signal processor ,Functional Block Diagram	3
5.2	Finite word length effects in DSP systems: Introduction (analysis not required), fixed-point and floating-point DSP arithmetic, ADC quantization noise,	3
5.3	Finite word length effects in IIR digital filters: coefficient quantization errors.	2
5.4	Finite word length effects in FFT algorithms: Round off errors	1

Simulation Assignments

The following simulations to be done in Scilab/ Matlab/ LabView/GNU Octave:

1. Consider a signal given by x(n)=[1,1,1,1].
    1. Compute the DTFT of the given sequence and plot its magnitude and phase
    2. Compute the 4 point DFT of the above signal and plot its magnitude and phase
    3. Compare the above plots and obtain the relationship?
2. Zero pad the sequence x(n) by 4 and compute the 8 point DFT and find the corresponding magnitude and phase plots. Compare the spectra with that in (b) and comment on it.
3. The first five values of the 8 point DFT of a real valued sequence x(n) are given by {0.25, 0.125-j0.3, 0, 0.125-j0.06, 0.5}. Determine the DFT of each of the following sequences using properties. Hint :IDFT may not be computed.
    1. x1(n)=x((2-n))8
    2. x3(n)=x^2(n)
    3. x4(n)=x(n)e$^{j\pi n/N)}$ in/4
4. a) Develop a function to implement the over-lap add method using circular convolution operation. The format should be function [y]=overlappadd(x,h,N), where y is the output sequence, x is the input sequence and N is the block -length>=2*Length(h)-1.
    1. Incorporate the radix-2 FFT implementation in the above function to obtain a high speed overlap add block convolution routine. Choose N=8. Hint :choose N=2^k
5. Design a low pass digital filter to be used in the given structure



to satisfy the following requirements. Sampling rate of 8000samples/second, Pass band edge of 1500Hz with a ripple of 3dB, Stopband edge of 2000Hz with attenuation of 40 dB, Equiripple passband but monotonic stopband. (Use impulse invariance technique)

1. Choose T=1 s for impulse invariance and determine the system function H(z) in parallel form.Plot the log-magnitude response in dB and impulse response h(n)
2. Choose T=1/8000 s and repeat the same procedure. Compare this design with that in (a) and comment on the effect of T on the impulse invariant design?

6. A filter is described by the following difference equation:

   16y(n)+12y(n-1)+2y(n-2)-4y(n-3)-y(n-4)=x(n)-3x(n-1)+11x(n-2)-27x(n-3)+18x(n-4)

   1. Determine the Direct form filter structure
   2. Using the Direct form structure, obtain the cascade form filter structure

7. Consider a signal given by $x(n)=(0.5)^n u(n)$. Decimate the signal by a factor 4 and plot the output in time domain and frequency domain?

   1. Interpolate the signal by a factor of 4 and plot the output in time domain and frequency domain?
   2. Compare the spectra and obtain the inference?

Model Question Paper

A P J Abdul Kalam Technological University

Fifth Semester B Tech Degree Examination
Branch: Electronics and Communication Engg.

Course: ECT 303 DIGITAL SIGNAL PROCESSING

Time: 3 Hrs Max. Marks: 100

PART A
Answer All Questions. Each question carry 3 marks

1 .Derive the relationship of DFT to Z-transform? (3)K3

2.Find the circular convolution of two sequences $x_1(n)=\{1, 2,-2,1,3\}$,$x_2(n)=\{2,-1,3,1,1\}$ (3)K3

3 Illustrate the basic butterfly computation used in decimation in time radix-2 FFT algorithm?(3)K1

4 Bring out the computational advantage of performing an N-point DFT using radix-2 FFT compared to direct method?

5. Determine the frequency response of a linear phase FIR filter given by the difference equation y(n)=0.15x(n)+0.25x(n-1)+x(n-3). Also find the phase delay (3) K3

6 .An all pole analog filter is given by the transfer function $H(s)=1/(s^2+5s+6)$. Find out the transfer function H(z) of the equivalent digital filter using impulse invariance method. Use T=1s (3) K3

7.Obtain the cascade form realization of the third order IIR filter transfer function given by

$$H(z)=\frac{0.44z^2+0.362z+0.02}{(z^2+0.8z^{\square}+.0.5)(z-0.4)}$$ (3) K3

8 . Prove that a factor of L upsampler is a linear-time varying system. (3) K3

9. Differentiate between Harvard architecture and Von-Nuemann Architecture used in processors? (3) K1

10. Express the fraction 7/8 and -7/8 in sign-magnitude, two’s compliment and one’s compliment format? (3) K3

Part B

Answer any one Question from each module. Each question carries 14 Marks

11. a) How will you perform linear convolution using circular convolution? Find the linear convolution of the given sequences x(n) = {2, 9,7, 4} and h(n) = {1, 3, 1, 2} using circular convolution? (8) K3

b) Explain the following properties of DFT a) Linearity b) Complex conjugate property c) Circular Convolution d) Time Reversal (6) K2

OR

12.a.) The first eight points of 14-point DFT of a real valued sequence are {12, -1+j3, 3+j4, 1-j5, -2+j2, 6+j3, -2-j3, 10}

i) Determine the remaining points

ii) Evaluate x[0] without computing the IDFT of X(k)?

iii) Evaluate IDFT to obtain the real sequence ? (8)K3

b) Explain with appropriate diagrams, the overlap-add method for filtering of long data sequences using DFT? (6) K2

13.a) Compute the 8 point DFT of x(n) = {2,1,-1,3,5,2,4,1} using radix-2 decimation in time FFT algorithm. (9) K3

b)Bring out how a 2N point DFT of a 2N point sequence can be found using the computation of a single N point DFT. (5) K3

OR

14 a.) Find the 8 point DFT of a real sequence x(n)={1,2,2,2,1,0,0,0,0} using radix-2 decimation in frequency algorithm (9)K3

b) Bring out how N-point DFT of two real valued sequences can be found by computing a single N-point DFT. (5) K3

15.a. Design a linear phase FIR low pass filter having length M = 15 and cut-off frequency ω_c = π/6. Use Hamming window. (10) K3

b.Prove that if z_1 is a zero of an FIR filter, then $1/z_1$ is also a zero? (4) K2

OR

16. a. Design a digital Butterworth low pass filter with $\omega_p = \pi/6$, $\omega_s = \pi/4$, minimum pass band gain = -2 dB and minimum stop band attenuation = 8 dB. Use bilinear transformation.(Take T = 1s) (10) K3

b. What is warping effect in bilinear transformation and how it can be eliminated? (4) K2

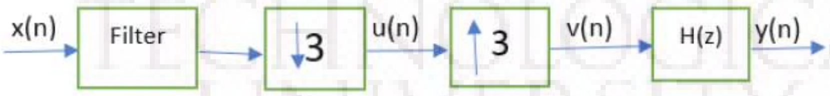
17.a) Derive and draw the direct form-I, direct form-II and cascade form realization of the given filter, whose difference equation is given as (9) K3

$y(n)=0.1\,y(n-1)+0.2\,y(n-2)+3\,x(n)+3.6\,x(n-1)+0.6\,x(n-2)$

b) Differentiate between anti-aliasing and anti-imaging filters. (5) K2

OR

18.a) Obtain the expression of output y(n) as a function of x(n) for the multi-rate structure given below? (9) K3



b) Draw the transposed direct form II Structure of the system given by the difference equation y(n)=05.y(n-1)-0.25y(n-2)+x(n)+x(n-1) . (5)K2

19.a.With the help of a functional block diagram, explain the architecture of TMS320C67xx DSP processor? (10) K2

b.What are the prominent features of TMS320C67xx compared to its predecessors ? (4) K2

OR

20.a)Explain how to minimize the effect of finite word length in IIR digital filters? (7) K2

b)Explain the roundoff error models used in FFT algorithms? (7) K2

ECT305	ANALOG AND DIGITAL COMMUNICATION	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to develop analog and digital communication systems.

Prerequisite: ECT 204 Signals and Systems, MAT 204 Probability, Random Process and Numerical Methods

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the existent analog communication systems.
CO 2	Apply the concepts of random processes to LTI systems.
CO 3	Apply waveform coding techniques in digital transmission.
CO 4	Apply GS procedure to develop digital receivers.
CO 5	Apply equalizer design to counteract ISI.
CO 6	Apply digital modulation techniques in signal transmission.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3										
CO 2	3	3	2	3	3							
CO 3	3	3	2	3	3	2						2
CO 4	3	3	2	3	3	2						2
CO 5	3	3	2	3	3	2						2
CO 6	3	3	2	3	3	2						2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): The existent analog communication system

1. What are the needs for analog modulation
2. Give the mathematical model of FM signal and explain its spectrum.

Course Outcome 2 (CO2): Application of random processes

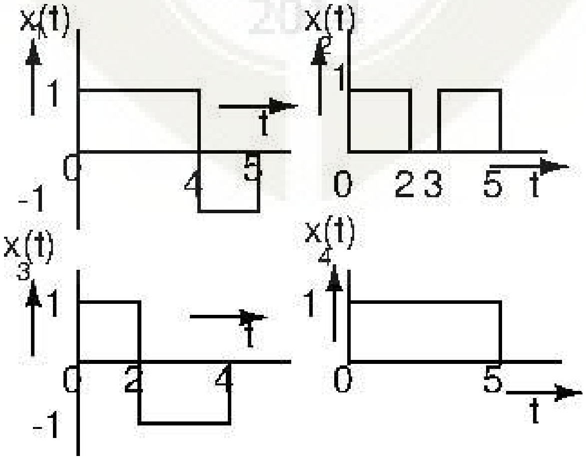
1. Compute the entropy of a Gaussian random variable.
2. A six faced die is thrown by a player. He gets Rs. 100 if face 6 turns up, loses Rs. 20 if face 3 or 4 turn up, gets Rs. 50 if face 5 turns up and loses Rs 10 if face 1 or 2 turn up. Draw the pdf and CDF for the random variable. Check if it is profitable based on statistical expectation.

Course Outcome 3 (CO3): Waveform coding

1. Compute the A and mu law quantized values of a signal that is normalized to 0.8 with A=32 and mu=255.
2. Design a 3-tap linear predictor for speech signals with the autocorrelation vector [0.95,0.85,0.7,0.6] , based on Wiener-Hopf equation. Compute the minimum mean square error.

Course Outcome 4 (CO4): G-S Procedure and effects in the channel

1. Apply G-S procedure on the following signals and plot their signal space.



2. Derive the Nyquist criterion for zero ISI.

Course Outcome 5 (CO5): Digital modulation

1. Give the mathematical model of a BPSK signal and plot its signal constellation.
2. Draw the BER-SNR plot for the BPSK system

SYLLABUS

Module 1 Analog Communication

Block diagram of a communication system. Need for analog modulation. Amplitude modulation. Equation and spectrum of AM signal. DSB-SC and SSB systems. Block diagram of SSB transmitter and receiver. Frequency and phase modulation. Narrow and wide band FM and their spectra. FM transmitter and receiver.

Module 2 Review of Random Variables and Random Processes

Review of random variables – both discrete and continuous. CDF and PDF, statistical averages. (Only definitions, computations and significance) Entropy, differential entropy. Differential entropy of a Gaussian RV. Conditional entropy, mutual information.

Stochastic processes, Stationarity. Conditions for WSS and SSS. Autocorrelation and power spectral density. LTI systems with WSS as input.

Module 3 Source Coding

Source coding theorems I and II (Statements only). Waveform coding. Sampling and Quantization. Pulse code modulation, Transmitter and receiver. Companding. Practical 15 level A and mu-law companders. DPCM transmitter and receiver. Design of linear predictor. Wiener-Hopf equation. Delta modulation. Slope overload.

Module 4 G-S Procedure and Effects in the Channel

Gram-Schmitt procedure. Signal space.

Baseband transmission through AWGN channel. Mathematical model of ISI. Nyquit criterion for zero ISI. Signal modeling for ISI, Raised cosine and Square-root raised cosine spectrum, Partial response signalling and duobinary coding. Equalization. Design of zero forcing equalizer.

Vector model of AWGN channel. Matched filter and correlation receivers. MAP receiver, Maximum likelihood receiver and probability of error.

Capacity of an AWGN channel (Expression only) -- significance in the design of communication schemes.

Module 5 Digital Modulation Schemes

Digital modulation schemes. Baseband BPSK system and the signal constellation. BPSK transmitter and receiver. Base band QPSK system and Signal constellations. Plots of BER Vs SNR with analysis. QPSK transmitter and receiver. Quadrature amplitude modulation and signal constellation.

Text Books

1. "Communication Systems", Simon Haykin, Wiley.
2. "Digital Communications: Fundamentals and Applications", Sklar, Pearson.
3. "Digital Telephony", John C. Bellamy, Wiley

References

1. "Principles of Digital Communication," R. Gallager, Oxford University Press
2. "Digital Communication", John G Proakis, Wiley.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Analog Communication**	
1.1	Block diagram of communication system, analog and digital systems , need for modulation	2
1.2	Amplitude modulation, model and spectrum and index of modulation	2
1.3	DSB-SC and SSB modulation. SSB transmitter and receiver	2
1.4	Frequency and phase modulation. Model of FM, spectrum of FM signal	2
2	**Review of Random Variables**	
2.1	Review of random variables, CDF and PDF, examples	2
2.2	Entropy of RV, Differential entropy of Gaussian RV, Expectation, conditional expectation, mutual information	4
2.3	Stochastic processes, Stationarity, WSS and SSS. Autocorrelation and power spectral density. Response of LTI systems to WSS	3
3	**Source Coding**	
3.1	Source coding theorems I and II	1
3.2	PCM,Transmitter and receiver, companding Practical A and mu law companders	4
3.3	DPCM, Linear predictor, Wiener Hopf equation	3
3.4	Delta modulator	1

4	**GS Procedure and Channel Effects**	
4.1	G-S procedure	3
4.2	ISI, Nyquist criterion, RS and SRC, PR signalling and duobinary coding	3
4.3	Equalization, design of zero forcing equalizer	3
4.4	Vector model of AWGN channel, Correlation receiver, matched filter	4
4.5	MAP receiver, ML receiver, probability of error	1
4.6	Channel capacity, capacity of Gaussian channel, Its significance in design of digital communication schemes	2
5	**Digital Modulation**	
5.1	Need of digital modulation in modern communication.	1
5.2	Baseband QPSK system, signal constellation. Effect of AWGN, probability of error (with derivation). BER-SNR curve, QPSK transmitter and receiver.	4
5.3	QAM system	1

Model Question Paper

A P J Abdul Kalam Technological University

Fifth Semester B Tech Degree Examination Branch:

Electronics and Communication

COURSE: ECT 305 ANALOG AND DIGITAL COMMUNICATION

Time: 3 Hrs **Max. Marks: 100**

PART A

Answer All Questions

1	Explain the need for modulation	(3)*K2*
2	Plot the spectrum of an FM signal	(3)*K2*
3	In a game a six faced die is thrown. If 1 or 2 comes the player gets Rs 30, if 3 or 4 the player gets Rs 10, if 5 comes he loses Rs. 30 and in the event of 6 he loses Rs. 100. Plot the CDF and PDF of gain or loss	(3) *K3*
4	Give the conditions for WSS	(3)*K2*
5	Compute the step size for a delta modulator without slope overload if the input is $A\cos 2\pi 120t$	(3)*K3*
6	State source coding theorems I and II	(3)*K1*
7	Give the Nyquist criterion for zero ISI.	(3)*K1*
8	Give the mathematical model of ISI	(3)*K2*
9	Plot BER against SNR for a BPSK system	(3)*K2*
10	Draw the signal constellation of a QPSK system with and without AWGN.	(3)*K3*

PART B

Answer one question from each module. Each question carries 14 mark.

Module I

11(A) Give the model of AM signal and plot its spectrum (10)*K2*

11(B) If a sinusoidal is amplitude modulated by the carrier $5 \cos 2\pi 300t$ to a depth of 30 %, compute the power in the resultant AM signal. (4)*K3*

OR

12(A) Explain how SSB is transmitted and received. (10)*K2*

12(B) Compute the bandwidth of the narrow band FM signal with modulating signal frequency of $1kHz$ and index of modulation 0.3 (4) *K3*

Module II

13(A) Compute the entropy of Gaussian random variable. (10)*K3*

13(B) Give the relation between autocorrelation and power spectral density of a WSS. (4)*K2*

OR

14(A) Test whether the random process $X(t) = A\cos 2\pi ft+\theta$ is WSS if θ is uniformly distributed in the interval $[-\pi,\pi]$ (10)*K3*

14(B) Explain mutual information. Give its relation with self information. (4)*K2*

Module III

15(A) A WSS process with autocorrelation $RX(\tau) = e{-}\alpha|\tau|$ is ap-plied to an LTI system with impulse response $h(t) = e{-}\beta t$ with $|\alpha| > 0$ and $|\beta| > 0$. Find the output power spectral density (10)K3

15(B) Give the conditions for stationarity in the strict sense. (4)*K2*

OR

16(A) Find an orthonormal basis set fot the set of signals (7)*K3*

$$s_1(t) = Asin(2\pi f_0 t); \qquad 0 \leq t \leq T$$

and

$$s_2(t) = Acos(2\pi f_0 t); \qquad 0 \leq t \leq T$$

where $f_0 = \frac{m}{T}$ where m is an integer.

16(B) Plot the above signal constellation and draw the decision region on it. Compute the probability of error. (7)*K3*

Module IV

17(A) Compute the probability of error for maximum likely hood detection of binary transmission. *(8)K3*

17(B) Explain the term matched filter. Plot the BER-SNR curve for a matched filter receiver (6)*K2*

OR

18(A) Design a zero forcing equalizer for the channel that is characterized by the filter taps *{*1,0.7,0.3*}* (8)*K3*

18(B) Explain partial rsponse signaling (6)*K2*

Module V

19 For a shift keying system defined by $s(t) = A_c\ k\sin(2\pi f_c t) \pm A_c k\cos(2\pi f_c t)$ plot the signal constellation. Compute the probability of error. (14)*K3*

OR

20(A) Derive the probability of error for a QPSK system with Gray coding. *(10)K3*

20(B) Draw the BER-SNR plot for a QPSK system (4)*K3*

ECT 305 Analog and Digital Communication Simulation Assignments

The following simulation assignments can be done with Python/MATLAB/ SCILAB/LabVIEW The following simulations can be done in MATLAB, Python,R or LabVIEW.

1 A-Law and μ-Law Characteristics

- Create a vector with say 1000 points that spans from −1 to 1.
- Apply A-Law companding on this vector get another vector. Plot it against the first vector for different A values and appreciate the transfer characteristics.
- Repeat the above steps for μ-law as well.

2 Practical A-Law compander

- Implement the 8-bit practical A-law coder and decoder in Appendix B 2 (pp 583–585) in *Digital Telephony by Bellamy*
- Test it with random numbers and speech signals. Observe the 15 levels of quantization.

3 Practical μ-Law compander

- Implement the 8-bit practical μ-law coder and decoder in Appendix B 1 (pp 579–581) in *Digital Telephony by Bellamy*
- Test it with random numbers and speech signals. Observe the 15 levels of quantization.

4 BPSK Transmitter and Receiver

- Cretae a random binary sequence of 5000 bit. Convert it into a bipolar NRZ code.
- Create a BPSK mapper that maps bit 0 to zero phase and bit 1 to π phase.
- Plot the real part of the mapped signal against the imaginary part to observe the signal constellation
- Add AWGN of difference variances to the base band BPSK signal and observe the changes in constellation.
- Realize the BPSK transmitter and receiver in Fig. 6.4 in pager 352 in

Communication Systems by Simon Haykin .

- Add AWGN of different variances and compute the bit error rate (BER) for different SNR values.
- Plot the BER Vs. SNR.
- Plot the theoretical BER-SNR curve, using Eq. 6.19 in pager 351 in *Communication Systems by Simon Haykin* .

5 QPSK Transmitter and Receiver

- Create a random binary sequence of 5000 bit. Convert it into a bipolar NRZ code.
- Create a QPSK mapper that maps bit patterns 00, 10, 11 and 01 to suitable phase values that are odd multiples of $\frac{\pi}{4}$
- Plot the real part of the mapped signal against the imaginary part to observe the signal constellation
- Add AWGN of difference variances to the base band QPSK signal and observe the changes in constellation.
- Realize the QPSK transmitter and receiver in Fig. 6.8 in page 359 in *Communication Systems by Simon Haykin* .
- Add AWGN of different variances and compute the bit error rate (BER) for different SNR values.
- Plot the BER Vs. SNR.
- Plot the theoretical BER-SNR curve, using Eq. 6.33 in page 358 in *Communication Systems by Simon Haykin* .

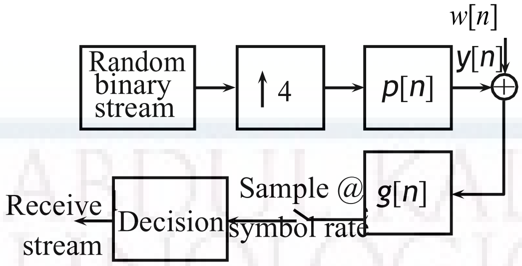
6 Matched Filter Receiver

The task is to develop a matched filter receiver, with zero ISI, as shown in the figure below.

- Generate 5000 random bits and up sample the stream by 4.
- For zero ISI, the impulse reponse of the transmitter and receiver filters are the RRC pulse with $\alpha = 0.2$.

$$p(t) = g(t) = (\frac{4\alpha}{\pi\sqrt{T}})[\frac{cos(1+\alpha)\frac{\pi t}{T} + \frac{T}{4\alpha t}sin(1-\alpha)\frac{\pi t}{T}}{1-(\frac{4\alpha t}{T})^2}] \qquad (1)$$

- Plot $p(t)$ and its approximate spectrum and apprecciate.



- Add AWGN ($w[n]$) of different variances and compute the BER-SNR curve for the bit patterns received.

ECT307	CONTROL SYSTEMS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to develop the skills for mathematical modelling of various control systems and stability analysis using time domain and frequency domain approaches.

Prerequisite: EC202 Signals & Systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	Analyse electromechanical systems by mathematical modelling and derive their transfer functions
CO 2	Determine Transient and Steady State behaviour of systems using standard test signals
CO 3	Determine absolute stability and relative stability of a system
CO 4	Apply frequency domain techniques to assess the system performance and to design a control system with suitable compensation techniques
CO 5	Analyse system Controllability and Observability using state space representation

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO 1	3	3	2		1							2
CO 2	3	3	2		1							2
CO 3	3	3	3		1							2
CO 4	3	3	3		1							2
CO 5	3	3	3		1							2

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
Analyse	K4			
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Analyse electromechanical systems by mathematical modelling and derive their transfer functions

1. For the given electrical/ mechanical systems determine transfer function.
2. Using block diagram reduction techniques find the transfer function of the given system.
3. Find the overall gain for the given signal flow graph using Mason's gain equation.

Course Outcome 2 (CO2): Determine Transient and Steady State behaviour of systems using standard test signals

1. Derive an expression for time response of a given first/ second order system to step/ ramp input.
2. Determine step, ramp and parabolic error constants for the given unity feedback control system.
3. Obtain the steady state error of a given system when subjected to an input.

Course Outcome 3 (CO3): Determine absolute stability and relative stability of a system

1. Using Ruth Hurwitz criterion, for the given control system determine the location of roots on S- plane and comment on the stability of the system.
2. Sketch the Root Locus for the given control system.

3. Compare P, PI and PID controllers.

Course Outcome 4 (CO4): Apply frequency domain techniques to assess the system performance and to design a control system with suitable compensation techniques

1. Explain frequency domain specifications.
2. Draw the Nyquist plot for the given control system and determine the range of K for which the system is stable.
3. Plot the bode plot for the given transfer function and find the gain margin and phase margin.
4. Describe the design procedure of a lag/ lead compensator.

Course Outcome 5 (CO5): Analyse system Controllability and Observability using state space representation

1. Obtain the state space representation of the given electrical/ mechanical system.
2. For the given control system, obtain the state equations and output equations:-
3. Plot the bode plot for the given transfer function and find the gain margin and phase margin.
4. Determine the controllability and observability of the given system.

SYLLABUS

Module 1:

Introduction: Basic Components of a Control System, Open-Loop Control Systems and Closed-Loop Control Systems, Examples of control system

Feedback and its effects: Types of Feedback Control Systems, Linear versus Nonlinear Control Systems, Time-Invariant versus Time-Varying Systems.

Mathematical modelling of control systems: Electrical Systems and Mechanical systems.

Transfer Function from Block Diagrams and Signal Flow Graphs: impulse response and its relation with transfer function of linear systems. Block diagram representation and reduction methods, Signal flow graph and Mason’s gain formula.

Module 2:

Time Domain Analysis of Control Systems: Introduction- Standard Test signals, Time response specifications.

Time response of first and second order systems to unit step input and ramp inputs, time domain specifications.

Steady state error and static error coefficients.

Frequency domain analysis: Frequency domain specifications, correlation between time and frequency responses.

Module 3:

Stability of linear control systems: Concept of BIBO stability, absolute stability, Routh Hurwitz Criterion, Effect of P, PI & PID controllers.

Root Locus Techniques: Introduction, properties and its construction, Application to system stability studies. Illustration of the effect of addition of a zero and a pole.

Module 4:

Nyquist stability criterion: Fundamentals and analysis

Relative stability: gain margin and phase margin. Stability analysis with Bode plot.

Design of Compensators: Need of compensators, design of lag and lead compensators using Bode plots.

Module 5:

State Variable Analysis of Linear Dynamic Systems: State variables, state equations, state variable representation of electrical and mechanical systems, dynamic equations, merits for higher order differential equations and solution.

Transfer function from State Variable Representation, Solutions of the state equations, state transition matrix

Concept of controllability and observability and techniques to test them - Kalman's Test.

Text Books

1. Farid Golnaraghi, Benjamin C. Kuo, Automatic Control Systems, 9/e, Wiley India.
2. I.J. Nagarath, M.Gopal: Control Systems Engineering (5th-Edition) —New Age International Pub. Co., 2007.
3. Ogata K., Discrete-time Control Systems, 2/e, Pearson Education.

Reference Books

1. I.J. Nagarath, M.Gopal: Scilab Text Companion for Control Systems Engineering (3rd-Edition) —New Age International Pub. Co., 2007.
2. Norman S. Nise, Control System Engineering, 5/e, Wiley India.
3. M. Gopal, Digital Control and State Variable Method, 4/e, McGraw Hill Education India, 2012.
4. Ogata K., Modern Control Engineering, Prentice Hall of India, 4/e, Pearson Education,2002.

5. Richard C Dorf and Robert H. Bishop, Modern Control Systems, 9/e, Pearson Education,2001.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Basic Components of a Control System, Open-Loop Control Systems and Closed-Loop Control Systems, Examples of control system	1
1.2	**Feedback and its effects:** Types of Feedback Control Systems, Linear versus Nonlinear Control Systems, Time-Invariant versus Time-Varying Systems	2
1.3	**Mathematical modelling of control systems:** Electrical Systems and Mechanical systems	3
	Transfer Function from Block Diagrams and Signal Flow Graphs	
1.4	Impulse response and its relation with transfer function of linear systems. Block diagram representation and reduction methods	2
	Signal flow graph and Mason's gain formula	2
2	**Time Domain Analysis of Control Systems**	
2.1	Introduction- Standard Test signals, Time response specifications	2
2.2	Time response of first and second order systems to unit step input and ramp inputs, time domain specifications	3
2.3	Steady state error and static error coefficients	2
2.4	**Frequency domain analysis:** Frequency domain specifications, correlation between time and frequency responses.	2
3	**Stability of linear control systems**	
3.1	Stability of linear control systems: concept of BIBO stability, absolute stability, Routh's Hurwitz Criterion	3
3.2	Effect of P, PI & PID controllers	3
	Root Locus Techniques	
3.3	Introduction, properties and its construction, Application to system stability studies. Illustration of the effect of addition of a zero and a pole	3
4	**Nyquist stability criterion**	
4.1	Fundamentals and analysis	2
4.2	**Relative stability:** gain margin and phase margin. Stability analysis with Bode plot	3
4.3	**Design of Compensators:** Need of compensators, design of lag and lead compensators using Bode plots	4

5	**State Variable Analysis of Linear Dynamic Systems**	
5.1	State variables, state equations	3
5.2	State variable representation of electrical and mechanical systems	2
5.3	Dynamic equations, merits for higher order differential equations and solution	2
5.4	Transfer function from State Variable Representation, Solutions of the state equations, state transition matrix	2
5.5	Concept of controllability and observability and techniques to test them - Kalman’s Test	4

Simulation Assignments

The following simulations can be done in Python/ Scilab/ Matlab/ LabView:

1. Plot the pole-zero configuration in s-plane for the given transfer function.
2. Determine the transfer function for given closed loop system in block diagram representation.
3. Plot unit step response of given transfer function and find delay time, rise time, peak time and peak overshoot.
4. Determine the time response of the given system subjected to any arbitrary input.
5. Plot root locus of given transfer function, locate closed loop poles for different values of k.
6. Plot bode plot of given transfer function and determine the relative stability by measuring gain and phase margins.
7. Determine the steady state errors of a given transfer function.
8. Plot Nyquist plot for given transfer function and determine the relative stability.
9. Create the state space model of a linear continuous system.
10. Determine the state space representation of the given transfer function.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B. TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT307

Course Name: CONTROL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

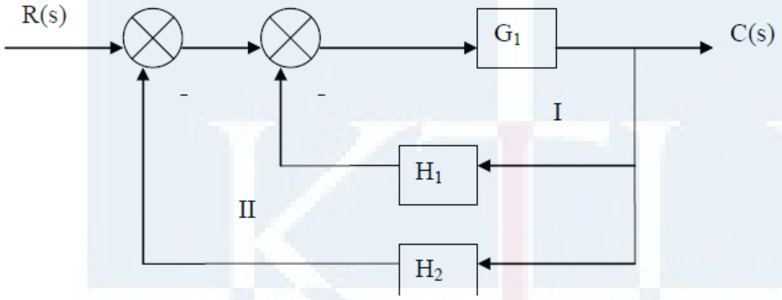
PART A

Answer ALL Questions. Each Carries 3 mark.

1 Draw the signal flow graph for the following set of algebraic equations: K2

$x_1=ax_0+bx_1+cx_2$, $x_2=dx_1+ex_3$

2 Using block diagram reduction techniques find C(s) / R(s) for the given system: K2



3 Derive the expression for peak time of a second order system K2

4 Determine the parabolic error constant for the unity feedback control system $G(s) = 10\ (S+2)/\ (s+1)\ s^2$ K3

5 Using Routh Hurvitz criterion, determine the number of roots in the right half of S-plane for the system $S^4+2S^3+10S^2+20S+5=0$. K3

6 Compare PI, PD and PID controllers. K1

7 State and explain Nyquist Stability criteria. K1

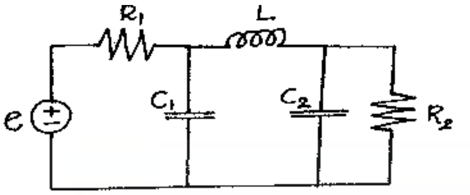
8 Briefly describe the design procedure of a lead compensator. K1

9 A dynamic system is represented by the state equation: K3

$$X= \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} r$$

Check whether the system is completely controllable.

10 Obtain the state space representation of the given electrical system: K3

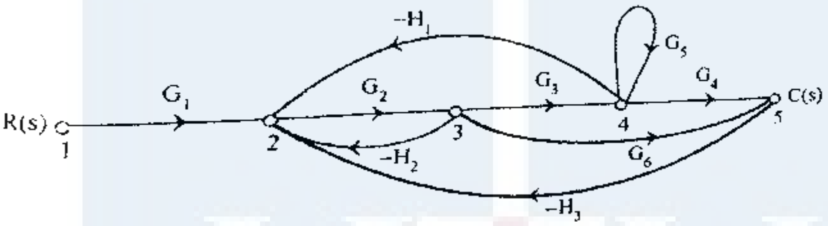


PART – B

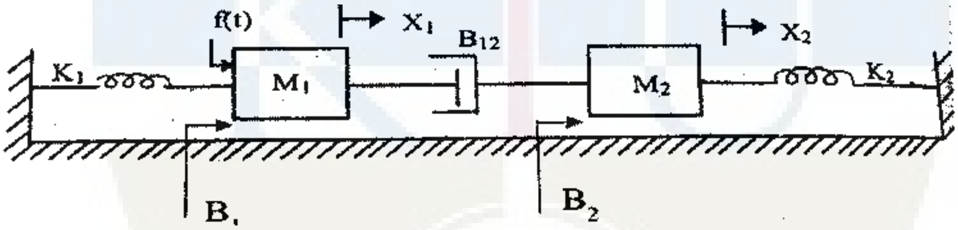
Answer one question from each module; each question carries 14 marks.

Module - I

11a. Find the overall gain C(s)/ R(s) for the signal flow graph shown using Mason's gain equation 7 CO1 K3

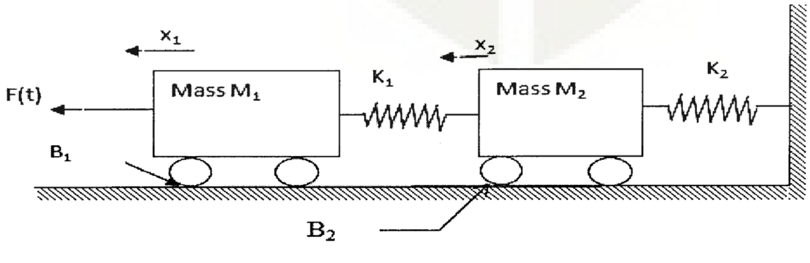


11b. Determine the transfer function $X_1(s)/ F(s)$ for the system shown below: 7 CO1 K3



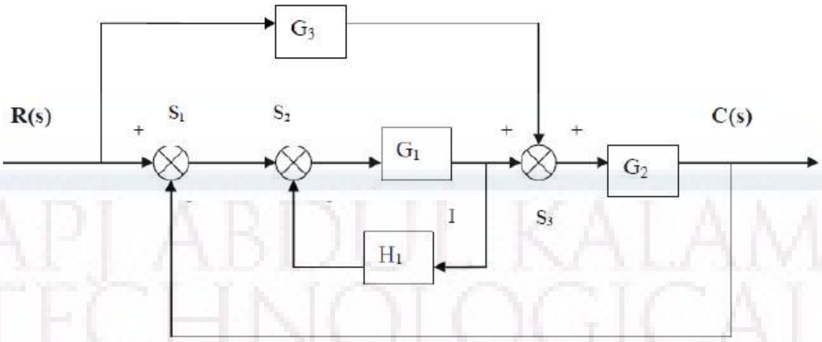
OR

12a. Find the transfer function $X_2(s)/ F(s)$. Also draw the force voltage analogy of the given system: 8 CO1 K3



12b.

Determine the overall transfer function of the block diagram shown in below figure: 6 CO1 K3



Module - II

13a. The open loop transfer function of a servo system with unity feedback is G(s) = 10/s(0.1s+1). Evaluate the static error constants of the system. Obtain the steady state error of the system when subjected to an input given by r(t)= $a_0+a_1t+a_2t^2/2$ 7 CO2 K2

13b. A unity feedback control system is characterized by an open loop transfer function G(s) = K/ s(s+10). Determine the gain K so that the system will have a damping ratio of 0.5 for this value of K. Determine the settling time, peak overshoot, rise time and peak time for a unit step input. 7 CO2 K2

OR

14a. Find kp, kv, ka and steady state error for a system with open loop transfer function G(s)H(s) = 15 (s+4) (s+9)/ s(s+3) (s+6) (s+8) 7 CO2 K2

14b. Derive the expression for time response of a second order under damped system to step input. 7 CO2 K2

Module - III

15a. Sketch the root locus for G(s)H(s) = K/ s(s+6) (s^2+4s+13) 7 CO3 K3

15b. The characteristic equation of a system is $s^7+9s^6+24s^5+24s^4+24s^3+24s^2+23s+15$. Determine the location of roots on S- plane and hence comment on the stability of the system using Ruth Hurwitz criterion. 7 CO3 K3

OR

16a. Prove that the breakaway points of the root locus are the solutions of dK/ds = 0. 7

16b. where K is the open loop gain of the system whose open loop transfer function is G(s). CO3 K2

17a. For a system with, F(s) = s4 + 22s3 + 10 s2 + s + K = 0. obtain the marginal value of K, and the frequency of oscillations of that value of K. 7 CO3 K3

Module - IV

17b. Plot the bode diagram for the transfer function G(S) = 10/ S(1+0.4S) (1+0.1S) and find the gain margin and phase margin. 7 CO4 K3

The open loop transfer function of a feedback system is given by G(s) = K / s (T1s+1) (T2s+1) Draw the Nyquist plot. Derive an expression for gain K in terms of T1, T2 and specific gain margin Gm. 7 CO4 K3

OR

18a. A servomechanism has an open loop transfer function of G(s) = 10 / s (1+0.5s) (1+0.1s) Draw the Bode plot and determine the phase and gain margin. A network having the transfer function (1+0.23s)/(1+0.023s) is now introduced in tandem. Determine the new gain and phase margins. Comment upon the improvement in system response caused by the network. 8 CO4 K3

18b. Draw the Nyquist plot for the system whose open loop transfer function is G(s)H(s) = K/ S(S+2) (S+10). Determine the range of K for which the closed loop system is stable. 6 CO4 K3

Module - V

19a. Obtain the state model for the given transfer function Y(s)/ U(s) = 1/ (S^2+S+1). 7 CO5 K3

19b. What is transfer matrix of a control system? Derive the equation for transfer matrix. 7 CO5 K2

OR

20a. A system is described by the transfer function Y(s)/ U(s) = 10 (s+4)/ s (s+2) (s+3). Find state and output equations of the system. 7 CO5 K3

20b. Determine the state transition matrix of 7 CO5 K3

$$A=\begin{bmatrix} 2 & 0 \\ -1 & 2 \end{bmatrix}$$

ECL331	ANALOG INTEGRATED CIRCUITS AND SIMULATION LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This course aims to (i) familiarize students with the Analog Integrated Circuits and Design and implementation of application circuits using basic Analog Integrated Circuits (ii) familiarize students with simulation of basic Analog Integrated Circuits.

Prerequisite: ECL202 Analog Circuits and Simulation Lab

Course Outcomes: After the completion of the course the student will be able to

CO 1	Use data sheets of basic Analog Integrated Circuits and design and implement application circuits using Analog ICs.
CO 2	Design and simulate the application circuits with Analog Integrated Circuits using simulation tools.
CO 3	Function effectively as an individual and in a team to accomplish the given task.

Mapping of course outcomes with program outcomes

	PO1	PO 2	PO3	PO 4	PO5	PO 6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	3	3						2			2
CO2	3	3	3	2	3				2			2
CO3	2	2	2		2				3	2		3

Assessment
Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	75	75	3 hours

Continuous Evaluation Pattern

Attendance	:	15 marks
Continuous Assessment	:	30 marks
Internal Test (Immediately before the second series test)	:	30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding awardof marks

(a) Preliminary work : 15 Marks
(b) Implementing the work/Conducting the experiment : 10 Marks
(c) Performance, result and inference (usage of equipments and trouble shooting): 25 Marks
(d) Viva voce : 20 marks
(e) Record : 5 Marks

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

Course Level Assessment Questions (Examples only)

Course Outcome 1 (CO1): Use data sheets of basic Analog Integrated Circuits and design and implement application circuits using Analog ICs.

1. Measure important opamp parameters of µA 741 and compare them with the data provided in the data sheet
2. Design and implement a variable timer circuit using opamp
3. Design and implement a filter circuit to eliminate 50 Hz power line noise.

Course Outcome 2 and 3 (CO2 and CO3): Design and simulate the application circuits with Analog Integrated Circuits using simulation tools.

1. Design a precission rectifier circuit using opamps and simulste it using SPICE
2. Design and simulate a counter ramp ADC

List of Experiments

I. Fundamentals of operational amplifiers and basic circuits [Minimum seven experiments are to be done]

1. Familiarization of Operational amplifiers - Inverting and Non inverting amplifiers, frequency response, Adder, Integrator, Comparators.
2. Measurement of Op-Amp parameters.
3. Difference Amplifier and Instrumentation amplifier.
4. Schmitt trigger circuit using Op–Amps.
5. Astable and Monostable multivibrator using Op-Amps.
6. Waveform generators using Op-Amps - Triangular and saw tooth
7. Wien bridge oscillator using Op-Amp - without & with amplitude stabilization.

8. RC Phase shift Oscillator.
9. Active second order filters using Op-Amp (LPF, HPF, BPF and BSF).
10. Notch filters to eliminate the 50Hz power line frequency.
11. Precision rectifiers using Op-Amp.

II. Application circuits of **555 Timer/565 PLL/ Regulator(IC 723) ICs** [Minimum three experiments are to be done]

1. Astable and Monostable multivibrator using Timer IC NE555
2. DC power supply using IC 723: Low voltage and high voltage configurations, Short circuit and Fold-back protection.
3. A/D converters- counter ramp and flash type.
4. D/A Converters - R-2R ladder circuit
5. Study of PLL IC: free running frequency lock range capture range

III. Simulation experiments [The experiments shall be conducted using SPICE]

1. Simulation of any three circuits from Experiments 3, 5, 6, 7, 8, 9, 10 and 11 of section I

2. Simulation of Experiments 3 or 4 from section II

Textbooks

1. D. Roy Choudhary, Shail B Jain, “Linear Integrated Circuits,”
2. M. H. Rashid, “Introduction to Pspice Using Orcad for Circuits and Electronics”, Prentice Hall

ECL333	DIGITAL SIGNAL PROCESSING LABORATORY	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble:

- The following experiments are designed to make the student do real time DSP computing.
- Dedicated DSP hardware (such as TI or Analog Devices development/evaluation boards) will be used for realization.

Prerequisites:

- ECT 303 Digital Signal Processing
- EST 102 Programming in C

Course Outcomes: The student will be able to

CO 1	Simulate digital signals.
CO 2	verify the properties of DFT computationally
CO 3	Familiarize the DSP hardware and interface with computer.
CO 4	Implement LTI systems with linear convolution.
CO 5	Implement FFT and IFFT and use it on real time signals.
CO 6	Implement FIR low pass filter.
CO 7	Implement real time LTI systems with block convolution and FFT.

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	3	1	2	3	0	0	0	3	0	0	1
CO2	3	3	1	2	3	0	0	0	3	0	0	1
CO3	3	3	3	2	3	0	0	0	3	1	0	1
CO4	3	3	1	2	3	0	0	0	3	0	0	1
CO5	3	3	1	1	3	0	0	0	0	0	0	1
CO6	3	3	1	1	3	0	0	0	0	0	0	1
CO7	3	3	1	3	3	0	0	0	3	3	0	0

Assessment Pattern

Mark Distribution:

Total Mark	CIE	ESE
150	50	100

Continuous Internal Evaluation Pattern:

Each experiment will be evaluated out of 50 credits continuously as

Attribute	Mark
Attendance	15
Continuous assessment	30
Internal Test (Immediately before the second series test)	30

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

Attribute	Mark
Preliminary work	15
Implementing the work/ Conducting the experiment	10
Performance, result and inference (usage of equipments and trouble shooting)	25
Viva voce	20
Record	5

Course Level Assessment Questions

CO1-Simulation of Signals

1. Write a Python/MATLAB/SCILAB function to generate a rectangular pulse.
2. Write a Python/MATLAB/SCILAB function to generate a triangular pulse.

CO2-Verfication of the Properties of DFT

1. Write a Python/MATLAB/SCILAB function to compute the N -point DFT

matrix and plot its real and imaginary parts.

2. Write a Python/MATLAB/SCILAB function to verify Parseval's theorem for $N = 1024$.

CO3-Familarization of DSP Hardware

1. Write a C function to control the output LEDs with input switches.
2. Write a C function to connect the analog input port to the output port and test with a microphone.

CO4-LTI System with Linear Convolution

1. Write a function to compute the linear convolution and download to the hardware target and test with some signals.

CO5-FFT Computation

1. Write and download a function to compute N point FFT to the DSP hardware target and test it on real time signal.
2. Write a C function to compute IFFT with FFT function and test in on DSP hardware.

CO6-Implementation of FIR Filter

1. Design and implement an FIR low pass filter for a cut off frequency of 0.1π and test it with an AF signal generator.

CO7-LTI Systems by Block Convolution

1. Implement an overlap add block convolution for speech signals on DSP target.

List of Experiments

(All experiments are mandatory.)

Experiment 1. Simulation of Signals Simulate the following signals using Python/ Scilab/MATLAB.

1. Unit impulse signal
2. Unit pulse signal
3. Unit ramp signal
4. Bipolar pulse
5. Triangular signal

Experiment 2. Verification of the Properties of DFT

- Generate and appreciate a DFT matrix.
    1. Write a function that returns the N point DFT matrix $\mathbf{V_N}$ for a given N.
    2. Plot its real and imaginary parts of $\mathbf{V_N}$ as images using *matshow* or *imshow* commands (in Python) for $N = 16$, $N = 64$ and $N = 1024$
    3. Compute the DFTs of 16 point, 64 point and 1024 point random sequences using the above matrices.
    4. Observe the time of computations for $N = 2^{\gamma}$ for 2 γ 18≤(Yo≤u may use the *time* module in Python).
    5. Use some iterations to plot the times of computation against γ. Plot and understand this curve. Plot the times of computation for the *fft* function over this curve and appreciate the computational saving with FFT.
- Circular Convolution.
    1. Write a python function *circcon.py* that returns the circular convoluton of an N_1 point sequence and an N_2 point sequence given at the input. The easiest way is to convert a linear convolution into circular convolution with $N = max(N_1, N_2)$.
- Parseval's Theorem

  For the complex random sequences $x_1[n]$ and $x_2[n]$,

$$\sum_{n=0}^{N-1} x_1[n]x_2^*[n] = \frac{1}{N}\sum_{k=0}^{N-1} X_1[k]X_2^*[k]$$

1. Generate two random complex sequences of say 5000 values.
2. Prove the theorem for these signals.

Experiment 3. Familarization of DSP Hardware

1. Familiarization of the code composer studio (in the case of TI hard- ware) or Visual DSP (in the case of Analog Devices hardware) or any equivalent cross compiler for DSP programming.
2. Familiarization of the analog and digital input and output ports of the DSP board.
3. Generation and cross compilation and execution of the C code to con- nect the input digital switches to the output LEDs.
4. Generation and cross compilation and execution of the C code to con- nect the input analog port to the output. Connect a microphone, speak into it and observe the output electrical signal on a DSO and store it.
5. Document the work.

Experiment 4. Linear convolution

1. Write a C function for the linear convolution of two arrays.
2. The arrays may be kept in different files and downloaded to the DSP hardware.
3. Store the result as a file and observe the output.
4. Document the work.

Experiment 5. FFT of signals

1. Write a C function for N - point FFT.
2. Connect a precision signal generator and apply 1 mV , 1 kHz sinusoid at the analog port.
3. Apply the FFT on the input signal with appropriate window size and observe the result.
4. Connect microphone to the analog port and read in real time speech.
5. Observe and store the FFT values.
6. Document the work.

Experiment 6. IFFT with FFT

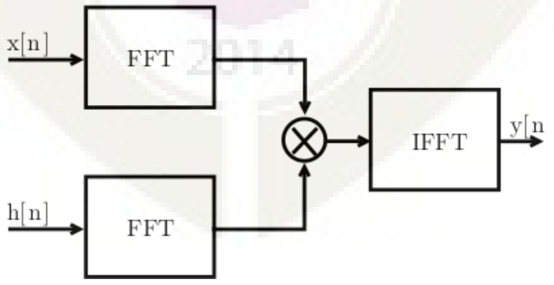
1. Use the FFT function in the previous experiment to compute the IFFT of the input signal.
2. Apply IFFT on the stored FFT values from the previous experiments and observe the reconstruction.
3. Document the work.

Experiment 7. FIR low pass filter

1. Use Python/scilab to implement the FIR filter response $h[n] = \frac{sin(\omega_c n)}{\pi n}$ for a filter size $N = 50$, $\omega_c = 0.1\pi$ and $\omega_c = 0.3\pi$.
2. Realize the hamming($w_H\,[n]$) and kaiser ($w_K[n]$) windows.
3. Compute $h[n]w[n]$ in both cases and store as file.
4. Observe the low pass response in the simulator.
5. Download the filter on to the DSP target board and test with 1 mV sinusoid from a signal generator connected to the analog port.
6. Test the operation of the filters with speech signals.
7. Document the work.

Experiment 8. Overlap Save Block Convolution

1. Use the file of filter coefficients From the previos experiment.
2. Realize the system shown below for the input speech signal $x[n]$.



3. Segment the signal values into blocks of length $N = 2000$. Pad the last

block with zeros, if necessary.

4. Implement the *overlap save* block convolution method
5. Document the work.

Experiment 9. Overlap Add Block Convolution

1. Use the file of filter coefficients from the previous experiment.
2. Realize the system shown in the previous experiment for the input speech signal $x[n]$.
3. Segment the signal values into blocks of length $N = 2000$. Pad the last block with zeros, if necessary.
4. Implement the *overlap add* block convolution method
5. Document the work.

Schedule of Experiments: Every experiment should be completed in three hours.

Textbooks

1. Vinay K. Ingle, John G. Proakis, “Digital Signal Processing Using MATLAB.”
2. Allen B. Downey, “Think DSP: Digital Signal Processing using Python.”
3. Rulph Chassaing, “DSP Applications Using C and the TMS320C6x DSK (Topics in Digital Signal Processing)”

SEMESTER V

MINOR

ECT381	EMBEDDED SYSTEM DESIGN	CATEGORY	L	T	P	CREDI T
		PCC	3	1	0	4

Preamble: This course aims to design an embedded electronic circuit and implement the same.

Prerequisite: ECT203 Logic Circuit Design, ECT206 Computer Architecture and Microcontrollers

Course Outcomes: After the completion of the course the student will be able to

CO 1 K2	Understand and gain the basic idea about the embedded system.
CO 2 K3	Able to gain architectural level knowledge about the system and hence to program an embedded system.
CO 3 K3	Apply the knowledge for solving the real life problems with the help of an embedded system.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3	2		1			2				2
CO 2	3	3	3		3			2				2
CO 3	3	3	3		3			2	3			2

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1) : Understand the embedded system fundamentals and system design (K1).

1. Give the challenges of embedded computing..
2. Give the structural description of embedded system.
3. What are the phases of EDLC?

Course Outcome 2 (CO2): Understand the peripheral devices and their interfacing with the processor. (K2)

1. Compare and contrast the PCI bus and PCI-X bus.
2. How the ROM memories are classified? Explain.
3. How the peripheral devices are connected with processors?

Course Outcome 3 (CO3): To write programs using high level languages for embedded systems. (K3)

1. Write an embedded C program for sorting 64 numbers stored in memory locations and find the smallest and largest number.
2. How the functions are called by using pointers in embedded 'C' ? Discuss with the help of examples.
3. Give the features of Object Oriented Programming.

Course Outcome 4 (CO4): To understand the ARM processor architecture and pipeline processor organization. (K2)

1. Give the architecture of the ARM processor and explain the registres.
2. Explain the pipelined architecture of ARM processor.
3. Write an ARM assembly language program to print the sum of two numbers.

Course Outcome 5 (CO5): To write programs in assembly and high level languages for ARM processor. (K3)

1. Write a note on Thumb single register in ARM processor.
2. Briefly discuss about the Advanced Microcontroller Bus Architecture (AMBA).
3. What are the data types supported by ARM programming high level languages.

SYLLABUS

Module 1 : Introduction to Embedded Systems(08 Hours)

1.1 Complex Systems and Microprocessors

Embedding Computers, Characteristics of Embedded Computing Applications, Application of Microprocessors, The Physics of Software, Challenges in Embedded Computing System, Characteristics and quality attributes of an embedded system, Performance in Embedded Computing

1.2 The Embedded System Design Process

Requirements, Specification , Architecture Design, Designing Hardware and Software Components and System Integration.

1.3 Formalisms for System Design

Structural Description, Behavioral Description, An embedded system design example.

1.4 Embedded product development cycle (EDLC)

Different phases of EDLC and EDLC models

Module 2 : Embedded system interfacing and peripherals (09Hours)

2.1 Communication devices

Serial Communication Standards and Devices - UART, HDLC and SPI. Serial Bus Protocols - I^2C Bus, CAN Bus and USB Bus, Parallel communication standards-ISA, PCI and PCI-X Bus.

2.2 Memory

Memory devices and systems :– ROM-Flash, EEPROM: RAM-SRAM, DRAM, Cache memory, memory mapping and addresses, memory management unit– DMA .

2.3 I/O Device

Interrupts:-Interrupt sources, recognizing an interrupt, ISR – Device drivers for handling ISR, Shared data problem, Interrupt latency.

Module 3 : Embedded Programming(11 Hours)

3.1 Programming languages:- Assembly Languages, High level languages, Embedded C, Object oriented programming, C++, JAVA.
3.2 Embedded C programming:- Keywords and Identifiers, Data Types, Storage Class, operators, branching, looping, arrays, pointers, characters, strings, functions, function pointers, structures, unions, pre-processors and macros, constant declaration, volatile type qualifier, delay generation, infinite loops, bit manipulation, ISR, direct memory allocation

Module 4 : ARM Processor fundamentals (07 Hours)

4.1 ARM Processor architecture:-The Acorn RISC Machine- Architectural inheritance, The ARM programmer's model, ARM development tools.
4.2 ARM Assembly Language Programming:-Data processing instructions, Data transfer instructions, Control flow instructions, writing simple assembly language programs.
4.3 ARM Organization and Implementation:-3 stage pipeline ARM organization, 5-stage pipeline ARM organization, ARM instruction execution, ARM implementation, The ARM coprocessor interface

Module 5: ARM Programming (10 Hours)

5.1 Architectural Support for High Level Languages :-Abstraction in software design, Data types, Floating-point data types, The ARM floating-point architecture, Expressions, Conditional statements, Loops, Functions and procedures, Use of memory, Run-time environment.
5.2 The Thumb Instruction Set :-The Thumb bit in the CPSR, The Thumb programmer's model, Thumb branch instructions, Thumb software interrupt instruction, Thumb data processing instructions, Thumb single register data transfer instructions, Thumb multiple register data transfer instructions, Thumb breakpoint instruction, Thumb implementation, Thumb applications.
5.3 Architectural Support for System Development:- The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA).

Text Books

1. Raj kamal, Embedded Systems Architecture, Programming and Design, TMH, 2003
2. K.V. Shibu, Introduction to Embedded Systems, 2e, McGraw Hill Education India, 2016.

3. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufman Publishers - Elsevier 3ed, 2008
4. Steve Furber, ARM system-on-chip architecture, Addison Wesley, Second Edition, 2000

Reference Books

1. David E. Simon, An Embedded Software Primer, Pearson Education Asia, First Indian Reprint 2000.
2. Steve Heath, Embedded Systems Design, Newnes – Elsevier 2ed, 2002
3. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide Designing and Optimizing System Software, Morgan Kaufmann Publishers 2004
4. Frank Vahid and Tony Givargis, Embedded Systems Design – A Unified Hardware / Software Introduction, John Wiley, 2002.
5. Tammy Noergaard, Embedded Systems Architecture, A Comprehensive Guide for Engineers and Programmers, Newnes – Elsevier 2ed, 2012
6. Iyer - Embedded Real time Systems, 1e, McGraw Hill Education New Delhi, 2003
7. Lyla B. Das, Embedded Systems: An Integrated Approach, 1/e , Lyla B. Das, Embedded Systems, 2012

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Embedded Systems**	
1.1	Complex Systems and Microprocessors	3
1.2	The Embedded System Design Process	1
1.3	Formalisms for System Design	2
1.4	Embedded product development cycle (EDLC)	2
2	**Embedded system interfacing and peripherals**	
2.1	Communication devices	3
2.2	Memory	3
2.3	I/O Device	3
3	**Embedded Programming**	
3.1	Programming languages	1
3.2	Embedded C programming	10
4	**ARM Processor**	
4.1	ARM Processor architecture	2
4.2	ARM Assembly Language Programming	3
4.3	ARM Organization and Implementation	2
5	**ARM Programming**	
5.1	Architectural Support for High-Level Languages	4
1	The Thumb Instruction Set	4
5.3	Architectural Support for System Development	2

Simulation Assignments:

1. At least one assignment should be of programming (Both assembly and C languages) of embedded processor with simulation tools like Keil, Eclipse.
2. Another assignment should be an embedded system design mini project like, Programming assignments can be the following
   a) Print "HELLO WORLD" or any text, b)Data transfer, copy operations c)Arithmetic operations d)Sorting operations, e)Input/output control, f)Programs using functions, g) Interrupts and ISR h) controller design
3. Mini project can be done in the following areas.
   a) Elevator controller design (b) Chocolate vending machine design (c) Industrial controller using sensors (d) IOT applications using sensors, communication devices and actuators

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT381

Course Name: EMBEDDED SYSTEM DESIGN

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer for all questions. Each Question Carries 3 marks)

1. Define an embedded system
2. Write any three challenges of embedded system design
3. Explain how an RS232 device is interfaced to a processor
4. What is interrupt latency?
5. What are the differences between assembly level language and high level language?
6. What is the difference between macros and functions?
7. Write the contents of CPSR register of ARM processor and their use.
8. Draw the five stage pipeline architecture of ARM processor
9. What is the use of thumb instruction set in ARM processor?
10. Write a note on ARM memory interface. [10 X 3 = 30 Marks]

PART – B

(Answer one question from each module; each question carries 14 Marks)

Module – I

11. a). What are the characteristics of an embedded system? Explain. [07 Marks]
b). Explain the different phases of EDLC. [07 Marks]

OR

(a) Write different steps involved in the embedded system design process. [07Marks]
(b) Explain the structural description of embedded system design. [07 Marks]

Module – II

12. (a) What is serial and parallel port communication? Explain with the help of necessary diagrams. [07 Marks]
(b) What is interrupt? How interrupts are handled in a processor? Explain ISR.[07 Marks]

OR

13. (a) With the help of a diagram show how ROM and RAM are interfaced to a processor. Explain the read/write processes. [07 Marks]
(b) Explain how a memory management unit is used in a processor. What are its uses? What is DMA ? [07 Marks]

Module – III

14. (a) What are the advantages and disadvantage of object oriented programming like C++ and Java. [07 Marks]
(b) Write an embedded C program for adding 64 numbers stored in memory locations and find the average of the same. [07 Marks]

OR

15. (a) What is pre-processor directive? How is a pre-processor directive instruction differentiated from normal program code? What are the different types of pre-processor directives available in 'Embedded C'? [07 Marks]
(b) Write an embedded C program to perform addition, subtraction, multiplication and division operations of 2 numbers stored in specific memory locations using a mode control . [07 Marks]

Module – IV

16. (a) Write a note on ARM processor architecture and its registers. [07 Marks]

(b) Write a note on data processing and data transfer instructions with the help of examples. [07 Marks]

OR

17. (a) What is pipelined architecture? Explain how an ARM instruction is executed in a five stage pipeline processor with the help of an example. [08 Marks]

(b) Write an ARM assembly language program to print text string "Hello World" .[06Marks]

Module – V

18. (a) Explain ARM floating point architecture and discuss how floating point numbers are handled. [07 Marks]

(b) Write a note on Thumb single register and multiple register data transfer instructions with the help of examples. [07 Marks]

OR

19. (a) What is Thumb instruction set? Why it is used? Explain Thumb programmers model. [07 Marks]

(b) Draw the block diagram of AMBA architecture. What are the different types of buses used in this architecture? [07 Marks]

ECT383	COMMUNICATION SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: The objective of this course to get awareness about various communication systems using in practice.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the components required for an Optical Communication Systems
CO2	Discuss the principle involved in RADAR and Navigation
CO3	Explain the concept and subsystems for Cellular Communication networks
CO4	Outline the requirement for Satellite communication systems
CO5	Discuss the role of different layers in TCP/IP protocol stack in communication networks

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										
CO2	3	3										
CO3	3	3										
CO4	3	3										
CO5	3	3										
CO6	3	3										

Assessment Pattern

Bloom's Category	Continuous Assessment Test		End Semester Examination
	1	2	
Remember, K1	10	10	10
Understand, K2	20	20	40
Apply, K3	20	20	50
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the components required for an Optical Communication Systems

1. Explain the block diagram for Optical Communication Systems
2. Distinguish between step index and graded index fiber
3. Explain various attenuations occurring in optical fiber

Course Outcome 2 (CO2): Discuss the principle involved in RADAR and Navigation

1. Explain Radar range equation and how the range of a radar system is increased?
2. Explain the block diagram for pulsed radar system
3. Explain Instrument landing system

Course Outcome 3 (CO3): Explain the concept and subsystems for Cellular Communication networks

1. What is frequency reuse?
2. Explain the principle of multicarrier communication
3. Explain GSM architecture

Course Outcome 4 (CO4): Outline the requirement for Satellite communication systems

1. Explain the block diagram for satellite uplink
2. What are geostationary satellites?
3. Explain various satellite orbits

Course Outcome 5 (CO5): Discuss the issues, challenges and architecture for various wireless ad hoc networks

1. Explain the issues and challenges of Wireless Ad Hoc Networks
2. What is 6LoWPAN?
3. Explain the function of each layer of TCP/IP protocol stack

Syllabus

Module 1 (Optical Communication)

Optical Communication System – Block Diagram – Advantages Of Optical Fiber Communication Systems – Principles Of Light Transmission In A Fiber Using Ray Theory – Single Mode Fibers, Multimode Fibers – Step Index Fibers, Graded Index Fibers (Basic Concepts Only) – Attenuation In Optical Fibers – Absorption Losses, Scattering Losses, Bending Losses, Core And Cladding Losses. **Optical transmitters**: LED and semiconductor LASER, characteristics, transmitter design. **Optical receivers**: Common photo detectors. Receiver design

Module 2 (Radar and Navigation)

Basic Radar System– Applications – Radar Range Equation (Qualitative Treatment Only) – Factors Influencing Maximum Range – Basic Pulsed Radar System – Block Diagram – Display Methods- A - Scope, PPI Display - Instrument Landing System – Ground Controlled Approach System.

Module 3 (Cellular Communication)

Cellular Communication, Hand off, Frequency Reuse, Principles of Multicarrier communication, Multiple Access techniques, CDMA Systems: General aspects of CDMA cellular systems, IS-95 standard, Downlink and uplink, GSM standard and service aspects – GSM architecture, Evolution to Third Generation systems, WCDMA and CDMA-2000 standards,4G, 5G

Module 4 (Satellite Communication)

Basic concept of satellite communication, Keppler's law, Satellite orbits, Geosynchronous satellites, Active and Passive satellite, Block diagram for Satellite uplink, Transponder and earth station receiver

Module 5 (Data Communication and Networks)

Study of OSI and TCP/IP protocol suit: The Model, Functions of each layer, TCP/IP Protocol Suites. Wireless Ad Hoc Networks: Issues and Challenges, Wireless Sensor Networks: Architecture, Data dissemination, Data gathering, MAC Protocols, Location discovery, Quality of a sensor network 6LoWPAN

Textbooks

1. Electronic communication system fundamentals Wayne Tomasi, Pearson Education.
2. Data Communication and Networking by Behrouz A. Forouzan (Fourth Edition), Tata McGraw Hill

References

1. Wireless communication principles and practice T S Rappaport, Pearson Education.
2. G. E. Keiser – Optical Fibre Communication – Mc Graw Hill Publication.
3. D. C. Agarwal – Satellite Communication – Khanna Publications

4. Jochen Schiller - Mobile Communications- Pearson Education
5. Siva ram Murthy, B S Manoj- Ad Hoc Wireless Networks – Printice Hall

Course Contents and Lecture Schedule

Sl No	Topic	No.of Lecture hours
1.1	**Module 1** Optical Communication System – Block Diagram – Advantages Of Optical Fiber Communication Systems – Principles Of Light Transmission In A Fiber Using Ray Theory – Single Mode Fibers, Multimode Fibers – Step Index Fibers, Graded Index Fibers (Basic Concepts Only) – Attenuation In Optical Fibers – Absorption Losses, Scattering Losses, Bending Losses, Core And Cladding Losses.	4
1.2	**Optical transmitters**: LED and semiconductor LASER, characteristics, transmitter design. **Optical receivers**: Common photo detectors. Receiver design	4
2.1	**Module 2** Basic Radar System– Applications – Radar Range Equation (Qualitative Treatment Only) – Factors Influencing Maximum Range – Basic Pulsed Radar System – Block Diagram – Display Methods- A - Scope, PPI Display	4
2.2	Instrument Landing System – Ground Controlled Approach System.	3
3.1	**Module 3** Cellular Communication, Hand off, Frequency Reuse, Principles of Multicarrier communication, Multiple Access techniques, CDMA Systems: General aspects of CDMA cellular systems, IS-95 standard, Downlink and uplink	5
3.2	GSM standard and service aspects – GSM architecture, Evolution to Third Generation systems, WCDMA and CDMA-2000 standards,4G, 5G	5
4.1	**Module 4** Basic concept of satellite communication, Keppler's law, Satellite orbits, Geosynchronous satellites	3
4.2	Active and Passive satellite, Block diagram for Satellite uplink, Transponder and earth station receiver	4
5.1	**Module 5** Study of OSI and TCP/IP protocol suit: The Model, Functions of each layer, TCP/IP Protocol Suites.	4
5.2	Issues and challenges in Wireless Ad Hoc Networks, Vehicular Ad Hoc Networks	2
5.3	Wireless Sensor Networks: Architecture, Data dissemination, Data gathering, MAC Protocols, Location discovery, Quality of a sensor network, 6LoWPAN	5

Sample Assignments

1. Explain the block diagram for optical communication systems
2. Write Radar range equation
3. Distinguish between A scope display and PPP display
4. Distinguish between step index and graded index fiber
5. Write Kepler’s law for planetary motion

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIFTH SEMESTER B.TECH. DEGREE EXAMINATION
ECT 383: Communication Systems
Max. Marks: 100 Duration: 3hours

PART A

(Answer all questions. Each question carries 3 marks each.)

1. Compare the advantages and disadvantages of fiber-optic cables and metallic cables
2. Define Numerical Aperture
3. Write the RADAR range equation
4. Explain the principle of A-scope display
5. Why a honeycomb pattern was is selected for cell area?
6. Distinguish between soft handoff and hard handoff
7. Define Apogee and Perigee
8. Define look angles, angle of elevation and azimuth
9. List the challenges of wireless ad hoc networks
10. Explain 3-way handshaking

PART B

(Answer any one question from each module. Each question carries 14 marks.)

Module 1

11. (a) Explain different losses in Optical Fiber cable
    (b) Explain the operation of LED
12. (a)Explain the block diagram for Optical Fiber Communication
    (b) Explain the function of photodiode

Module 2

13. Explain the block diagram for pulsed RADAR
14. Explain the principle of PPI display

Module 3

15. Explain the architecture for GSM
16. Explain block diagram for CDMA system

Module 4

17. Explain Kepler’s law of planetary motion
18. Explain the block diagram for satellite transponder

Module 5

19. Explain the role of each layer in TCP/IP protocol stack
20. Explain various data dissemination protocols used in wireless sensor networks

ECT385	TOPICS IN DIGITAL IMAGE PROCESSING	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to develop the skills for methods of various transformation and analysis of image enhancement, image reconstruction, image compression, image segmentation and image representation.

Prerequisite: ECT286 Introduction to Digital Signal Processing

Course Outcomes: After the completion of the course the student will be able to

CO 1	Analyze the various concepts and restoration techniques for image processing
CO 2	Differentiate and interpret the various image enhancement techniques
CO 3	Illustrate image segmentation algorithm
CO 4	Analyse basic image compression techniques

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2		1							2
CO 2	3	3	2		1							2
CO 3	3	3	3		1							2
CO 4	3	3	3		1							2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember K1	10	10	10
Understand K2	20	20	20
Apply K3	20	20	70
Analyse K4			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Analyze the various concepts and restoration techniques for image processing

1. For the given image check whether pixel P and Q have 8 connectivity .
2. Find filtered image using median filter.
3. Explain Weiner filtering.

Course Outcome 2 (CO2): Differentiate and interpret the various image enhancement techniques

1. Classify different image enhancement process. Differentiate between spatial domain and frequency domain techniques of image enhancement.
2. What is histogram equalisation? Briefly discuss the underlying logic behind histogram equalisation.
3. Apply mean and median filters over a given image.

Course Outcome 3 (CO3): Illustrate image segmentation algorithm

1. Name two basic approaches of image segmentation and mention their differences.
2. How can you decide optimal thresholds when the image contains a background and several foreground objects? Write down a corresponding algorithm.
3. Write down the region growing algorithm. What are its advantages and disadvantages.

Course Outcome 4 (CO4): Analyze basic image compression techniques

1. What do you mean by compression ratio? Do you consider that lower compression ratio ensures better images upon reproduction?
2. How can achievable compression ratio to be determined from image histogram?
3. Mention the steps of lossy and lossless JPEG compression

SYLLABUS

Module 1

Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures.

Brightness, contrast, hue, saturation, mach band effect, Colour image fundamentals-RGB, CMY, HIS models, 2D sampling, quantization.

Module 2

Image Enhancement: Spatial domain methods: point processing-intensity transformations, histogram processing, image subtraction, image averaging, geometric transformation
Sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.

Module 3

Image segmentation: Classification of Image segmentation techniques, region approach, clustering techniques
Classification of edges, edge detection, Hough transform, active contour
Thresholding – global and adaptive

Module 4

Image restoration: Restoration Models, Linear Filtering Techniques: Inverse and Wiener, Non linear filtering: Mean, Median, Max and Min filters
Noise Models: Gaussian, Uniform, Additive, Impulse
Image restoration applications

Module 5

Image Compression- Need for compression, redundancy, classification of image compression schemes, Huffman coding, arithmetic coding
Redundancy–inter-pixel and psycho-visual; Lossless compression – predictive, entropy; Lossy compression- predictive and transform coding – DST, DCT, wavelet transform (basics only); Still image compression standards – JPEG and JPEG-2000

Text Books

1. Farid Gonzalez Rafel C, Digital Image Processing, Pearson Education, 2009
2. S Jayaraman, S Esakkirajan, T Veerakumar, Digital image processing ,Tata Mc Graw Hill, 2015

Reference Books

1. Jain Anil K, Fundamentals of digital image processing, PHI 1988
2. Kenneth R Castleman, Digital image processing, Pearson Education, 2/e, 2003
3. Pratt William K, Digital Image Processing, John Wiley,4/e, 2007.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition	1
1.2	Image sampling and quantization, basic relationships between pixels – neighbourhood, adjacency, connectivity, distance measures	2
1.3	Brightness, contrast, hue, saturation, mach band effect	3
1.4	Impulse response and its relation with transfer function of linear systems. Block diagram representation and reduction methods	3
1.5	2D sampling, quantization	1
2	**Image Enhancement**	
2.1	Spatial domain methods: point processing-intensity transformations	1
2.2	Histogram processing, image subtraction, image averaging, geometric transformations	3
2.3	Sharpening filters	2
2.4	First and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass	1
3	**Image segmentation:**	
3.1	Spatial domain methods: point processing-intensity transformations	3
3.2	Classification of Image segmentation techniques, region approach, clustering techniques	2
3.3	Classification of edges, edge detection, Hough transform, active contour	2
3.4	Thresholding – global and adaptive	3
4	**Image Restoration:**	
4.1	Restoration Models -Noise Models : Gaussian , Uniform, Additive, Impulse and Erlang	2
4.2	Linear Filtering Techniques : Inverse and Wiener	3
4.3	Non linear filtering: Mean, Median, Max and Min filters	2
4.3	Applications of Image restoration	1
5	**Image Compression-**	
5.1	Need for compression, redundancy,	1

5.2	classification of image compression schemes, Huffman coding, arithmetic coding	2
5.3	Redundancy–inter-pixel and psycho-visual;	1
5.4	Lossless compression – predictive, entropy;	2
5.5	Lossy compression- predictive and transform coding DST, wavelet	2
5.6	Still image compression standards – JPEG and JPEG-2000	1

Simulation Assignments

The following simulation assignments can be done with Python/MATLAB/ SCILAB/LabVIEW

1 Simple Image Processing Operations

- Read a gray scale image like *Lena* or *ascent*, available in the platform.
- Print the pixel values in $[0, 255]$ and appreciate them.
- Show the image.
- Observe the histogram of this image and appreciate it.
- Apply a nonlinear transformation such as logarithm of pixels and observe the changes in intensity due to compression/ expansion of pixel values.
- Plot the histogram of the transformed image over the previous histgram and appreciate the changes.
- Apply cropping to the image and observe the cropped values.
- transform the gray scale image to a binary image by setting all values above 127 to 255 and those below to 0 and observe the binary image.
- Read in a color image and separate the RGB channels and observe them in color separately.
- Apply the logarithmic transfomation to all channels separately and combined the transformed images to form a new color image and com-pare with the original color image.

2 Image Compression with Singular Value De-composition

- Read in a gray scale and read the pixel values (I) into an array.
- Apply singular value decomposition of this array as

$$\tilde{I} = \sum_{i=0}^{Q} \lambda_i U_i V_i^T$$

- Plot the eiegn values and appreciate their fading in magnitude.
- Take the first $Q = 10$ eigen values and make the rest zero.
- Now reconstruct a compressed image for $Q = 10$, $Q = 100$ and appreciate the compression ratios.
- Take a picture of your face and crop it ito suitable dimensions and apply the previous steps and observe the compression by SVD.

3 Filters for Noise Removal

- Read in a gray scale image and observe it.
- Add AWGN to it of known variance.
- Construct mean and median filters and apply on the noisy images and observe the removal of noise.
- Quantify the noise removal by computing the SNR and PSNR values as

  $$SNR = 10\log_{10}\left[\frac{\sum\limits_{n_1}\sum\limits_{n_2} r^2[n_1,n_2]}{\sum\limits_{n_1}\sum\limits_{n_2}[r^2[n_1,n_2]-t^2[n_1,n_2]]}\right]$$

  The peak value of the SNR is expressed as

  $$PSNR = 10\log_{10}\left[\frac{\max\left(r^2[n_1,n_2]\right)}{\frac{1}{N_1N_2}\sum\limits_{n_1}\sum\limits_{n_2}[r^2[n_1,n_2]-t^2[n_1,n_2]]}\right]$$

  where r denotes the reference image and t denotes the test image.
- Plot these values against different noise variances for mean and median filters and appreciate.

4 Gaussian Filter for Smoothing

- Read in a gray scale image and observe it.
- Realize a Gaussian kernel with impulse response

  $$h = \frac{1}{273}\begin{bmatrix} 1 & 4 & 7 & 4 & 1 \\ 4 & 16 & 26 & 16 & 4 \\ 7 & 26 & 41 & 26 & 7 \\ 4 & 16 & 26 & 16 & 4 \\ 1 & 4 & 7 & 4 & 1 \end{bmatrix}$$

- Perfom the two dimensional convolution and observe the smoothinng, Also observe the blurring.
- Make the image noisy and repeat the procedure.
- Assess the visual quality of the image after Gaussian smoothing by computing teh structural similarity index as

  $$SSIM(\mathbf{x},\mathbf{y}) = \frac{(2\mu_x\mu_y + C_1)(2\sigma_{xy} + C_2)}{(2\mu_x^2 + 2\mu_y^2 + C_1)(2\sigma_x^2 + 2\sigma_y^2 + C_2)}$$

  The parameters μ_x and μ_y are the means and σ_x^2 and σ_y^2 are the variances of $\mathbf{x}$ and $\mathbf{y}$ respectively. σ_{xy}^2 is the covariance between $\mathbf{x}$ and $\mathbf{y}$. C_1 and C_2 are non-zero constants included to avoid unstable results when $\sigma_x^2 + \sigma_y^2$ or $\mu_x^2 + \mu_y^2$ is very close to zero.
- One may take $\mathbf{x}$ as the input image and $\mathbf{y}$ as the filtered image and appreciate the performance of the filter.

5 Edge Detection Filters

- Read in a grayscale image.
- Construct a Laplacian filter with kernel

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

- Apply Laplacian filter to the image and observe the edges.
- Test the invulnerability of edge detection to noise. Add noise to the signal of known variance and extract edges.
- Compute the cripness of the edges (κ) with

$$\kappa = \frac{1}{N_1 N_2} \sum_{n_1} \sum_{n_2} \frac{|\sigma^2_{l[n_1,n_2]_{test}} - \sigma^2_{l[n_1,n_2]_{ref}}|}{\sigma^2_{l[n_1,n_2]_{ref}} \mu_{l[n_1,n_2]_{ref}}}$$

  where the reference image is the output of filter without noise and the test image is the one with noise.

- Plot κ for different noise variances.
- Use the Gaussian kernel in Sec. 4 to perfom two dimnsion convolution an the image.
- Perform Laplacian filtering on the resultant image to perform Laplacian of Gaussian (LoG) filtering. Observe the edges detected.
- Compute κ for different noise variances and compare the plots with those of Laplacian and understand the noise invulnerability of LoG filter.

6 Image Compression with DCT

- Read in a gray scale image.
- Apply type-II DCT and observe the coefficient.
- Make DCT coefficients that are less than 20% of the maximum equal to zero.
- Take inverse DCT and observe the image. Compute the compression ratio.
- Repeat for 30%, 40% and 50% values and observe the compressed image and the compression ratios.

SEMESTER V

HONOURS

ECT393	FPGA BASED SYSTEM DESIGN	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to develop the skill of FPGA based system design.

Prerequisite: ECT203 Logic Circuit Design

Course Outcomes: After the completion of the course the student will be able to

CO 1	Design simple digital systems with programmable logic devices
CO 2	Analyze the architecture of FPGA
CO 3	Analyze the design considerations of FPGA
CO4	Design simple combinational and sequential circuits using FPGA

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3			2							2
CO 2	3	3			2							2
CO 3	3	3			2							2
CO 4	3	3			2							2

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyze	K4			
Evaluate				
Create				

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10marks
Continuous Assessment Test(2numbers) : 25marks
Assignment/Quiz/Course project : 15marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Design simple digital systems with programmable logic devices.

1. Design a decade counter using Verilog.
2. Implement a full adder using ROM

Course Outcome 2 (CO2): Analyze the architecture of FPGA

1. Compare coarse and fine grained FPGA.
2. Explain the architecture of logic block of FPGA

Course Outcome 3 (CO3): Analyze the design considerations of FPGA

1. What are the vendor specific issues in FPGA design.
2. Analyze Timing and Power dissipation in a typical FPGA.

Course Outcome 4 (CO4): Design simple combinational and sequential circuits using FPGA.

1. Implement a counter in Xilinx Virtex.
2. Explain how sequential circuit can be mapped into Xilinx Virtex LUT.

SYLLABUS

Module 1:

Introduction: Digital system design options and tradeoffs, Design methodology and technology overview, High Level System Architecture and Specification: Behavioral modelling and simulation, Hardware description languages (emphasis on Verilog), combinational and sequential design, state machine design, synthesis issues, test benches.

Module 2:

Programmable logic Devices: ROM, PLA, PAL, CPLD, FPGA Features, Limitations, Architectures and Programming. Implementation of MSI circuits using Programmable logic Devices.

Module 3:

FPGA architecture: FPGA Architectural options, granularity of function and wiring resources, coarse V/s fine grained, vendor specific issues (emphasis on Xilinx and Altera), Logic block architecture: FPGA logic cells, timing models, power dissipation I/O block architecture: Input and Output cell characteristics, clock input, Timing, Power dissipation.

Module 4:

Placement and Routing: Programmable interconnect - Partitioning and Placement, Routing resources, delays; Applications -Embedded system design using FPGAs, DSP using FPGAs.

Module 5:

Commercial FPGAs: Xilinx, Altera, Actel (Different series description only), Case study Xilinx Virtex: implementation of simple combinational and sequential circuits.

Text Books

1. FPGA-Based System Design Wayne Wolf, Verlag: Prentice Hall
2. Modern VLSI Design: System-on-Chip Design (3rd Edition) Wayne Wolf, Verlag

Reference Books

1. Field Programmable Gate Array Technology - S. Trimberger, Edr, 1994, Kluwer Academic
2. Digital Design Using Field Programmable Gate Array, P.K. Chan & S. Mourad, 1994, Prentice Hall
3. Field programmable gate array, S. Brown, R.J. Francis, J. Rose, Z.G. Vranesic, 2007, BS

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction**	
1.1	Digital system design options and tradeoffs	1
1.2	Design methodology and technology overview	2
1.3	High Level System Architecture and Specification: Behavioral modelling and simulation	2
1.4	Hardware description languages, combinational and sequential design	2
1.5	State machine design, synthesis issues, test benches.	2
2	**Programmable logic Devices**	
2.1	ROM, PLA, PAL, CPLD	3
2.2	FPGA Features, Limitations, Architectures and Programming.	2
2.3	Implementation of MSI circuits using Programmable logic Devices.	3
3	**FPGA architecture**	
3.1	FPGA Architectural options	1
3.2	Granularity of function and wiring resources, coarse V/s fine grained, vendor specific issues (emphasis on Xilinx and Altera)	3
3.3	Logic block architecture: FPGA logic cells, timing models, power dissipation	3
3.4	I/O block architecture: Input and Output cell characteristics, clock input, Timing, Power dissipation.	3
4	**Placement and Routing**	
4.1	Programmable interconnect - Partitioning and Placement	3
4.2	Routing resources, delays	3
4.3	Applications -Embedded system design using FPGAs, DSP using FPGAs	3
5	**Commercial FPGAs**	
5.1	Xilinx, Altera, Actel (Different series description only)	2
5.2	Case study Xilinx Virtex	4
5.3	Implementation of simple combinational and sequential circuits	3

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT393

Program: Electronics and Communication Engineering

Course Name: FPGA Based System Design

Max.Marks: 100 Duration: 3Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	What are the synthesis issues in FPGA design.	K2
2	Describe FPGA design methodology.	K2
3	Differentiate PLA with PAL	K2
4	What are the limitations of FPGA.	K2
5	Compare coarse and fine grained FPGA architecture.	K2
6	What are the timing models in logic block architecture.	K2
7	List the applications of FPGA.	K2
8	Describe routing resources in FPGA routing.	K2
9	Describe how a combnational circuit can be mapped into Xilinx Virtex LUT.	K2
10	List different commercially available FPGAs.	K2

PART – B

Answer one question from each module; each question carries 14 marks.

Module – I

11. a)	Design a full adder using Verilog.	7	CO1	K3
11. b)	Explain behavioral modeling and simulation with an example.	7	CO1	K2
	OR			
12.a)	What is FSM? How it is used for FPGA.	7	CO1	K2
12.b)	Explain the purpose of test bench and how it is written in a HDL.	7	CO1	K2

Module – II

13 a)	Design the function F=XYZ'+Y' Z+X Y' using PLA	8	CO2	K3
13 b)	Compare CPLD with FPGA	6	CO2	K2
	OR			
14 a)	Implement the following Boolean function using PAL: F(w, x, y, z) = Σm (0, 2, 4, 10, 11, 12, 14, 15)m (0, 2, 4, 10, 11, 12, 14, 15)	8	CO2	K3
14 b)	Draw the structure of PAL and explain it.	6	CO2	K2

Module – III

15 a)	Draw and explain I/O block architecture of FPGA.	7	CO2	K2
15 b)	Draw and explain coarse grained FPGA architecture.	7	CO2	K2
	OR			
16 a)	Explain timing and power dissipation in Logic block and I/O block.	7	CO2	K2
16 b)	Draw and explain fine grained FPGA architecture.	7	CO2	K2

Module – IV

17 a)	Explain partitioning and placement processes in FPGA	8	CO4	K2
17 b)	Explain embedded system design using FPGAs	6	CO4	K2
	OR			
18 a)	Explain the delays associated with placement and routing	7	CO4	K2
18 b)	Explain DSP design using FPGAs	7	CO4	K2

Module – V

19 a)	With neat diagram explain the architecture of Xilinx Virtex IOB.	7	CO3	K2
19 b)	Design a four bit up counter with parallel load feature using Xilinx Virtex.	7	CO3	K3
	OR			
20 a)	Explain the mapping of combinational and sequential circuits using LUTs.	5	CO3	K3
20 b)	Explain the architecture of Xilinx Virtex CLB	9	CO3	K2

ECT395	DETECTION AND ESTIMATION THEORY	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to impart the fundamentals of detection and estimation theory in engineering applications

Prerequisite: MAT 101 Linear Algebra and Calculus
MAT 204 Probability, Random Process, and Numerical Methods
ECT 204 Signals and Systems

Course Outcomes: After the completion of the course the student will be able to

CO1 K2	Understand the fundamentals of statistical detection and estimation principles used in various engineering problems.
CO2 K3	Apply various types of statistical decision rules in engineering applications.
CO3 K3	Apply different types of estimation algorithms in engineering applications.

Mapping of course outcomes with program outcomes

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO11	PO12
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember			
Understand K2	30	30	60
Apply K3	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the fundamentals of statistical detection and estimation principles used in various engineering problems. (K2)

1. Differentiate estimation and detection techniques.

2. Differentiate classical approach and bayesian approch in detection theory (or estimation).

3. Enumerate different applications which are using estimation and detection techniques.

4. Give the mathematical formulation of estimation and detection methods.

5. Draw receiver operating characteristics with all details

6. Give the significance of Bayes risk

7. How multiple hypothesis testing is done.

8. Give the significance of linear models in estimation and detection theory.

9. Significance of Cramer-Rao Lower Bound in estimation.

10. Differentiate MAP and ML methods in estimation (or detection).

Course Outcome 2 (CO2): Apply various types of statistical decision rules in engineering applications. (K3)

1. Describe Neyman-Pearson theorem (or Bayes risk or minimization of probability of error) and apply it to any binary hypothesis (eg. Signal in white Gaussian noise)

2. Derive/Obtain the matched filters for the detection of deterministic signals

3. Derive/Obtain the estimator-correlator for the detection of random signals

Course Outcome 3 (CO3): Apply different types of estimation algorithms in engineering applications. (K3)

1. Derive/Obtain the Minimum variance unbiased estimator (or best linear unbiased estimator) for any simple examples (eg. DC Signal in white Gaussian noise)
2. Derive/Obtain the Maximum likelihood estimator (or least squares estimator or minimum mean square error estimator) for any simple examples (eg. DC Signal in white Gaussian noise)
3. Using Bayesian approach, obtain an estimator for any simple examples.

SYLLABUS

Module 1 : Introduction to Detection and Estimation Theory

Fundamentals of detection theory, the mathematical detection problem. Fundamentals of estimation theory, the mathematical estimation problem. Review of Gaussian distribution. Application examples.

Module 2 : Statistical Detection Theory I

Hypothesis testing, classical approach, Neyman-Pearson theorem, likelihood ratio test, receiver operating characteristics, Bayesian approach, minimum probability of error, Bayes risk, multiple hypothesis testing.

Module 3 : Statistical Detection Theory II

Detection of deterministic signals, matched filters, detection of random signals, estimator-correlator, linear model, application examples.

Module 4 : Statistical Estimation Theory I

Minimum variance unbiased estimation, basics of Cramer-Rao Lower Bound, linear models, best linear unbiased estimation, application examples.

Module 5 : Statistical Estimation Theory II

Maximum likelihood estimation, least squares, Bayesian philosophy, minimum mean square error estimation, application examples.

Text Books

1. S.M. Kay, “Fundamentals of Statistical Signal Processing” Vol I: Estimation Theory, Pearson, 3/e, 2010.
2. S.M. Kay, “Fundamentals of Statistical Signal Processing” Vol II: Detection Theory, Pearson, 3/e, 2010.

Reference Books

1. H. L. Van Trees, “Detection, Estimation, and Modulation Theory”, Vol. I, John Wiley & Sons, 1968
2. Monson H. Hayes ,“Statistical Digital Signal Processing and Modelling" by, John Wiley & Sons, 2002.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Detection and Estimation Theory**	
1.1	Fundamentals of detection theory, review of probability and random variable	2
1.2	The mathematical detection problem	2
1.3	Fundamentals of estimation theory	1
1.4	The mathematical estimation problem	2
1.5	Review of Gaussian distribution. Application examples.	2
2	**Statistical Detection Theory I**	
2.1	Hypothesis testing	2
2.2	Classical approach, Neyman-Pearson theorem	2
2.3	Likelihood ratio test, Receiver operating characteristics	2
2.4	Bayesian approach, minimum probability of error, Bayes risk	2
2.5	Multiple hypothesis testing.	1
3	**Statistical Detection Theory II**	
3.1	Detection of deterministic signals	1
3.2	Matched filters	2
3.3	Detection of random signals	2
3.4	Estimator-correlator	2
3.5	Linear model, application examples.	2
4	**Statistical Estimation Theory I**	
4.1	Minimum variance unbiased estimation	2
4.2	Basics of Cramer-Rao Lower Bound	2
4.3	Linear models	2
4.4	Best linear unbiased estimation	2
4.5	Application examples	1
5	**Statistical Estimation Theory II**	
5.1	Maximum likelihood estimation	2
5.2	Least squares solution	2
5.3	Bayesian philosophy	2
5.4	Minimum mean square error estimation	2
5.5	Application examples	1

Simulation Assignments (using MATLAB or Python)

1. Generate and familiarize PDF and CDF of Normal distribution.
2. Generate DC level in White Gaussian Noise.
3. Simulate a Neyman-Pearson Detector.
4. Simulate a Maximum Likelihood Estimator.
5. Simulate a Best Linear Unbiased Estimator.

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIFTH SEMESTER B.TECH DEGREE EXAMINATION

ECT 395 - Detection and Estimation Theory

Max. Marks: 100 Duration: 3 hrs

PART A

*(Answer **all** questions. Each question carries 3 marks each).*

1. Enumerate different applications which are using estimation and detection techniques. (3)
2. Differentiate estimation and detection techniques. (3)
3. Differentiate classical approach and bayesian approch in detection theory. (3)
4. Give the mathematical formulation of detection methods. (3)
5. Draw receiver operating characteristics with all details (3)
6. Give the significance of Bayes risk (3)
7. Give the significance of linear models in estimation theory. (3)
8. Significance of Cramer-Rao Lower Bound in estimation. (3)
9. What is Minimum Variance Unbiased Estimation? (3)
10. Differentiate MAP and ML methods in estimation. (3)

PART B

*(Answer any **one** question from each module. Each question carries 14 marks each.)*

Note:

(1) Notation $x \sim \mathrm{N}(\mu, \sigma^2)$ denotes x is normally distributed with mean μ and variance σ^2.

(2)Also, bold small letters indicate vectors and bold capital letters indicate matrices.

11. Obtain the mathematical formulation of estimation method with an example. (14)

OR

12 Using radar system as an example, differentiate estimation and detection techniques. (14)

.

13. Design Neyman-Pearson detector for the unknown level A in White Gaussian Noise with variance σ^2. (14)

OR

14. Describe the Bayesian approaches in the design of detectors. (14)

15. Obtain Matched Filter detector for N-sample deterministic signal in noise, $w[n] \sim \mathrm{N}(0, \sigma^2_n)$ where $w[n]$'s are uncorrelated. (14)

OR

16. Describe estimator-correlator in the detection of random signals. (14)

17. Consider the multiple observations (14)

$$x[n] = A + w[n]; \quad n = 0, 1, \ldots, N-1$$

where $w[n] \sim \mathrm{N}\ (0, \sigma^2)$. Determine CRLB for A?

OR

18. Derive the Best Linear Unbiased Estimator for the multiple observations (14)

$$x[n] = A + w[n]; \quad n = 0, 1, \ldots, N-1$$

where A is an unknown level to be estimated and $w[n]$ is White Noise with unspecified PDF and variance σ^2.

19. Derive the Maximum Likelihood Estimator for the multiple observations (14)

$$x[n] = A + w[n]; \quad n = 0, 1, \ldots, N-1$$

where A is an unknown level to be estimated and $w[n]$ is White Gaussian Noise with known variance σ^2.

OR

20.Prove that the optimal estimator which minimizes the Bayesian Mean Square Error is the mean of the posterior PDF.

(14)

ECT397	**COMPUTATIONAL TOOLS FOR SIGNAL PROCESSING**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		VAC	**3**	**1**	**0**	**4**

Preamble: This course aims to use the computational tools in signal processing to solve industry problems.

Prerequisite: ECL201 Scientific Computing Lab, ECT204 Signals and Systems, ECT303 Digital Signal Processing

Course Outcomes: After the completion of the course the student will be able to

CO 1	Compute posterior probability using pymc3 for practical applications
CO 2	Compute linear and logistic regression with pymc3
CO 3	Perform Bayesian analysis for practical applications.
CO 4	Implement Kalman filters
CO 5	Implement partcle fillters for practical applications

Mapping of course outcomes with program outcomes

	PO1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3			3							2
CO 2	3	3	2	3	3							2
CO 3	3	3	2	3	3	2						2
CO 4	3	3	2	3	3	2						2
CO 5	3	3	2	3	3	2						2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Computing posterior probability with pymc3

1. Write Python code to compute the posterior distribution of a 10X10 Gaussian random data set.
2. Write Python functio to compute the autocorrelation of a 5X5 unform random data.

Course Outcome 2 (CO2): Compute linear and logistic regression with pymc3

1. Write a python code to design a regression model by coding setosa =0, versicolor =1, and virginica = 2 in IRIS data set.?
2. Write a python code usig pymc3 to estimate regression parameters using a simple linear model y~ax+b, where y is Normally distributed with mean ax+b and variance σ2

Course Outcome 3 (CO3): Perform Bayesian analysis for practical applications.

1. Write a python code using pymc3 to compute the bayes factor for the coin toss using a uniform prior beta(1,1) . Set p(heads)=0.5
2. Write a python code using pymc3 to implement a bauesian regression model with intercept1 and slope 3.Use posterior predictive checks to validate the model

Course Outcome 4 (CO4): Implement Kalman filters.

1. Write a python code to predict a random walk using discrete Bayes filter
2. Write a python code to track the movement of an accelerating aircraft using Kalman filter

Course Outcome 5 (CO5): Implement partcle fillters for practical applications

1. Write a python code using pymc3 to create a model that specifies the posterior probability of human sleeping pattern as a function of time using MCMC method.
2. Write a python code to track a robotic movement using Particle Filter

SYLLABUS

Module 1 Probabilistic Programming

Statistical Modelling using pymc3, Probability concepts, Bayes theorem, Bayesian Statistics and modelling, Modelling Coin flipping as Bayesian, Choosing the likelihood and prior, Posterior computation, Posterior predictive analysis, Posterior plots. Likelihood theory and Estimation

Module 2 Modelling Linear and Logistic Regression

Modelling Linear Regression, Polynomial Regression, Multiple Linear Regression,Logistic Regression, Poisson Regression using pymc3

Module 3 Bayesian Modelling

Bayesian analysis using pymc3, Posterior predictive checks, Model specifications using pymc3,Examples of Bayesian Analytics. Bayes factor, Sequential Monte carlo to compute Bayes factors, Recursive state estimation, Modeling functions using pymc3, Covariance functions and kernels, Bayesian Regression Models

Module 4 GH and Kalman Filter

GH filter, Choosing G and H factors, Simple simulation models using GH filters, Discrete Bayes Filter for predicting the random movement, Recursive estimation and prediction, Effect of noisy environment. Kalman filter- updation using measurements and observations, Kalman Gain calculation and Prediction, Process noise and Measurement noise. Kalman Filter Equations implementation in python.

Module 5 Particle Filter

Multivariate Kalman Filter-Modelling and Designing, Effect of Nonlinearity, Nonlinear Filters, Smoothing, Adaptive Filtering. Markov concepts, Monte carlo integration, Basics of Markov chain Monte Carlo, Implementation using filterpy module.Particle Filter algorithm and Implementation.

Textbooks and References

1. "Bayesian Analysis with python", Osvaldo Martin, PACKT Open Source Publishing
2. "Machine Learning: A Bayesian and Optimization Perspective",Sergios Theodoridis, Academic Press.
3. https://github.com/rlabbe/Kalman-and-Bayesian-Filters-in-Python
4. http://140.113.144.123/EnD108/Bayesian%20filtering-%20from%20Kalman%20filters%20to%20Particle%20filters%20and%20beyond.pdf
5. "Ipython Interactive Computing and Visualization Cookbook", Cyrille Rossant , PACKT Open Source Publishing
6. "Bayesian Signal Processing: Classical, Modern, and Particle Filtering Methods", James V. Candy, Wiley-IEEE Press

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Probabilistic Programming**	
1.1	Statistical Modelling using pymc3, Probability concepts	2
1.2	Bayes theorem, Bayesian Statistics and modelling	2
1.3	Modelling Coin flipping as Bayesian, Choosing the likelihood and prior, Posterior computation,	2
1.4	Posterior predictive analysis, Posterior plots. Likelihood theory and Estimation	3
2	**Modelling Linear and Logistic Regression**	
2.1	Modelling Linear Regression	2
2.2	Polynomial Regression, Multiple Linear Regression	2
2.3	Logistic Regression, Poisson Regression using pymc3	4

3	**Bayesian Modelling**	
3.1	Bayesian analysis using pymc3, Posterior predictive checks, Model specifications using pymc3,Examples of Bayesian Analytics.	3
3.1	Bayes factor, Sequential Monte carlo to compute Bayes factors, Recursive state estimation, Modeling functions using pymc3, Covariance functions and kernels.	3
3.3	Bayesian Regression Models.	2
4	**GH and Kalman Filter**	
4.1	GH filter, Choosing G and H factors, Simple simulation models using GH filters.	2
4.2	Discrete Bayes Filter for predicting the random movement, Recursive estimation and prediction, Effect of noisy environment.	2
4.3	Kalman filter- updation using measurements and observations, Kalman Gain calculation and Prediction, Process noise and Measurement noise. Kalman Filter Equations implementation in python.	4
5	**Particle Filter**	
5.1	Multivariate Kalman Filter - Modelling and Designing	2
5.2	Effect of Nonlinearity, Nonlinear Filters, Smoothing, Adaptive Filtering.	2
5.3	Markov concepts, Monte carlo integration, Basics of Markov chain Monte Carlo	2
5.4	Implementation using filterpy module. Particle Filter algorithm and Implementation.	4

Simulation Assignments

1. Create a noisy measurement system. Design a g-h filter to filter out the noise and plot it. Write a code to filter 100 data points that starts at 5, has a derivative of 2, a noise scaling factor of 10, and uses g=0.2 and h=0.02. Set your initial guess for x to be 100.

2. Design a filter to track the position of a train. Its position is expressed as its position on the track in relation to some fixed point which we say is 0 km. I.e., a position of 1 means that the train is 1 km away from the fixed point. Velocity is expressed as meters per second. Measurement of position is doeonce per second, and the error is ± 500 meters.The train is currently at 23 kilometer, moving at 15 m/s,accelerating at 0.2 m/secˆ2. Plot the results.

3. Using Discrete Bayes Filter, predict the movemet of a dog. The current position of the dog is 17 m. The epoch is 2 seconds long, and the dog is traveling at 15 m/s. Where will the dog be in two seconds?

4. Compute the statistics of a Gaussian function using filterpy() module

5. Design a Kalman filter to track the movement of a dog(parameters same as previous one) in a Noisy environment

6. Prove that the binomial and beta distributions are conjugate pairs with respect to the mean value.
7. Show that the conjugate prior of the multivariate Gaussian with respect to the precision matrix, Q, is a Wishart distribution.

8. Prove that if a probability distribution p satisfies the Markov condition, as implied by a BN, hen p is given as the product of the conditional distributions given the values of the parents.

9. Suppose that n balls are thrown independently and uniformly at random into n bins.

   (a) Find the conditional probability that bin 1 has one ball given that exactly one ball fell into the irst three bins.
   (b) Find the conditional expectation of the number of balls in bin 1 under the condition that bin 2 received no balls.
   (c) Write an expression for the probability that bin 1 receives more balls than bin 2.

Model Question Paper

A P J Abdul Kalam Technological University

Fifth Semester B Tech Degree Examination

Course: ECT 397 Computational Tools for Signal Processing

Time: 3 Hrs **Max. Marks: 100**

PART A

Answer All Questions

1	State Bayes theorem and explain the significance of the terms prior, likelihood and posterior.	(3)	K_2
2	Write Python code with pymc3 to realize a Bernoulli trial with $p(head) = 0.4$	(3)	K_3
3	Compare logistic and linear regression	(3)	K_2
4	Explain the concept of Poisson regression and logistic regression?	(3)	K_2
5	Write the significance of choosing conjugate priors in Bayesian analysis	(3)	K_2
6	Explain Schwarz Criterion.	(3)	K_1
7	Compare process noise and measurement noise in Kalman Filter.	(3)	K_2
8	Write the algorithm for GH filter design	(3)	K_3
9	Write a python code to compute relative error in the true value of π	(3)	K_3
10	Compare Nonlinear and Linear filters	(3)	K_2

PART B

Answer one question from each module. Each question carries 14 mark.

Module I

11(A)	Assume that you have a dataset with 100 data points of Gaussian distribution with a mean of 13 and standard deviation of 1.5. Using PyMC3, write Python code to compute: · The posterior distribution · The prior distribution · The posterior predictive distribution .	(8)	K_3
11(B)	Write a python code to find the Bayesian credible interval in the above question. How is it different from confidence interval.	(6)	K_3

OR

12(A)	Write a python code to evaluate the statistical correlation between variables in a 5 × 5 Gaussian random dataset.	(8)	K_3
12(B)	Show that $N(x\vert \mu, \Sigma)$ for known Σ is of an exponential form and that its conjugate prior is also Gaussian.	(6)	K_2

Module II

13(A)	Consider the linear model $y\ ax \sim + b$ sampled from a probability distribution $y\ N(ax + b, \sim\sigma^2)$. Use pymc3, write a python code to estimate the parameters a,b and σ.	(8)	K_3
13(B)	Assume that x_n, $n = 1, 2, ..., N$, are iid observations from a Gaussian distribution $N(\mu, \sigma^2)$. Obtain the MAP estimate of μ, if the prior follows the exponential distribution $p(\mu) = \lambda \exp(-\lambda\mu)$, $\lambda > 0$, $\mu >= 0$,	(6)	K_2

OR

14(A)	Write a python code to generate random dataset using a noisy linear process with intercept1 , slope 2 and noise variance of 0.5. Simulate 100 data points and write a code to fit a linear regression to the data	(8)	K_3
14(B)	Write the steps involved in multiple linear regression technique	(6)	K_2

Module III

15(A)	Write a python code to estimate the mean and standard deviation of a randomly generated gaussian data using SMC method in pymc3	(8)	K_3
15(B)	Explain how posterior predictive checks are used in validating a model using pymc3	(6)	K_2

OR

16(A)	Consider the linear model $y = \alpha + \beta * x$ sampled from a probability distribution $y \sim N(\alpha + \beta * x, \varepsilon)$. Use pymc3, write a python code to estimate the best values of α, β using Bayesian Linear Regression model. .	(8)	K_3
16(B)	Explain the steps involved in calculating Bayes factor in pymc3	(6)	K_2

Module IV

17(A)	Design an algorithm using Kalman filter to track a constant velocity aircraft in one dimension.	(8)	K_3
17(B)	Give a brief idea about recursive estimation technique.	(6)	K_2

OR

18(A)	Design an algorithm using Kalman filter to track an accelerating aircraft in one dimension.	(8)	K_3
18(B)	Explain the concept of Kalman filter gain factor.	(6)	K_2

Module V

19(A)	Describe the essential steps in the derivation of the Particle filter.	(8)	K_2
19(B)	Explain Sequntial Importance sampling algorithm?	(6)	K_2

OR

20(A)	Explain Multivariate Kalman Filter algorithm.	(8)	K_2
20(B)	Explain different resampling algorithms used in designing particle filter	(6)	K_2

SEMESTER VI

ECT302	ELECTROMAGNETICS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to impart knowledge on the basic concepts of electric and magnetic fields and its applications.

Prerequisite:MAT102 Vector Calculus

Course Outcomes: After the completion of the course the student will be able to

CO 1 K2	To summarize the basic mathematical concepts related to electromagnetic vector fields.
CO 2 K3	Analyse Maxwell's equation in different forms and apply them to diverse engineering problems.
CO3 K3	To analyse electromagnetic wave propagation and wave polarization
CO4 K3	To analyse the characteristics of transmission lines and solve the transmission line problems using Smith chart.
CO5 K3	To analyse and evaluate the propagation of EM waves in Wave guides.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	1	1								2
CO2	3	3	1	1								2
CO3	3	3	1	1								2
CO4	3	3	1	1								2
CO5	3	3	1	1								2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember K1			
Understand K2	20	20	40
Apply K3	30	30	60
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): To summarize the basic mathematical concepts related to electromagnetic vector fields. (K2)

1. State and explain divergence theorem. Give a geometrical explanation.

2. Find the curl of the vector A =2rcosϕ a_ρ +r a_ϕ in cylindrical coordinates

3. Show that curl grad **F** and div curl **F** are identically zero.

4.Show that $V = \frac{1}{4\pi\xi_o}\frac{Q}{r}$ where $r = (x^2 + y^2 + z^2)^{1/2}$ satisfies Laplace's equation.

Course Outcome 2 (CO2): Analyse Maxwell's equation in different forms and apply them to diverse engineering problems. (K3)

1. State and explain Maxwell's equations in the integral and differential forms.

2. Derive the solution of uniform plane wave in lossy dielectric medium.

Course Outcome 3 (CO3): To analyse electromagnetic wave propagation and wave polarization (K3)

1. Derive an expression for reflection coefficient of a plane wave under oblique incidence with parallel polarization at a dielectric interface.

2. Explain wave polarization and different polarisation with example.

3. Derive the expression for Brewster angle for parallel polarised wave.

Course Outcome 4 (CO4): To analyse the characteristics of transmission lines and solve the transmission line problems using Smith chart. (K3)

1.A transmission line of length 0.2 λ and characteristic impedance 100Ω is terminated with a load impedance of 50+200j . Find input impedance, reflection coefficient at load end, reflection coefficient at the input end and VSWR.

2. A lossless transmission line has a characteristic impedance of 50Ω and phase constant of 3 Rad/ m at 100 MHz . Find Inductance per meter and Capacitance per meter of the transmission line .

3. A 50 + j200 Ω load is connected to a 100Ω lossless transmission line . Using Smith chart , find i. Reflection coefficient at load ii. VSWR

Course Outcome 5 (CO5): To analyse and evaluate the propagation of EM waves in Wave guides.(K3)

1.For TE10 mode of propagation in a rectangular wave guide, with length 8cm and

6 cm respectively , find the following when frequency of operation is 6 GHz .

i. Cut off frequency

ii. Cut off wavelength

iii. Guide wavelength

iv. Phase constant

v. Phase velocity

vi. Group velocity

vii. Wave impedance

2.A rectangular wave guide has a dimension of 3cm x 5cm , and is operating at a frequency of 10 GHz . Calculate the cutoff wavelength, cutoff frequency , guide wavelength , phase velocity and group velocity . and the wave impedance for TE10 mode.

3.Derive the expression for Electric and magnetic field intensities for TM mode of propagation of rectangular waveguide.

SYLLABUS

MODULE 1 :

Introduction to Electromagnetic Theory. Review of vector calculus- curl, divergence gradient. Rectangular, cylindrical and spherical coordinate systems. Expression of curl divergence and Laplacian in cartesian, cylindrical and spherical coordinate system. Electric field and magnetic field, Review of Coulomb's law, Gauss law and Amperes current law.
Poisson and Laplace equations, Determination of E and V using Laplace equation.

MODULE 2 :

Derivation of capacitance and inductance of two wire transmission line and coaxial cable. Energy stored in Electric and Magnetic field. Displacement current density, continuity equation. Magnetic vector potential. Relation between scalar potential and vector potential. Maxwell's equation from fundamental laws. Boundary condition of electric field and magnetic field from Maxwells equations.Solution of wave equation.

MODULE 3 :

Propagation of plane EM wave in perfect dielectric, lossy medium, good conductor, media-attenuation, phase velocity, group velocity, skin depth. Reflection and refraction of plane electromagnetic waves at boundaries for normal & oblique incidence (parallel and perpendicular polarization), Snell's law of refraction, Brewster angle.

MODULE 4 :

Power density of EM wave, Poynting vector theorem. Polarization of electromagnetic wave-linear, circular and elliptical polarisation.
Uniform lossless transmission line - line parameters.Transmission line equations, Voltage and Current distribution of a line terminated with load .Reflection coefficient and VSWR. Derivation of input impedance of transmission line.

MODULE 5 :

Transmission line as circuit elements (L and C). Development of Smith chart - calculation of line impedance and VSWR using smith chart.
The hollow rectangular wave guide –modes of propagation of wave-dominant mode, group velocity and phase velocity -derivation and simple problems only

Text Books

1. John D. Kraus, Electromagnetics, 5/e, TMH, 2010.
2. Mathew N O Sadiku, Elements of Electromagnetics, Oxford University Press, 6/e, 2014.
3. William, H. Hayt, and John A. Buck. Engineering Electromagnetics. McGraw-Hill, 8/e McGraw-Hill, 2014.

Reference Books

1. Edminister, “Schaum’s Outline of Elctromagnetics”, 4/e, McGraw-Hill, 2014.
2. Jordan and Balmain , Electromagnetic waves and Radiating Systems, PHI, 2/e,2013
3. Martin A Plonus , Applied Electromagnetics, McGraw Hill, 2/e,1978.
4. Nannapaneni Narayana Rao, Elements of Engineering Electromagnetics, Pearson, 6/e, 2006.
5. Umran S. Inan and Aziz S. Inan, Engineering Electromagnetics, Pearson, 2010.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Introduction to Electromagnetic Theory. Review of vector calculus- curl, divergence gradient.	3
1.2	Rectangular, cylindrical and spherical coordinate systems. Expression of curl divergence and Laplacian in cartesian , cylindrical and spherical coordinate system.	3
1.3	Electric field and magnetic field.Review of Coulomb’s law , Gauss law and Amperes current law.	2
1.4	Poisson and Laplace equations, Determination of E and V using Laplace equation.	2
2	**Module 2**	
2.1	Derivation of capacitance and inductance of two wire transmission line and coaxial cable.	2
2.2	Energy stored in Electric and Magnetic field.	1
2.3	Displacement current density, continuity equation. Magnetic vector potential. Relation between scalar potential and vector potential.	3
2.4	Maxwell’s equation from fundamental laws.	2
	Boundary condition of electric field and magnetic field from Maxwell’s equations.	1
2.5	Solution of wave equation	1
3	**Module 3**	
3.1	Propagation of plane EM wave in perfect dielectric, lossy medium, good conductor, media-attenuation, phase velocity, group velocity, skin depth.	4
3.2	Reflection and refraction of plane electromagnetic waves at boundaries for normal & oblique incidence (parallel and perpendicular polarization), Snell’s law of refraction, Brewster angle.	4
4	**Module 4**	

4.1	Power density of EM wave, Poynting vector theorem.	2
4.2	Polarization of electromagnetic wave-linear, circular and elliptical polarisation.	2
4.3	Uniform lossless transmission line - line parameters. Transmission line equations	3
4.4	Voltage and Current distribution of a line terminated with load .Reflection coefficient and VSWR.Derivation of input impedance of transmission line.	3
5	**Module 5**	
5.1	Transmission line as circuit elements (L and C).	1
5.2	Development of Smith chart - calculation of line impedance and VSWR using smith chart.	3
5.3	The hollow rectangular wave guide –modes of propagation of wave-dominant mode, group velocity and phase velocity -derivation and simple problems only	4

Assignments:

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT302

Course Name: ELECTROMAGNETICS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	Define Curl of a vector field. Explain its physical significance.	K2
2	Obtain Coulomb's law from Gauss' law	K2
3	Write Poisson's and Laplace's Equation with applications	K1
4	A Parallel plate capacitor with plate area of 5cm^2 and a plate separation of 3mm has a voltage 50sin10^{3}t Volt applied to its plates. Calculate the displacement current assuming $\varepsilon = 2\varepsilon_0$.	K3
5	List all Maxwell's equations in integral form	K1

6 Explain the significance of skin depth. K2

7 What is Snell's law? K1

8 What is wave polarisation? What are the different types of polarisation? K1

9 State the relation between standing wave ratio and reflection coefficient. K1

10 How a quarter wave dissipationless line can be used for impedance matching?. K2

PART – B

Answer one question from each module; each question carries 14 marks.

Module - I

11 a. Derive the equation for curl of a vector field in Cartesian co-ordinate system. 7 CO1 K2

b. A Spherical volume charge distribution is given by 7 CO1 K3

$\rho = \rho_0 (1 - \frac{r^2}{a^2}); r \leq a$

$\rho = 0; r > a$

Find the electric field intensity E; i) inside and ii) outside the charge distribution

OR

12 Interpret the following 7 CO1 K3

i) $\nabla \times B = \mu_0 J$ ii) $\nabla \times E = 0$ where B and J stands for magnetic flux density and electric current density

b. Apply Ampere's circuital law to the case of an infinitely long coaxial cable carrying a uniformly distributed total current I. Compute the magnetic field intensity existing in different parts of the cable. 7 CO1 K3

Module - II

13 a. Derive the expression of capacitance of two wire transmission line. 7 CO2 K2

b. Show that the energy stored in a system of n point charges is given by 7

$W_E = \frac{1}{2}\sum_{i=1}^{n} Q_i V_i$ where V_i is the potential of the point charge Q_i. CO2 K3

OR

14a Define vector magnetic potential and show that $B = \nabla \times A$, where B is the magnetic flux density and A is the vector magnetic potential at any point. 7 CO2 K2

b State and prove boundary conditions for E and H in accordance with Maxwell's equations. 7 CO2 K2

Module - III

15 a. Derive the expression for reflection coefficient for a wave of perpendicular polarization , travelling from one medium to another at oblique incidence . 7 CO3 K2

b. In a lossy dielectric medium,characteristic impedance of the medium is 173 +j100 Ω , Expression of Magnetic field of a plane wave is given by 7 CO3 K3

$10\ e^{-\alpha x}\cos(\omega\ t - 0.5x)a_z$ A/m . Find

i. Direction of propagation

ii. Loss tangent

iii. Attenuation constant

iv. Phase constant

v. Skin depth

OR

16 a Derive continuity equation from fundamental laws. 7 CO3 K2

b Find the skin depth, δ at a frequency of 1.6 MHz in aluminium, where

σ=38.2MS/m and μ_r= 1. Also find the propagation constant, γ and the wave velocity v . 7 CO3 K3

Module - IV

17a Derive the equation for transmission and reflection coefficients of an electromagnetic wave incident normally on the boundary between two different regions. 7 CO4 K2

b Derive an expression for net outward power flow associated with an electromagnetic wave, from a surface. 7 CO4 K2

OR

18 a. Derive standard Transmission line equations. 7 CO4 K2

b. Given two dielectric media,the first medium is free space and the second medium has $\varepsilon_2 = 4\varepsilon_0$ and $\mu = \mu_0$. Find the reflection coefficient for oblique incidence at $\theta_1 = 30^o$ for i) perpendicular polarisation and ii) parallel polarisation 7 CO4 K3

Module - V

19 a. A rectangular wave guide has a dimension of 3cm x 5cm , and is operating at a frequency of 10 GHz . Calculate the cutoff wavelength, cutoff frequency , guide wavelength , phase velocity and group velocity . and the wave impedance for TE10 mode. 7 CO5 K3

b. At a frequency of 80 MHz, a lossless transmission line has a characteristic impedance of 300Ω and a wavelength of 2.5m. Find: 7

i) L ii) C iii) If the line is terminated with a parallel combination of 200Ω and 5pF, determine the reflection co-efficient and the standing wave ratio. CO5 K3

OR

20 a A 50 + j200 Ω load is connected to a 100Ω lossless transmission line . Using smith chart , find 7

	i. Reflection coefficient at load ii. VSWR iii. Load admittance	CO5 K3
b	Derive the expression for Electric and magnetic field intensities for TM mode of propagation of rectangular waveguide.	7 CO5 K2

ECT304	VLSI CIRCUIT DESIGN	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to impart the knowledge of VLSI design methodologies and Digital VLSI circuit design.

Prerequisite:

1. ECT201 Solid State Devices
2. ECT202 Analog Circuits
3. ECT 203 Logic Circuit Design.

COURSE OUTCOMES.

After the completion of the course the student will be able to:

CO1	Explain the various methodologies in ASIC and FPGA design.
CO2	Design VLSI Logic circuits with various MOSFET logic families.
CO3	Compare different types of memory elements.
CO4	Design and analyse data path elements such as Adders and multipliers.
CO5	Explain MOSFET fabrication techniques and layout design rules.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		3									2
CO2	3	2	3									2
CO3	3	2	3									2
CO4	3	2	3									2
CO5	3		2									2

Assessment Pattern:

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	2	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyze			
Evaluate			
Create			

Mark distribution:

Total Marks	CIE	ESE	Duration
150	50	100	3Hrs

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignments : 15 marks.

End Semester Examination Pattern

Maximum Marks : 100 **Time : 3 hours**

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. Mark patterns are as per the syllabus with 75% for theory and 25% for logical/numerical problems.

Course Level Assessment Questions.

CO1:

1. Differentiate between full custom and semi-custom ASIC.
2. With a neat flow chart, explain ASIC design flow.
3. Describe Gate array based ASIC with neat diagram.
4. What are the processes involved in Soc design.

CO2:

1. With a neat diagram explain static and transient analysis of CMOS inverter
2. Realize the given logic function using static CMOS logic and transmission gate logic.
3. Compare the advantages and disadvantages of static and dynamic circuits.

CO3:

1. Compare different ROM structures.
2. Compare static and dynamic RAM structures.
3. Compare the advantages of three transistor and one transistor DRAM cell.

CO4:

1. Design a full adder with static CMOS logic
2. Compare the delay of Carry-Bypass adder, Linear Carry- Select adder, Square- root carry-select adder.

CO5:

1. Explain how electronic grade silicon (EGS) is developed .
2. Explain the necessity of single crystalline silicon in VLSI fabrication and how single crystal silicon is made.
3. Explain diffusion and ion implantation techniques.
4. Explain the advantages of SiO2 and the oxidation techniques.

Syllabus

Module 1: VLSI Design Methodologies.

Introduction: Moore's law .ASIC design, Full custom ASICs, Standard cell based ASICs, Gate array based ASICs, SoCs, FPGA devices, ASIC and FPGA Design flows, Top-Down and Bottom-Up design methodologies. Logical and Physical design. Speed power and area considerations in VLSI design

Module 2: Static CMOS Logic Design

MOSFET Logic Design - NMOS Inverter (Static analysis only), basic logic gates,
CMOS logic, Static and transient analysis of CMOS inverter, Switching power dissipation and delays. Realization of logic functions with static CMOS logic, Pass transistor logic, and transmission gate logic

Module 3: Dynamic logic Design and Storage Cells

Dynamic Logic Design-Pre charge- Evaluate logic, Domino Logic, NP domino logic.
Read Only Memory-4x4 MOS ROM Cell Arrays(OR,NOR,NAND)
Random Access Memory –SRAM-Six transistor CMOS SRAM cell, DRAM –Three transistor and One transistor Dynamic Memory Cell.

Module 4: Arithmetic circuits

Adders: Static adder, Carry-Bypass adder, Linear Carry- Select adder, Square- root carry- select adder. **Multipliers:** Array multiplier.

Module 5: Fabrication techniques and MOSFET physical Design

Material Preparation

Purification and Crystal growth (CZ process), wafer preparation
Thermal Oxidation- Growth mechanisms, Dry and Wet oxidation.
Diffusion and ion implantation techniques.
Epitaxy : molecular beam epitaxy.
Lithography- Photo lithographic sequence, Electron Beam Lithography, Etching and metal deposition techniques.

MOSFET Fabrication techniques

Twin-Tub fabrication sequence, Fabrication process flow.
Layout Design and Design rules, Stick Diagram and Design rules-micron rules and Lambda rules. (definitions only).layout of CMOS Inverter, two input NAND and NOR gates.

Text Books:

1. Sung –Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits- Analysis & Design, McGraw-Hill, Third Ed., 2003
2. S.M. SZE, VLSI Technology, 2/e, Indian Edition, McGraw-Hill,2003
3. Wayne Wolf ,Modern VLSI design, Third Edition, Pearson Education,2002.

References:

1. Michael John Sebastian Smith, Application Specific Integrated Circuits, Pearson Education,2001.
2. Neil H.E. Weste, Kamran Eshraghian, Principles of CMOS VLSI Design- A Systems Perspective, Second Edition. Pearson Publication, 2005.
3. Jan M. Rabaey, Digital Integrated Circuits- A Design Perspective, Prentice Hall, Second Edition, 2005.
4. Razavi - Design of Analog CMOS Integrated Circuits,1e, McGraw Hill Education India Education, New Delhi, 2003.
5.

Course Contents and Lecture Schedule.

No	Topic	No. of. Lectures
Module 1: VLSI Design Methodologies. (11 Hrs)		
1.1	Introduction: Moore slaw .ASIC design, Full custom ASICs, Standard cell based ASICs, Gate array based ASICs,	**3**
1.2	SoCs, FPGA devices	**2**
1.3	ASIC and FPGA Design flows Top-Down and Bottom-Up design methodologies.	**3**
1.4	Logical and Physical design. Speed power and area considerations in VLSI design	**3**
Module 2:Static CMOS Logic Design (9 Hrs)		
2.1	**MOSFET Logic Design** - NMOS logic (Static analysis of Basic gates only)	**3**
2.2	CMOS logic, Static and transient analysis of CMOS inverter Switching power dissipation and delays	**3**
2.3	Realization logic functions in static CMOS logic, Pass transistor logic, and transmission gate logic (Static analysis only)	**3**
Module 3: Dynamic logic Design and Storage Cells (8 Hrs)		
3.1	Dynamic Logic Design-Pre charge- Evaluate logic, Domino Logic, NP domino logic.	**3**

3.2	**Read Only Memory**-4x4 MOS ROM Cell Arrays(OR,NOR,NAND)	**2**
3.3	**Random Access Memory** –SRAM-Six transistor CMOS SRAM cell, DRAM –Three transistor and One transistor Dynamic Memory Cell.	**3**
Module 4: Arithmetic circuits (5 Hrs)		
4.1	**Adders**- Static adder, Carry-Bypass adder, Linear Carry- Select adder, Square- root carry- select adder.	**3**
4.2	**Multipliers**-Array multiplier.	**2**
Module 5: MOSFET physical Design and Fabrication techniques (13 Hrs)		
5.1	**Material Preparation** (qualitative analysis only) Purification and Crystal growth (CZ process), wafer preparation.	**2**
5.2	**Thermal Oxidation-** Growth mechanisms, Dry and Wet oxidation. Diffusion and ion implantation techniques.	**3**
5.3	**Epitaxy :** Molecular beam epitaxy. **Lithography-** Photo lithographic sequence, Electron Beam Lithography, Etching and metal deposition techniques	**3**
5.4	**MOSFET Fabrication techniques**(*qualitative analysis only*) Twin-Tub fabrication sequence, Fabrication process flow.	**2**
5.5	**Layout Design and Design rules**, Stick Diagram and Design rules-micron rules and Lambda rules. Layout of CMOS Inverter, two input NAND and NOR gates,	**3**

Model Question Paper

A P J Abdul Kalam Technological University
Sixth Semester B Tech Degree Examination
Branch: Electronics and Communication Course:
ECT 304 VLSI CIRCUIT DESIGN

Time: 3 Hrs Max.
Marks: 100

PART A
(*Answer All Questions*)

1	What is Moore's law in VLSI design?	(3)
2	Differentiate between ASIC and FPGA.	(3)
3	Switching threshold voltage equation of CMOS inverter and explain each parameter	(3)
4	List the advantage of CMOS logic.	(3)
5	List the advantages of dynamic logic over static logic circuits.	(3)
6	Differentiate between volatile and non volatile memories.	(3)
7	Explain propagate delete and generate signals.	(3)
8	What are the different types of power dissipation in a CMOS inverter?	(3)
9	List the advantages of SiO2	(3)
10	Define lambda rules and micron rules.	(3)

PART B
(*Answer one question from each module. Each question carries 14 mark.*)

11(A)	What is FPGA? What are its applications? With block diagram explain its internal architecture?	(6)
11(B)	Explain ASIC design flow.	(8)
	OR	
12(A)	Compare different ASIC design methodologies.	(8)
12(A)	List the advantages of SOC	(6)
13(A)	Derive expression for the switching threshold of a CMOS inverter.	(7)
13(B)	What is meant by pass transistor logic? What are the differences in transmission characteristics of N MOS and P MOS transistors?	(7)
	OR	
14(A)	What are the different types of power dissipation in a CMOS inverter? Derive expression for the total power dissipation.	(8)
14(B)	Why PMOS transistor can pass only strong ones and NMOS can pass strong zeros.	(6)

15(A) Draw the circuit diagram and explain the principle of operation of a CMOS based static RAM cell. Explain the read and write operations. What are the constraints on the sizes of transistors? (7)

15(B) Draw the circuit diagram and explain the principle of operation of a one transistor dynamic RAM cell. Explain the read, write and refresh operations (7)

OR

16(A) Explain the read and write operation of a three-transistor DRAM cell (7)

16(B) Explain the read and write operation of a six transistor CMOS SRAM cell. (7)

OR

17(A) With diagram illustrate the principle of operation of an array multiplier. Show the critical path. Estimate the delay of the multiplier. (8)

17(B) With block diagram illustrate the principle of operation of a square root carry select adder. Estimate the delay of an n bit adder (6)

OR

18(A) Draw circuit diagram of a full adder with not more than 28 transistors in standard CMOS logic (8)

18(B) Explain the working a 16-bit carry-by pass adder and write down the expression for worst-case delay. (6)

19(A) Illustrate with diagram the principle of crystal growth by Czochralzki method. (7)

19(B) What is photolithography? With diagram illustrate the steps involved in photolithography process. (7)

OR

20(A) Explain the principle of molecular beam epitaxy, with schematic diagram of an MBE system. What are its advantages and disadvantages? (8)

20(B) With schematic diagram and chemical reactions involved, illustrate wet and dry oxidation processes (6)

MODEL ASSIGNMENT QUESTIONS

Module 1

1. How to choose between FPGA and ASIC ?
2. Describe ASIC in terms of Size, power and performance, IP protection and competitive Edge
3. Compare Gate-array design and Full-custom design?
4. What are the differences between CPLDs and CLBs
5 List some of the commonly used FPGA development board ?
6. Discuss the architecture of any one of the leading FPGA in industry ?

Module 2

1. Power and interconnect delay analysis of CMOS inverter?
2. Implement XOR function using pass transistor logic?
3. Derive V_{IL}, V_{IH},V_{OH}, and V_{OL} of depletion load inverter?
4. Design 8:1 MUX using transmission gate logic?
5. What are the advantages of NMOS over CMOS ?

Module 3

1. Explain the working of sense amplifiers in memory structures?
2. Design a voltage comparator in precharge-evaluate logic .
3. Discuss the cascading problem of P-E logic
4. Discuss the architecture of FLASH EPROM
5. Explain the working of FGMOS

Module 4

1. With diagram illustrate the principle of operation of an array multiplier. Show the critical path. Estimate the delay of the multiplier
2. Implement a 3x3 array multiplier?

Module 5

1. What is photolithography? With diagram illustrate the steps involved in photolithography process?
2. What is Deal Grove model of oxidation? What are linear and parabolic rate coefficients with reference to oxidation process?
3. Illustrate with diagram the principle of crystal growth by Czochralzki method
4. Explain DEAL-GROVE model of oxidation?
5. What are the requirements of a "clean-room" in VLSI fabrication

ECT306	INFORMATION THEORY AND CODING	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to lay down the foundation of information theory introducing both source coding and channel coding. It also aims to expose students to algebraic and probabilistic error-control codes that are used for reliable transmission.

Prerequisite: MAT 201 Linear Algebra and Calculus, MAT 204 Probability, Random Process and Numerical Methods, ECT 204 Signals and Systems.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain measures of information – entropy, conditional entropy, mutual information
CO 2	Apply Shannon's source coding theorem for data compression.
CO 3	Apply the concept of channel capacity for characterize limits of error-free transmission.
CO 4	Apply linear block codes for error detection and correction
CO 5	Apply algebraic codes with reduced structural complexity for error correction
CO 6	Understand encoding and decoding of covolutional and LDPC codes

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3										
CO 2	3	3	2	3	3							
CO 3	3	3	2	3	3	2						2
CO 4	3	3	2	3	3	2						2
CO 5	3	3	2	3	3	2						2
CO 6	3	3	2	3	3	2						2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Entropy, Mutual Information

1. Prove that entropy of a discrete random variable is upper bounded by logarithm of alphabet size.
2. Prove that I(X:Y|Z) is always greater than or equal to 0.

Course Outcome 2 (CO2): Source Coding

1. State and prove Kraft's inequality for uniquely decodable codes.
2. Describe operational meaning of entropy in the light of Shannons's source coding theorem.

Course Outcome 3 (CO2): Channel Capacity

1. Derive the expression for capacity of binary symmetric channel.
2. Define differential entropy and derive its expression for a Gaussian distributed random variable with zero mean value and variance σ2.
3. Explain the inferences from Shannon Hartley theorem with the help of spectral efficiency versus SNR per bit graph.

Course Outcome 4 (CO4): Linear Block Codes

1. Construct a table for GF(23) based on the primitive polynomial, p(x) = 1 + *x* + *x*3.
2. Find generator and parity check matrix in systematic format of the (6,3) linear block code for the given parity matrix.

$$P = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 0 & 1 \end{bmatrix}$$

3. Explain standard array decoding of linear block codes.

Course Outcome 4 (CO4): Algebraic codes

1. Draw and explain the decoder circuit of (n, k) cyclic codes.
2. Give the properties of BCH codes.

Course Outcome 5 (CO5): Convlutional and LDPC Codes

1. Obtain the output codeword corresponding to the information sequence (1 1 0 1 1) for a convolutional encoder with rate ½ and constraint length 4, for generator sequences, g(1) = (1011) and g(2)
   = (1111).
2. Explain the message-passing decoding algorithm for LDPC codes with respect to binary erasure channel.

SYLLABUS

Module 1 – Entropy, Sources and Source Coding

Entropy, Properties of Entropy, Joint and Conditional Entropy, Mutual Information, Properties of Mutual Information.

Discrete memoryless sources, Source code, Average length of source code, Bounds on average length, Uniquely decodable and prefix-free source codes. Kraft Inequality (with proof), Huffman code. Shannon's source coding theorem (both achievability and converse) and operational meaning of entropy.

Module 2 – Channels and Channel Coding

Discrete memoryless channels. Capacity of discrete memoryless channels. Binary symmetric channels (BSC), Binary Erasure channels (BEC). Capacity of BSC and BEC. Channel code. Rate of channel code. Shannon's channel coding theorem (both achievability and converse without proof) and operational meaning of channel capacity.

Modeling of Additive White Gaussian channels. Continuous-input channels with average power constraint. Differential entropy. Differential Entropy of Gaussian random variable. Relation between differential entropy and entropy. Shannon-Hartley theorem (with proof – mathematical subtlities regarding power constraint may be overlooked).

Inferences from Shannon Hartley theorem – spectral efficiency versus SNR per bit, power-limited and bandwidth-limited regions, Shannon limit, Ultimate Shannon limit.

Module 3 – Introduction to Linear Block Codes

Overview of Groups, Rings, Finite Fields, Construction of Finite Fields from Polynomial rings, Vector spaces.

Block codes and parameters. Error detecting and correcting capability. Linear block codes. Two simple examples -- Repetition code and single parity-check code. Generator and parity-check matrix. Systematic form.

Maximum likelihood decoding of linear block codes. Bounded distance decoding. Syndrome. Standard array decoding.

Module 4 – A Few Important Classes of Algebraic codes
Cyclic codes. Polynomial and matrix description. Interrelation between polynomial and matrix view point. Systematic encoding. Decoding of cyclic codes.

(Only description, no decoding algorithms) Hamming Codes, BCH codes, Reed-Solomon Codes.

Module 5 – Convolutional and LDPC Codes
Convolutional Codes. State diagram. Trellis diagram. Maximum likelihood decoding. Viterbi algorithm.

Low-density parity check (LDPC) codes. Tanner graph representation. Message-passing decoding for transmission over binary erasure channel.

Text Books and References

1. "Elements of Information Theory", Joy A Thomas, Thomas M Cover, Wiley-Interscience.
2. "Information Theory, Inference and Learning Algorithms", David JC McKay, Cambridge University Press
3. "Principles of digital communication", RG Gallager, Cambridge University Press
4. "Digital Communication Sysmtes", Simon Haykin, Wiley.
5. "Introduction to Coding Theory", Ron M Roth, Cambrdige University Press
6. Shu Lin & Daniel J. Costello. Jr., Error Control Coding : Fundamentals and Applications, 2nd Edition.
7. Modern Coding Theory, Rüdiger Urbanke and TJ Richardson, Cambdridge University Press.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Entropy, Sources and Source Coding**	
1.1	Entropy, Properties of Entropy, Joint and Conditional Entropy	2
1.2	Mutual Information, Properties of Mutual Information	2
1.3	Discrete memoryless sources, Source code, Average length of source code, Bounds on average length	2
1.4	Uniquely decodable and prefix-free source codes. Kraft Inequality (with proof)	2
1.5	Huffman code. Shannon's source coding theorem and operational meaning of entropy	2
2	**Channels and Channel Coding**	
2.1	Discrete memoryless channels. Capacity of discrete memoryless channels	1
2.2	Binary symmetric channels (BSC), Binary Erasure channels (BEC). Capacity of BSC and BEC.	2

2.3	Channel code. Rate of channel code. Shannon's channel coding theorem (without proof) and operational meaning of channel capacity.	2
2.4	Modeling of Additive White Gaussian channels. Continuous-input channels with average power constraint.	1
2.5	Differential entropy. Differential Entropy of Gaussian random variable. Relation between differential entropy and entropy	2
2.6	Shannon-Hartley theorem and its proof	1
2.7	Inferences from Shannon Hartley theorem – spectral efficiency versus SNR, power-limited and bandwidth-limited regions, Shannon limit, Ultimate Shannon limit.	2
3	**Introduction to Linear Block Codes**	
3.1	Overview of Groups, Rings, Finite Fields, Construction of Finite Fields from Polynomial rings, Vector spaces.	5
3.2	Block codes and parameters. Error detecting and correcting capability	1
3.3	Linear block codes. Generator and parity-check matrix. Systematic form. Two simple examples -- Repetition code and single parity-check code. General examples.	2
3.5	Maximum likelihood decoding of linear block codes. Bounded distance decoding. Syndrome. Standard array decoding.	3
4	**A Few Important Classes of Algebraic codes**	
4.1	Cyclic codes. Polynomial and matrix description. Interrelation between polynomial and matrix view point. Systematic encoding. Decoding of cyclic codes.	4
4.2	Hamming Codes,	1
4.3	BCH codes, Reed-Solomon Codes.	2
5	**Convolutional and LDPC Codes**	
5.1	Convolutional Codes.	1
5.2	State diagram. Trellis diagram.	2
5.3	Maximum likelihood decoding. Viterbi algorithm	
5.4	Low-density parity check (LDPC) codes. Tanner graph representation Message-passing decoding for transmission over binary erasure channel.	2

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ECT 306 Information Theory and Coding
Simulation Assignments

The following simulation assignments can be done with Python/MATLAB/ SCILAB/LabVIEW

1. **Source Coding - Huffman Code**
    1. Generate Huffman code for the source with symbol probabilities {1/2, 1/3, 1/6}.
    2. Find the entropy, average codeword length and efficiency of the code.
    3. Create the second order extended source by taking probabilities of 9 symbols in the extended source as the product of every possible combinations of two symbols from the original source.
    4. Generate Huffman code for the extended source symbols and find the entropy, average codeword length and efficiency of the code.
    5. Compare the two efficiencies and appreciate the Shannon's source coding theorem.

2. **Binary Symmetric Channel**
    1. Create a 2 x 2 matrix, P(Y/X) for binary symmetric channel with channel transition probability, $p < 0.5$.
    2. Let the input symbol probabilities corresponding to symbol 0 and 1 be α and $(1 - \alpha)$ respectively. For different values of α ranging from 0 to 1, find the joint probability matrix, P(X,Y) and output probability, P(Y)
    3. Find mutual information, $I(X; Y) = H(Y) – H(Y/X)$ for each value of α. Plot the I(X; Y) versus α graph and observe the channel capacity.

3. **Linear Block Code (LBC)**
    1. Create the k x n generator matrix, G of (n, k) LBC.
    2. Generate all possible codewords by multiplying the message vector of length, k with G.
    3. Calculate the Hamming weight of all codewords and obtain the minimum distance, dmin of the code.
    4. Find its error correcting and detecting capability.

5. **Cyclic Code – Encoder & Decoder**
    1. Realize the encoder circuit for (7, 4) cyclic code in Fig. 4.2 in page 96 in *Error Control Coding: Fundamentals and Applications by Shu Lin & Daniel J. Costello. Jr.*

2. Create a random binary vector of length 4 as input message vector and generate the codeword.

3. Create binary vector of length 7 with Hamming weight 1 as error vector and add it to the encoder output to generate the receiver output.

4. Realize the decoder circuit for (7, 4) cyclic code in Fig. 4.9 in page 107 in *Error Control Coding: Fundamentals and Applications by Shu Lin & Daniel J. Costello. Jr.*

5. Observe the encoder and decoder outputs for different message vectors and error vectors and find the error correcting capability of the code.

6. **Convolutional Code**

   1. Implement (2,1,3) convolutional encoder in Fig. 10.1 in page 288 in *Error Control Coding: Fundamentals and Applications by Shu Lin & Daniel J. Costello. Jr.*

   2. Give a message vector, u of arbitrary length as input to the encoder.

   3. Generate the output code sequence.

MODEL QUESTION PAPER

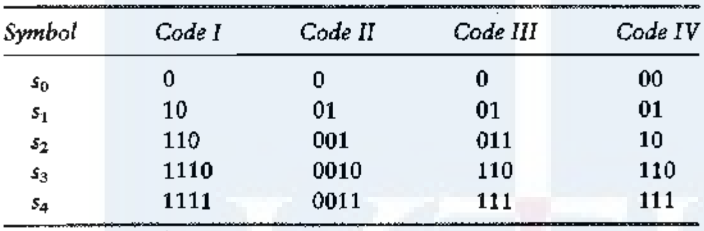
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
ECT 306 INFORMATION THEORY AND CODING

Time: 3 hours **Max. Marks:100**

PART A

Answer ***all*** questions. Each question carries ***3 marks***.

1. A source emits one f four symbols, s_0, s_1, s_2, s_3 with probabilities 1/3, 1/6, 1/4 and 1/4 respectively. The successive symbols emitted by the source are statistically independent. Calculate the entropy of the source.
2. Identify the instantaneous codes from the code sets listed below.



Symbol	Code I	Code II	Code III	Code IV
s_0	0	0	0	00
s_1	10	01	01	01
s_2	110	001	011	10
s_3	1110	0010	110	110
s_4	1111	0011	111	111

3. State Shannon's channel coding theorem. What is its significance in digital communication system?
4. An analog signal band limited to 'B' Hz is sampled at Nyquist rate. The samples are quantized into 4 levels. The quantization levels are assumed to be independent and occur with probabilities: p1= p4 = 1/8, p2 = p3 = 3/8. Find the information rate of the source assuming B = 100Hz.
5. List the properties of group. Give an example.
6. Show that C = {0000, 1100, 0011, 1111} is a linear code. What is its minimum distance?
7. Explain generation of systematic cyclic code using polynomial description.
8. List the features of Reed Solomon code.
9. Draw a (3,2,1) convolutional encoder with generator sequences, $g_1^{(1)}=(11), g_1^{(2)}=(01), g_1^{(3)}=(11)$ and $g_2^{(1)}=(01), g_2^{(2)}=(10), g_2^{(3)}=(10)$.
10. Draw the tanner graph of rate 1/3 LDPC code for the given parity check matrix.

$$H = \begin{bmatrix} 1 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 \end{bmatrix}$$

PART B

Answer ***any one*** question from each module. Each question carries 14 marks.

MODULE I

11 (a) The joint probability of a pair of random variables is given below. Determine H(X, Y), H(X/Y), H(Y/X) and I(X,Y). Verify the relationship between joint, conditional and marginal entropies.

$$P(X, Y) = \begin{bmatrix} 1/3 & 1/3 \\ 0 & 1/3 \end{bmatrix}$$

(10 marks)

11 (b) Explain uniquely decodable and prefix-free property of source code. (4 marks)

12 (a) Find the binary Huffman code for the source with probabilities {1/3, 1/5, 1/5, 2/15, 2/15}. Also find the efficiency of the code. (9 marks)

12 (b) Prove that $H(Y) \geq H(Y/X)$. (5 marks)

MODULE II

13 (a) A voice grade channel of the telephone network has a bandwidth of 3.4 KHz. Calculate channel capacity of the telephone channel for signal to noise ratio of 30 dB. Also determine the minimum SNR required to support information transmission through the telephone channel at the rate of 4800 bits/sec.

(7 marks)

13 (b) Derive the expression for channel capacity for binary erasure channel. (7 marks)

14 (a) A binary channel has the following noise characteristic.

$$P(Y/X) = \begin{bmatrix} 2/3 & 1/3 \\ 1/3 & 2/3 \end{bmatrix}$$

If the input symbols are transmitted with probabilities 3/4 and 1/4 respectively, find I(X;Y). Also compute channel capacity and what are the input symbol probabilities that correspond to the channel capacity. (9 marks)

14 (b) State Shannon Hartley theorem and explain the significance of Shannon limit. (6 marks)

MODULE III

15 (a) The parity check matrix of (7,4) linear block code is given as

$$H = \begin{bmatrix} 1 & 00 & 1 & 01 & 1 \\ 0 & 10 & 1 & 11 & 0 \\ 0 & 01 & 0 & 11 & 1 \end{bmatrix}.$$

Compute the minimum distance of the code and find its error detection and correcting capability. Suppose that the received codeword, r = (1001111). Determine whether the received codeword is in error? If so, form the decoding table and obtain the correct codeword. (9 marks)

16 (b) List the properties of vector space. Define subspace. (5 marks)

17 (a)The parity bits of a (8, 4) linear systematic block code are generated by

c5 = d1+d2+d4
c6 = d1+d2+d3
c7 = d1+d3+d4
c8 = d2+d3+d4
(+ sign denotes modulo-2 addition)

where d1, d2, d3 and d4 are message bits and c5, c6, c7 and c8 are parity bits. Find generator matrix G and parity check matrix H for this code. Draw the encoder circuit (7 marks)

17 (b) Explain the construction of finite field from polynomial ring with the help of an ex-ample.

(7 marks)

MODULE IV

18 (a) Consider a (7, 4) cyclic code with generator polynomial, $g(x) = 1 + x + x^3$. Express the generator matrix and parity-check matrix in systematic and non-systematic form

(8 Marks)

18 (b) Find the generator polynomial for single, double and triple error correcting BCH code of block length, n = 15. (6 marks)

19 (a) Draw syndrome circuit for a (7,4) cyclic code generated by $g(x)=1+x+x^3$. If the re-ceived vector r is [0010110] what is the syndrome of r? Explain the circuit with a table showing the contents of the syndrome register. (8 Marks)

19 (b) What are the features of Hamming code? Find the parity check matrix for (15, 11) Hamming code. (6 marks)

MODULE V

20 (a) Draw the state diagram of a convolution encoder with rate 1/3 and constraint length 3 for generator sequences $g^{(1)} = (1\ 0\ 0)$, $g^{(2)} = (1\ 0\ 1)$, $g^{(3)} = (1\ 1\ 1)$. (7 marks)

20 (b) Explain message passing decoding algorithm for LDPC codes with the help of an example.

(7 marks)

21 For a (2,1,2) convolutional encoder with generator sequences $g^{(1)} = (1\ 1\ 1)$ and $g^{(2)} = (1\ 0\ 1)$. Draw Trellis and perform Viterbi decoding on this trellis for the received sequence {01, 10, 10, 11, 01, 01, 11} and obtain the estimate of the transmitted se-quence. (14 marks)

ECT308	COMPREHENSIVE COURSE WORK	CATEGORY	L	T	P	CREDIT
		PCC	1	0	0	1

Preamble: The objective of this Course work is to ensure the comprehensive knowledge of each student in the most fundamental Program core courses in the curriculum. Five core courses credited from Semesters 3, 4 and 5 are chosen for the detailed study in this course work. This course has an End Semester Objective Test conducted by the University for 50 marks. One hour is assigned per week for this course for conducting mock tests of objective nature in all the listed five courses.

Prerequisite:

1. **ECT202 Analog Circuits**
2. **ECT203 Logic Circuit Design**
3. **ECT301 Linear Integrated Circuits**
4. **ECT303 Digital Signal processing**
5. **ECT305 Analog and Digital communication**

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply the knowledge of circuit theorems and solid state physics to solve the problems in electronic Circuits
CO 2	Design a logic circuit for a specific application
CO 3	Design linear IC circuits for linear and non-linear circuit applications.
CO 4	Explain basic signal processing operations and Filter designs
CO 5	Explain existent analog and digital communication systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	1									2
CO 2	3	3	1									2
CO 3	3	3	1									2
CO 4	3	2										2
CO 5	3	2	1									2

Assessment Pattern

Bloom's Category	End Semester Examination
Remember	10
Understand	20
Apply	20
Analyse	
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
50	0	50	1 hour

End Semester Examination Pattern: Objective Questions with multiple choice (Four). Question paper include Fifty Questions of One mark each covering the five identified courses.

Syllabus

Full Syllabus of all five selected courses

.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Analog Circuits**	
1.1	Mock Test on Module 1 and Module 2	1
1.2	Mock Test on Module 3, Module 4 and Module 5	1
1.3	Feedback and Remedial	1
2	**Logic Circuit design**	
2.1	Mock Test on Module 1, Module 2 and Module 3	1
2.2	Mock Test on Module 4 and Module 5	1
2.3	Feedback and Remedial	1
3	**Linear IC**	
3.1	Mock Test on Module 1 and Module 2	1
3.2	Mock Test on Module 3, Module 4 and Module 5	1
3.3	Feedback and Remedial	1
4	**Digital Signal Processing**	
4.1	Mock Test on Module 1, Module 2 and Module 3	1
4.2	Mock Test on Module 4 and Module 5	1
4.3	Mock Test on Module 1, Module 2 and Module 3	1
5	**Analog and Digital Communication**	
5.1	Mock Test on Module 1, Module 2 and Module 3	1
5.2	Mock Test on Module 4 and Module 5	1
5.3	Feedback and Remedial	1

ECL332	COMMUNICATION LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble:

- The experiments are categorized into three parts Part A, Part B and Part C.
- The experiments in Part A involves design and setting up of prototype circuits on breadboard or trainer kits.
- The experiments in Part B are software simulations and can be done using GNU Octave or Python. Other softwares such as MATLAB/ SCILAB/ LabVIEW can also be used.
- The experiments in Part C are emulations using SDR (software-designed-radio) dongle connected to laptops. A control software has to be in- stalled on the laptops. A combination of open-source GNU Radio soft- ware, RTL-SDR (for reception) and HackRF / LimeSDR (for trans- mission) can be used to conduct these experiments. Other platforms such as LabView with NI-USRP or Simulink with RTL-SDR can also be used.

Prerequisites:

- ECT 305 Analog and Digital Communication
- ECT 303 Digital Signal Processing

Course Outcomes : The student will be able to

CO 1	Setup simple prototype circuits for waveform coding and digial modulation techniques working in a team.
CO 2	Simulate the error performance of a digital communication system using standard binary and *M* -ary modulation schemes.
CO 3	Develop hands-on skills to emulate a communication system with software-designed-radio working in a team.

Mapping of Course Outcomes with Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	0	0	0	3	2	0	1
CO2	3	3	3	2	3	0	0	0	0	0	0	1
CO3	3	3	3	3	3	0	0	0	3	2	0	3

Assessment Pattern Mark

Distribution;

Total Mark	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:

Attribute	Mark
Attendance	15
Continuous assessment	30
Internal Test (Immediately before the second series test)	30

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.

Attribute	Mark
Preliminary work	15
Implementing the work/Conducting the experiment	10
Performance, result and inference (usage of equipments and trouble shooting)	25
Viva voce	20
Record	5

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

Experiments

Part A

Any two experiments are mandatory. The students shall design and setup simple prototype circuits with the help of available ICs. They can observe Waveforms produced by these circuits for standard ideal inputs.

1. FM generation and demodulation using PLL
2. Generation and Detection of PCM signals

3. Generation and Detection of Delta modulated signals
4. Generation and Detection of BPSK
5. Generation and Detection of 16-QPSK

Part B

All experiments are mandatory. The students shall write scripts to simulate components of communication systems. They shall plot various graphs that help to appreciate and compare performance.

1. Performance of Waveform Coding Using PCM

1. Generate a sinusoidal waveform with a DC offset so that it takes only positive amplitude value.
2. Sample and quantize the signal using an uniform quantizer with number of representation levels *L*. Vary *L*. Represent each value using decimal to binary encoder.
3. Compute the signal-to-noise ratio in dB.
4. Plot the SNR versus number of bits per symbol. Observe that the SNR increases linearly.

2. Pulse Shaping and Matched Filtering

1. Generate a string of message bits.
2. Use root rasied cosine pulse $p(t)$ as the shapig pulse, and generate the corresponding baseband signal with a fixed bit duration T_b. You may use roll-off factor as $\alpha = 0.4$.
3. Simulate transmission of baseband signal via an AWGN channel
4. Apply matched filter with frequency response $P_r(f) = P^*(f)$ to the received signal.
5. Sample the signal at mT_b and compare it against the message sequence.

3. Eye Diagram

1. Generate a string of message bits.
2. Use rasied cosine pulse $p(t)$ as the shapig pulse, and generate the corresponding baseband signal with a fixed bit duration T_b. You may use roll-off factor as $\alpha = 0.4$.
3. Use various roll off factors and plot the eye diagram in each case for the received signal. Make a comparison study among them.

4. Error Performance of BPSK

1. Generate a string of message bits.
2. Encode using BPSK with energy per bit E_b and represent it using points in a signal-space.
3. Simulate transmission of the BPSK modulated signal via an AWGN channel with variance $N_0/2$.
4. Detect using an ML decoder and plot the probability of error as a function of SNR per bit E_b/N_0.

5. Error Performance of QPSK

1. Generate a string of message bits.
2. Encode using QPSK with energy per symbol E_s and represent it using points in a signal-space.
3. Simulate transmission of the QPSK modulated signal via an AWGN channel with variance $N_0/2$ in both *I*-channel and *Q*-channel.
4. Detect using an ML decoder and plot the probability of error as a function of SNR per bit E_b/N_0 where $E_s = 2E_b$.

Part C

Any two experiments are mandatory. The students shall emulate communication systems with the help of software-defined-radio hardware and necessary control software. Use available blocks in GNU Radio to implement all the signal processing. These experiments will help students to appreciate better how theoretical concepts are translated into practice.

1. Familiarization with Software Defined Radio (Hardware and Control Software)

1. Familiarize with an SDR hardware for reception and transmission of RF signal.
2. Familiarize how it can be interfaced with computer.
3. Familiarize with GNU Radio (or similar software's like Simulink/ Lab-View) that can be used to process the signals received through the SDR hardware.
4. Familiarize available blocks in GNU Radio. Study how signals can be generated and spectrum (or power spectral density) of signals can be analyzed. Study how filtering can be performed.

2. **FM Reception**

   1. Receive digitized FM signal (for the clearest channel in the lab) using the SDR board.
   2. Set up an LPF and FM receiver using GNU Radio.
   3. Use appropriate sink in GNU Radio to display the spectrum of signal.
   4. Resample the voice to make it suitable for playing on computer speaker.

3. **FM Transmission**

   1. Use a wave file source.
   2. Set up an FM transmitter using GNU Radio.
   3. Resample the voice source and transmit using the SDR.

Schedule of Experiments Every experiment should be completed in three hours.

Text books and References

1. Carl Laufer, "The Hobbyist's Guide to the RTL-SDR: Really Cheap Software Defined Radio"
2. Neel Pandeya, "Implementation of a Simple FM Receiver in GNU Radio," https://kb.ettus.com/
3. WH Tranter, KS Shanmugan, TS Rappaport, KL Kosbar, "Principles of Communication Systems Simulation with Wireless Applications", Prentice Hall
4. Michael Ossmann, "Software Defined Radio with HackRF," YouTube Tutorial
5. Mathuranathan Viswanathan, "Digital Modulations using Python"

ECD334	MINIPROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble: The course aims

- To estimate the ability of the students in transforming the theoretical knowledge studied in to a working model of an electronic system
- For enabling the students to gain experience in organisation and implementation of small projects.
- Design and development of Small electronic project based on hardware or a combination of hardware and software for electronics systems.

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex electronic system with practical applications, this should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

Course Outcomes

CO1	Be able to practice acquired knowledge within the selected area of technology for project development.
CO2	Identify, discuss and justify the technical aspects and design aspects of the project with a systematic approach.
CO3	Reproduce, improve and refine technical aspects for engineering projects.
CO4	Work as a team in development of technical projects.
CO5	Communicate and report effectively project related activities and findings.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	2		3						2
CO 2	3	3	3	2		3					3	2
CO 3	3	3	3	2		3					3	2
CO 4								3		3	3	2
CO 5								3	3	3		2

Evaluation

The internal evaluation will be made based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, Academic coordinator for that program, project guide/coordinator.

The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	1 hour

Split-up of CIE

Component	Marks
Attendance	10
Marks awarded based on guide's evaluation	15
Project Report	10
Evaluation by Committee	40

Split-up of ESE

Component	Marks
Level of completion	10
Demonstration of functionality	25
Project Report	10
Viva-voce	20
Presentation	10

SEMESTER VI

PROGRAM ELECTIVE I

ECT312	DIGITAL SYSTEM DESIGN	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to design hazard free synchronous and asynchronous sequential circuits and implement the same in the appropriate hardware device

Prerequisite: ECT203 Logic Circuit Design

Course Outcomes: After the completion of the course the student will be able to

CO 1 **K4**	Analyze clocked synchronous sequential circuits
CO 2 **K4**	Analyze asynchronous sequential circuits
CO 3 **K3**	Design hazard free circuits
CO 4 **K3**	Diagnose faults in digital circuits
CO 5 **K2**	Summarize the architecture of FPGA and CPLDs

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	3		2				2	2		3
CO2	3	3			2				2	2		3
CO3	3	3	3	3					2	2		3
CO4	3	2		1					2	2		3
CO5	2								2	2		3

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	15
Understand	K2	10	20	30
Apply	K3	20	20	35
Analyse	K4	10		20
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

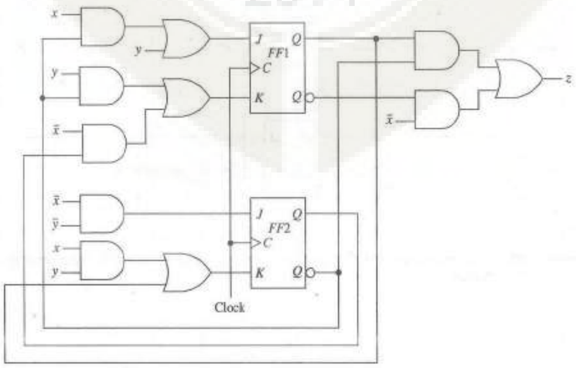
Course Outcome 1 (CO1): Analyze clocked synchronous sequential circuits (K4)

1. Construct an ASM chart for a sequence recognizer to recognize the input sequence of pairs x1x2= 01, 01, 11, 00. The output variable, ‘z’ is asserted when x1x2= 00 if and only if the three preceding pairs of inputs are x1x2= 01, 01 and 11, in that order.

2. Obtain a minimal state table for a clocked synchronous sequential network having a single input line ‘x’ in which the symbols 0 and 1 are applied and a single output line ‘z’. An outputof 1 is to be produced if and only if the 3 input symbols following two consecutive input 0’s consist of at least one 1. An example of input/output sequences that satisfy the conditions of the network specifications is:

   x=01000100100100100000000011
   z=00000010000000100000000001

3. Analyse the following clocked synchronous sequential network. Derive the next state and output equations. Obtain the excitation table, transition table, state table and state diagram.

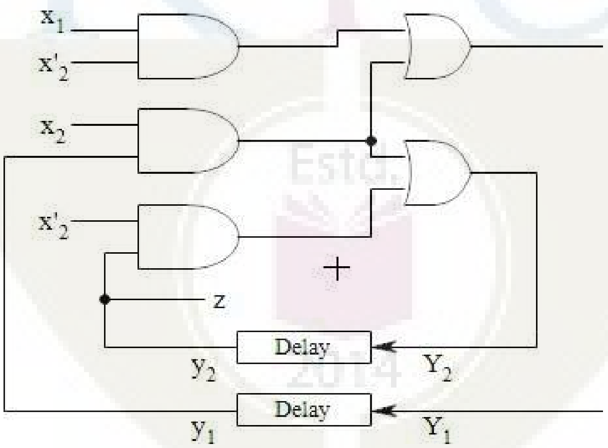


Course Outcome 2 (CO2): Analyze asynchronous sequential circuits (K4)

1. A reduced flow table for a fundamental-mode asynchronous sequential network is given below. Using the universal multiple-row state assignment, construct the corresponding expanded flow table and transition table. Assign outputs where necessary such that there is at most a single output change during the time the network is unstable. Assume that the inputs x1 and x2 never change simultaneously.

Present state	Next state				Output (z)			
	Input state (x_1x_2)				Input state (x_1x_2)			
	00	01	10	11	00	01	10	11
A	A	B	A	D	1	-	0	-
B	D	B	B	C	-	0	1	-
C	A	C	C	C	-	1	1	0
D	D	C	A	D	0	-	-	1

2. Analyze the asynchronous sequential network by forming the excitation/transition table, state table, flow table and flow diagram. The network operates in the fundamental mode with the restriction that only one input variable can change at a time.



3. Describe races in ASN with example.

Course Outcome 3 (CO3): Design hazard free circuits (K3)

1. Differentiate between static and dynamic hazard.
2. Examine the possibility of hazards in the (i) OR-AND logic circuit whose Boolean function is given by $f = \Sigma(0,2,6,7)$ (ii) AND-OR logic circuit whose Boolean function is given by $f = \Sigma(3,4,5,7)$. Show how the hazard can be detected and eliminated in each circuit.

3. Investigate the problem of clock skew in practical sequential circuits and suggest solutions with justification to minimize or eliminate it.

Course Outcome 4 (CO4): Diagnose faults in digital circuits (K3)

1. Illustrate the fault table method used for effective test set generation for the circuit whose Boolean function is $z = \overline{x_1}x_2 + x_3$
2. Find the test vectors of all SA0 and SA1 faults of the circuit whose Boolean function is $f = \bar{x}_1 x_2 + x_1x_2x_3$ by the Kohavi algorithm.
3. Write a note on BIST techniques.

Course Outcome 5 (CO5): Summarize the architecture of FPGA and CPLDs (K2)

1. Draw and explain the architecture of Xilinx XC4000 configurable logic block.
2. Draw and explain the architecture of Xilinx 9500 CPLD family.
3. Explain the internal structure of XC4000 input/output block.

SYLLABUS

Module 1: Clocked Synchronous Networks

Analysis of clocked Synchronous Sequential Networks (CSSN), Modelling of CSSN – State assignment and reduction, Design of CSSN, ASM Chart and its realization

Module 2: Asynchronous Sequential Circuits

Analysis of Asynchronous Sequential Circuits (ASC), Flow table reduction- Races in ASC, State assignment problem and the transition table- Design of AS, Design of ALU

Module 3: Hazards

Hazards – static and dynamic hazards – essential, Design of Hazard free circuits – Data synchronizers, Mixed operating mode asynchronous circuits, Practical issues- clock skew and jitter, Synchronous and asynchronous inputs – switch bouncing

Module 4: Faults

Fault table method – path sensitization method – Boolean difference method, Kohavi algorithm, Automatic test pattern generation – Built in Self Test (BIST)

Module 5: CPLDs and FPGA

CPLDs and FPGAs - Xilinx XC 9500 CPLD family, functional block diagram– input output block architecture - switch matrix, FPGAs – Xilinx XC 4000 FPGA family – configurable logic block - input output block, Programmable interconnect

Text Books

1. Donald G Givone, Digital Principles & Design, Tata McGraw Hill, 2003
2. John F Wakerly, Digital Design, Pearson Education, Delhi 2002
3. John M Yarbrough, Digital Logic Applications and Design, Thomson Learning

Reference Books

1. Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman, Digital Systems Testing and Testable Design, John Wiley & Sons Inc.
2. Morris Mano, M.D.Ciletti, Digital Design, 5th Edition, PHI.
3. N. N. Biswas, Logic Design Theory, PHI
4. Richard E. Haskell, Darrin M. Hanna , Introduction to Digital Design Using Digilent FPGA Boards, LBE Books- LLC
5. Samuel C. Lee, Digital Circuits and Logic Design, PHI
6. Z. Kohavi, Switching and Finite Automata Theory, 2nd ed., 2001, TMH

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Clocked Synchronous Networks**	
1.1	Analysis of clocked Synchronous Sequential Networks(CSSN)	2
1.2	Modelling of CSSN – State assignment and reduction	2
1.3	Design of CSSN	2
1.4	ASM Chart and its realization	1
2	**Asynchronous Sequential Circuits**	
2.1	Analysis of Asynchronous Sequential Circuits (ASC)	2
2.2	Flow table reduction- Races in ASC	2
2.3	State assignment problem and the transition table- Design of AS	2
2.4	Design of ALU	2
3	**Hazards**	
3.1	Hazards – static and dynamic hazards – essential	1
3.2	Design of Hazard free circuits – Data synchronizers	1
3.3	Mixed operating mode asynchronous circuits	1
3.4	Practical issues- clock skew and jitter	1
3.5	Synchronous and asynchronous inputs – switch bouncing	2
4	**Faults**	
4.1	Fault table method – path sensitization method – Boolean difference method	2
4.2	Kohavi algorithm	2
4.3	Automatic test pattern generation – Built in Self Test(BIST)	3
5	**CPLDs and FPGA**	
5.1	CPLDs and FPGAs - Xilinx XC 9500 CPLD family, functional block diagram– input output block architecture - switch matrix	3
5.2	FPGAs – Xilinx XC 4000 FPGA family – configurable logic block - input output block, Programmable interconnect	3

Simulation Assignments:

At least one assignment should be design of digital circuits that can be used in day today life. This has to be done in a phased manner. The first phase involves the design in HDL (VHDL/ Verilog) and the second phase implementing the same in a hardware device. Some of the assignments are as listed below:

1. Design of vending machine
2. Design of ALU
3. Architecture of different FPGAs
4. Architecture of different CPLDs
5. Fault detection methods other than those mentioned in the syllabus
6. Metastability condition and methods to avoid it

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT312

Course Name: DIGITAL SYSTEM DESIGN

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each carries 3 marks.

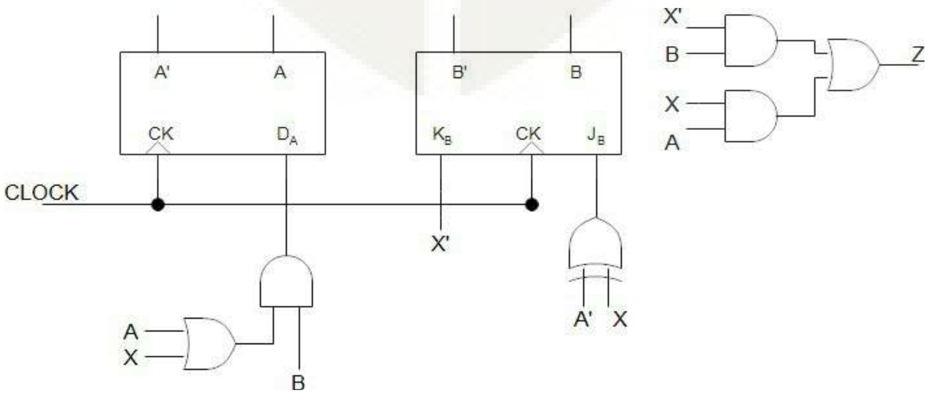
1	Differentiate Mealy and Moore models.	K1
2	What are the elements in an ASM chart?	K1
3	Describe one-hot assignment technique.	K2
4	Define critical and non-critical races.	K1
5	What is jitter? List the sources of clock jitter.	K2
6	Differentiate positive skew and negative skew.	K2
7	List the different types of faults in digital circuits.	K1
8	Differentiate between fault and defect.	K2
9	What are FPGA? What are the advantages of FPGA?	K1
10	Differentiate between FPGA and CPLD	K2

PART – B

Answer one question from each module; each question carries 14 marks.

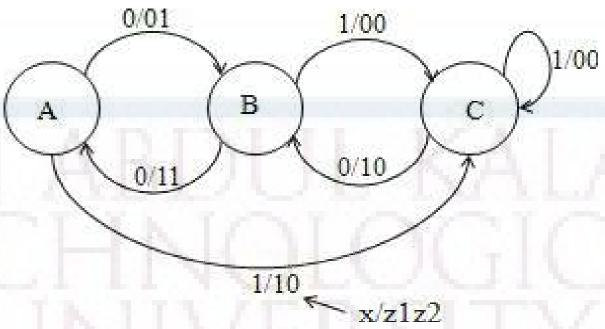
Module - I

11 a Analyze the following sequential network. Derive the next state and output equations. Obtain its transition table and state table. 8 CO1 K4



b. Construct an ASM chart for the following state diagram shown. Determine the model of CSSN that this system conforms to with proper justification. 6

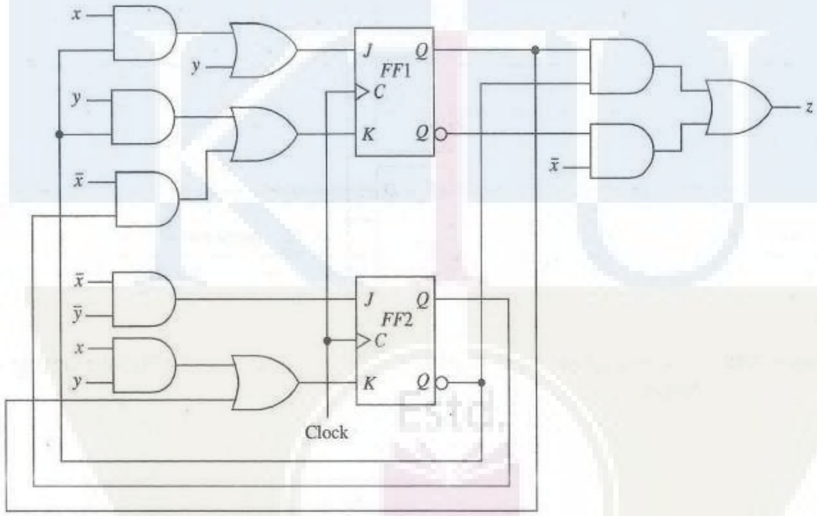
CO1
K3



OR

12 For the clocked synchronous sequential network, construct the excitation table, transition table, state table and state diagram. 8

CO1
K4



b. Obtain a minimal state table for a clocked synchronous sequential network having a single input line ‘x’ in which the symbols 0 and 1 are applied and a single output line ‘z’. An output of 1 is to be produced if and only if the 3 input symbols following two consecutive input 0’s consist of at least one 1. An example of input/output sequences that satisfy the conditions of the network specifications is: 6

x= 0100010010010010000000011

z= 0000001000000100000000001

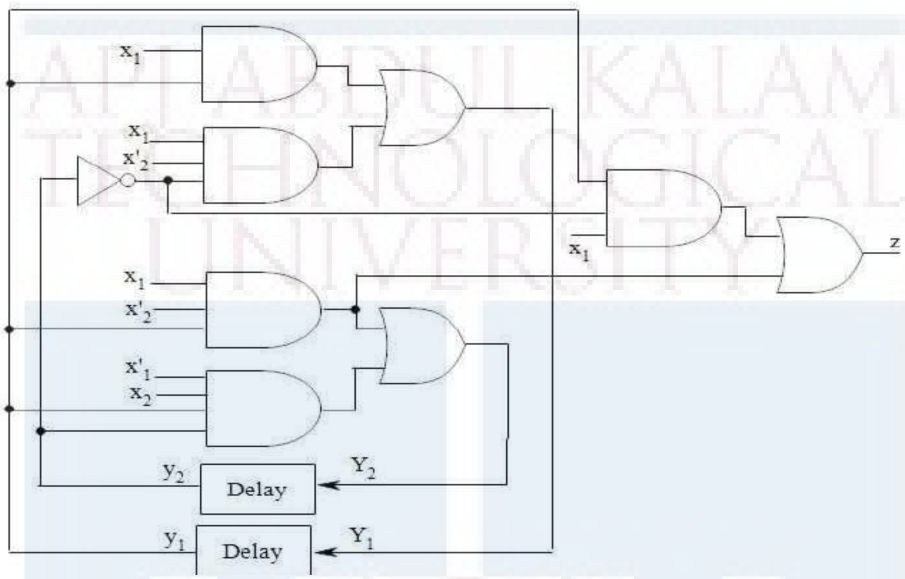
CO1
K3

Module - II

13a Analyze the asynchronous sequential network by forming the excitation/transition table, state table, flow table and flow diagram. The network operates in the fundamental mode with the restriction that only one input variable can change at a time.

14

CO2
K4



OR

x_1 x_2

14a A reduced flow table for a fundamental-mode asynchronous sequential network is given below. Using the universal multiple-row state assignment, construct the corresponding expanded flow table and transition table. Assign outputs where necessary such that there is at most a single output change during the time the network is unstable. Assume that the inputs and never change simultaneously.

14

CO2
K4

Present state	Next state				Output (z)			
	Input state (x_1x_2)				Input state (x_1x_2)			
	00	01	10	11	00	01	10	11
A	Ⓐ	B	Ⓐ	D	1	-	0	-
B	D	Ⓑ	Ⓑ	C	-	0	1	-
C	A	Ⓒ	Ⓒ	Ⓒ	-	1	1	0
D	Ⓓ	C	A	Ⓓ	0	-	-	1

Module - III

15a. Examine the possibility of hazard in the OR-AND logic circuit whose Boolean function is given by $f = \Sigma(0,2,6,7)$. Show how the hazard can be detected and eliminated. 8 CO3 K3

b. Explain essential hazards in asynchronous sequential networks. What are the constraints to be satisfied to avoid essential hazards? 6 CO3 K3

OR

16a Draw the logic diagram of the POS expression Y= (x1+x2’) (x2+x3). Show that there is a static-0 hazard when x1 and x3 are equal to 0 and x2 goes from 0 to 1. Find a way to remove the hazard by adding one or more gates. 9 CO3 K3

b Discuss the concept of switch bouncing and suggest a suitable solution. 5 K3

Module - IV

17a Illustrate the fault table method used for effective test set generation for the circuit whose Boolean function is $z = \overline{x_1}x_2 + x_3$ 8 CO 4 K3

b How can the timing problems in asynchronous sequential circuits be solved using mixed operating mode circuits? 6 K3

OR

18 a. Find the test vectors of all SA0 and SA1 faults of the circuit whose Boolean function is $f = \bar{x}_1 x_2 + x_1x_2x_3$ by the Kohavi algorithm. 8 CO4 K3

b. Identify different test pattern generation for BIST 6 CO4 K3

Module - V

19 Explain the architecture of XC 4000 FPGA family. 14 CO5 K2

OR

20 Draw and explain the architecture of Xilinx 9500 CPLD family. Also explain the function block architecture. 14 CO5 K2

ECT322	POWER ELECTRONICS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to develop the skill of the design of various power electronic circuits.

Prerequisite: ECT201 Solid State Devices, ECT202 Analog Circuits

Course Outcomes: After the completion of the course the student will be able to

CO 1 K2	Understand the characteristics of important power semiconductor switches
CO 2 K3	Apply the principle of drive circuits and snubber circuits for power semiconductor switches
CO 3 K3	Build diode bridge rectifiers and Controlled rectifiers
CO 4 K3	Develop DC – DC Switch-Mode Converter
CO 5 K2	Illustrate the principle of DC – AC Switch-Mode Inverter
CO 6 K3	Apply the principle of power electronics for various applications

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1		2			2							
CO 2		3			2							
CO 3		3			2							
CO 4		3			2							
CO 5		2			2							
CO 6		3			2							

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the characteristics of important power semiconductor switches.

1. Illustrate the static and dynamic characteristics, Power BJT, Power MOSFET and IGBT.
2. Illustrate the construction and characteristics of SCR and GTO
3. Model and simulate power semiconductor switches.

Course Outcome 2 (CO2): Apply the principle of drive circuits and snubber circuits for power semiconductor switches.

1. Design the base drive circuits for Power BJT.
2. Design the gate drive circuits for Power MOSFET.
3. Outline the principle of snubber circuits for power switches.
4. Model and simulate above circuits.

Course Outcome 3 (CO3): Build diode bridge rectifiers and Controlled Rectifiers.

1. Explain the operation of three phase diode rectifier and the effect of various loads on the rectifier function
2. Explain the operation of controlled rectifiers and the effect of various loads on the rectifier function
3. Model and simulate diode rectifiers and controlled rectifiers for various loads

Course Outcome 4 (CO4): Develop the principle of DC – DC Switch-Mode Converter

1. Illustrate the principle of DC-DC converters under steady state conditions.
2. Design non-isolated and isolated DC-DC converters for given specifications.
3. Model and simulate non-isolated and isolated DC-DC Switch-Mode converters

Course Outcome 5 (CO5): Illustrate the principle of DC – AC Switch-Mode Inverter.

1. Understand the different types of inverters
2. Construct Driven Inverters for given specifications.
3. Model and simulate Driven Inverters

Course Outcome 6 (CO6): Apply the principle of power electronics for various applications.

1. Illustrate the principle of Adjustable-speed DC drive.
2. Explain the principle of Variable frequency PWM-VSI Induction Motor drives
3. Give at least two applications of power electronic circuits for residential applications.
4. Explain at least two applications of power electronic circuits for industrial applications

SYLLABUS

Module 1 : Power Semiconductor Switches

Power diodes, Power BJT, Power MOSFET and IGBT - static and dynamic characteristics, SCR and GTO

Module 2 : Protection circuits and Rectifiers

BJT and MOSFET drive circuits, Snubber circuits, Three phase diode bridge rectifiers, Single phase and three phase controlled rectifiers.

Module 3 : DC – DC Switch Mode Converters

Buck, Boost and Buck-boost DC-DC converters

Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode. (No derivation required)

Isolated converters: Flyback, Forward, Push Pull, Half bridge and Full bridge converters – Waveforms and governing equations (No derivation required)

Module 4 : DC-AC Switch Mode Inverters

Inverter topologies, Driven Inverters : Push-Pull, Half bridge and Full bridge configurations, Three phase inverter, Pulse width modulation

Module 5 : Applications

DC Motor Drives, Induction Motor Drives, Residential and Industrial applications.

Text Books

1. Umanand L, "Power Electronics: Essentials & Applications", Wiley India, 2015
2. Ned Mohan, Tore M Undeland, William P Robbins., "Power Electronics: Converters, Applications, and Design"., Wiley India Pvt. Ltd, 3/e, 2015

Reference Books

1. Muhammad H. Rashid., "Power Electronics : Circuits, Devices, and Applications", Pearson Education India, 4/e, 2014.
2. Daniel W. Hart, Power Electronics, McGraw Hill, 2011.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Power Semiconductor Switches**	
1.1	Power diodes and Bipolar power transistors – structure, static and dynamic characteristics	2
1.2	Power MOSFET and IGBT – structure, static and dynamic characteristics	3
1.3	SCR and GTO – construction and characteristics	2
2	**Protection circuits and Rectifiers**	
2.1	BJT and MOSFET driver circuits (at least two circuits each)	2
2.2	Snubber circuits – ON and OFF snubbers	1
2.3	Three phase diode bridge rectifiers – basic principles only	1
2.4	Single phase and three phase Controlled rectifiers (with R, RL & RLE loads) – basic principles only	3
3	**DC – DC Switch Mode Converters**	
3.1	Buck, Boost and Buck-Boost DC-DC converters	2
3.2	Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode (No derivation required)	3
3.3	Isolated converters: Flyback, Forward, Push Pull, Half bridge and Full bridge converters – Waveforms and governing equations (No derivation required)	3
4	**DC-AC Switch Mode Inverters**	
4.1	Inverter topologies	2
4.2	Driven Inverters: Push-Pull, Half bridge and Full bridge	2

	configurations	
4.3	Three phase inverter	1
4.4	Sinusoidal and Space vector modulation PWM in three phase inverters	2
5	**Applications**	
5.1	DC Motor Drives – Adjustable-speed DC drive	2
5.2	Induction Motor Drives – Variable frequency PWM-VSI drives	2
5.3	Residential and Industrial applications	2

Assignment:

At least one assignment should be simulation of power electronic circuits using any circuit simulation software.

Simulation Assignments (ECT 322)

The following simulations can be done in LTspice or any other circuit simulation software.

1. Model and simulate BJT test circuit Fig. 1.50 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.48.
2. Model and simulate MOSFET test circuit Fig. 1.51 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.49.
3. Model and simulate IGBT test circuit Fig. 1.52 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.50.
4. Model and simulate BJT drive test circuit Fig. 2.33 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.86.
5. Model and simulate MOSFET drive test circuit Fig. 2.36 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.88.
6. Model and simulate MOSFET shunt snubber test circuit Fig. 2.37of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.89.
7. Model and simulate MOSFET seriessnubber test circuit Fig. 2.39of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.90.
8. Model and simulate diode rectifiers and controlled rectifiers for various loads.
9. Model and simulate Buck converter circuit Fig. 5.68of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.277.
10. Model and simulate Boost converter circuit Fig. 5.70of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.278.
11. Model and simulate Buck-boost converter circuit Fig. 5.71of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.279.

12. Model and simulate Forward converter circuit Fig. 5.72of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.280.
13. Model and simulate Flyback converter circuit Fig. 5.73of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.281.
14. Model and simulate Driven Inverters
15. Model and simulate Pulse Width Modulator

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT 322

Program: Electronics and Communication Engineering
Course Name: Power Electronics
Max.Marks: 100 Duration: 3Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	What is meant by reverse recovery time for a diode	K2	CO1
2	What is the tail current in IGBT ?	K2	CO1
3	What is the purpose of snubber circuits ?	K2	CO2
4	Obtain the expression for average load voltage in three phase full wave bridge rectifier	K3	CO3
5	What is volt-second balancing?	K2	CO4
6	What is the flux walking problem in push-pull converter ?	K2	CO4
7	What is the distinction between chopper, oscillators and inverters ?	K3	CO5
8	Distinguish between driven and self-driven inverters.	K2	CO5
9	How converters are used in induction heating ?	K2	CO6
10	What is regenerative breaking in PWM-VSI drive?	K2	CO6

PART – B

Answer one question from each module; each question carries 14 marks.

	Module – I			
11(a)	Compare and contrast power BJT, MOSFET and IGBT for switching applications	7	CO 1	K2
11(b)	A diode and a 10 Ω resistor are connected in series to a square wave voltage source of 50V peak. The reverse recovery time for the diode is 200nsec. Find the switching loss of the diode when the input frequency is 100 KHz.	7	CO 1	K3
	OR			
12(a)	With the two-transistor model of SCR, explain the working principle of SCR	7	CO 1	K2
12(b)	Illustrate the dynamic characteristics of GTO	7	CO 1	K2
	Module – II			
13(a)	Illustrate the base current requirement of power BJT	7	CO 2	K2
13(b)	Explain the operation of any one type of the power BJT base drive circuit	7	CO 2	K2
	OR			
14(a)	Illustrate the principle of operation of a single-phase, 2 pulse, fully controlled rectifier for RL load with circuit diagram and waveforms.	10	CO 3	K2
14(b)	Deduce the expression for average load voltage in the circuit.	4	CO 3	K2
	Module – III			
15(a)	Explain the operation of Buck-Boost converter and illustrate the operation with the inductor current and switching waveforms.	8	CO 4	K2
15(b)	A Buck-Boost converter that switching at 50 KHz is supplied with an input voltage that varies between 5V to 10V. The output is required to be regulated at 15V. A load resistor of 15Ω is connected across the output. If the maximum allowable inductor current ripple is 10% of the average inductor current, estimate the value of the inductance to be used in the Buck-Boost converter.	6	CO 4	K3
	OR			

16(a)	Describe the principle of operation of the full-bridge converter with circuit diagram and waveforms.	8	CO 4	K2
16(b)	How is the flux walking problem solved in full-bridge converter ?	6	CO 4	K2
	Module – IV			
17(a)	Explain the operation of push-pull inverter	8	CO 5	K2
17(b)	Illustrate the PWM switching scheme for sine wave output of the inverter	6	CO 5	K2
	OR			
18(a)	Enumerate the principle of operation of three phase inverters	8	CO 5	K2
18(b)	What is Space vector modulation in three phase inverters	6	CO 5	K2
	Module – V			
19(a)	Explain the principle of adjustable speed DC drive using switched mode DC-DC converter.	8	CO 6	K2
19(b)	Compare adjustable speed DC drives using switched mode DC-DC converter and line frequency-controlled converter.	6	CO 6	K2
	OR			
20 (a)	Illustrate the principle of operation of Variable frequency PWM-VSI Induction Motor drive.	9	CO 6	K2
20(b)	Explain dissipative braking scheme in Induction Motor drive.	5	CO 6	K2

ECT332	DATA ANALYSIS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to set the foundation for students to develop new-age skills pertaining to analysis of large-scale data using modern tools.

Prerequisite: None

Course Outcomes: After the completion of the course the student will be able to

CO 1	Read and write data to and fro spreadsheets and databases
CO 2	Work with large data as pandas data frames
CO 3	Perform PCA and cluster analysis on data frames
CO 4	Perform Bayesian analysis on data frames.
CO 5	Apply machine learning in data analysis problems
CO 6	Apply methods in high performance computing for data analysis

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3			3							2
CO 2	3	3	2	3	3							
CO 3	3	3	2	3	3	2						2
CO 4	3	3	2	3	3	2						2
CO 5	3	3	2	3	3	2						2
CO 6	3	3	2	3	3	2						2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Read and write data to and fro spreadsheets and databases

1. Write Python code to read an .xls file using xlrd module. Sve it as a different .xlsx file using openpyxl.
2. Write Python code to read mongodb data base.

Course Outcome 2 (CO2): Work with pandas dataframes

1. Write Python code read a table in a pdf file as a pandas dataframe.
2. Write Python code to create a pandas dataframe. Pickle this data and store it. Write another Python code to retrive the data from the pickle.

Course Outcome 3 (CO3): PCA and Cluster Analysis

1. Write Python code to perform PCA on a pandas dataframe. Write code to create a scree plot.
2. Write Python code to do K-means clustering.

Course Outcome 4 (CO4): Bayesian Analysis on Dataframes

1. Write Python code to compute the posterior probability of a data set with Pymc3
2. Write a python code to evaluate the statistical correlation between variables in 5X5 random data set.

Course Outcome 5 (CO5): Machine learning in Data Analysis

1. Write python code to use Keras for training a CNN
2. Write Python code to read an RGB image and convert to gray scale and write the grayscale image in .jpg format.

Course Outcome 5 (CO6): High Performance Computing Methods in Data analysis

1. Write Python code to use numexpr for faster parallel computation
2. Write Python code with Ipython-parallel to perform parallel computing with 4 cores.

SYLLABUS

Module 1: Overview of Data Analysis and Python

Numpy and Scipy Python modules for data analysis. Reading and processing spreadsheets and csv files with Python using xlrd, xlwt and openpyxl. Data visualization with Matplotlib. Two dimensional charts and plots. Scatter plots with matplotlib. Three dimensional visualization using Mayavi module. Reading data from sql and mongodb databases with Python.

Module 2: Big Data Arrays with Pandas

Familiarization of the python pandas. Reading and writing pandas dataframes. Reading rows and columns from pandas dataframe. Handling NaN values. Reading and writing .txt, .csv, .pdf, .html and json files with pandas. Merging, concatenating and grouping of data frames. Use of pivot tables. Pickling of data frames in Python.

Module 3: PCA and Cluster Analysis

Singular value decomposition of a matrix/array. Eigen values and eigen vectors. Principal component analysis of a data frame**.** Scree plot. Dimensioanality reduction with PCA. Loadings for principal components. Case study with Python. Cluster analysis. Hierarchial and K-means clustering. Interpretation of dendrograms.

Module 4: Statistical Data Analysis

Hypothesis testing. Bayesian analysis. Meaning of prior, posterior and likelyhood functions. Use of pymc3 module to compute the posterior probability. MAP Estimation. Credible interval, conjugate distributions. Contingency table and chi square test. Kernel density estimation.

Module 5: Machine Learning

Supervised and unsupervised learning. Use of scikit-learn. Regression using scikit-learn. Deep learning with convolutional newural networks. Structure of CNN. Use of Keras and Tensorflow. Machine learning with pytorch. Reading and writing images with openCV. Case study of character recognition with MNIST dataset. High performance computing for machine learning. Use of numba, jit and numexpr for faster Python code. Use of Ipython-parallel.

Text Books and References

1. “Python Data Analytics”, Fabio Nelli, Apress.
2. “Data Analysis from Scratch with Python”, Peters Morgan, AI Sciences.
3. “Python for Data Analysis”, Wes McKinny, O’Reilly.
4. “Ipython Interactive Computing and Visualization Cookbook”, Cyrille Rossant , PACKT Open Source Publishing
5. “Deep Learning with Python”, Francois Chollet, Manning

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Overview of Data Analysis and Python**	
1.1	Numpy and Scipy Python modules for data analysis.	2
1.2	Reading and processing spreadsheets and csv files with Python using xlrd, xlwt and openpyxl.	2
1.3	Data visualization with Matplotlib. Two dimensional charts and plots. Scatter plots with matplotlib. Three dimensional visualization using Mayavi module.	2
1.4	Reading data from sql and mongodb databases with Python	2
2	**Big Data Arrays with Pandas**	
2.1	Intro. To Python pandas	1
2.2	Reading and writing of data as pandas dataframes. Separating header, columns row etc and other manipulations	3
2.3	Reading data from different kind of files, Merging, concatenating and grouping of data frames. Use of pivot tables. Pickilng	3
3	**PCA and Cluster Analysis**	
3.1	Singular value decomposition of a matrix/array. Eigen values and eigen vectors.	1
3.2	PCA,Scree plot. Dimensioanality reduction with PCA. Loadings for principal components. Case study with Python. Cluster analysis.	3
3.3	Cluster analysis, dendrograms	2
4	**Statistical Data Analysis**	
4.1	Hypothesis testing. Bayesian analysis. Meaning of prior, posterior and likelyhood functions. Use of pymc3 module to compute the posterior probability.	3
4.2	MAP Estimation. Credible interval, conjugate distributions .Contingency table and chi square test. Kernel density estimation.	3
4.3	Contingency table and chi square test. Kernel density estimation.	3
5	**Machine Learning**	
5.1	Supervised and unsupervised learning. Use of scikit-learn. Regression	2
	using scikit-learn.	
5.2	Deep learning with convolutional newural networks. Structure of CNN.	2
5.3	Use of Keras and Tensorflow. Machine learning with pytorch. Case study of character recognition with MNIST dataset.	3
5.4	High performance computing for machine learning. Use of numba, jit and numexpr for faster Python code. Use of Ipython-parallel.	2

Simulation Assignments

1. Download the iris data set and read into a pandas data frame. Extract the heaser and replace with a new header. Extract colums and rows. Extract pivot tables. Filter the data based on the labels. Store a pivot table as a pickle and retrieve it.
2. For the same data sert, perform principal component analysis. Observe the scree plot. Identify the principal components. Obtain a low dimensional data, with only the principal components and compute the mean square error between the original data and the approximated one. Compute the loadings for the principal components.
3. For the same data, perform hierarchical and K-means clustering with Python codes. Obtain dendrograms in each case and appreciate the clusters.
4. Download the MNIST letter data set. Construct a CNN network with appropriate layers using Keras and Tensorflow. Train the CNN with the MNIST data set. Appreciate the selection and use of training, test and cross-validation data sets. Save the model and weights and use the model to identify letter images. You may use openCV for reading images.
5. Write a Python script to generate alphanumeric images (26 upper case, 26 lowercase and 10 numbers each 12 point in size) of say 16X16 dimension out of windows .ttf files. Create 62 folders each containg a data set of every alphanumeric character. Create a new CNN with Keras and Tensorflow. Create a cross validation data set by taking 10 images out of every 62 folder. Use 80% of the total data for training and 20% for testing the CNN. Use an HPCC like system to train the model and save the model and weight. Test this model to recognize letter images. You may use openCV for reading images.
6. Repeat assignment 4 using pytorch instead of Keras
7. Repeat assignment 5 using pytorch instead of Keras

Model Question Paper

A P J Abdul Kalam Technological University
Sixth Semester B Tech Degree Examination
Course: ECT 332 Data Analysis

Time: 3 Hrs Max. Marks: 100

PART A

Answer All Questions

1 Create a two dimensional array of real numbers using numpy. Write Python code to pickle this data. (3) K_3

2 Write Python code to import mayavi module and perform 3-D visualization of $x^2 + y^2 + z^2 = 1$ (3) K_3

3 Write Python code to generate a 5 × 5 pandas data frame of random numbers. Add a header to this dataframe. (3) K_3

4 Write Python code to concatenate two dataframes of same num- ber of columns. (3) K_3

5 Write the expression for the singular value decomposition of a matrix A (3) K_3

6 Explain how principal components are isolated using scree plot. (3) K_1

7 State Bayes theorem and explain the significance of the terms prior, likelyhood and posterior. (3) K_1

8 Write Python code with pymc3 to realize a Bernoulli trial with $p(head) = 0.2$ (3) K_3

9 Give the structure a convolutional neural network (3) K_1

10 Compare supervised and unsupervised learning (3) K_1

PART B

Answer one question from each module. Each question carries 14 mark.

Module I

11(A) Write Python code to read a spreadsheet in .xls format a text file in .csv format and put these data into numpy arrays. in both cases, plot the second column against the first column using matplotlib (8) K_3

11(B) Write Python code to read tables from sql and mongodb databases. (6) K_3

OR

12(A) Write Python code to create a normally distributed 5 × 5 random array and convert it into a matrix. Write code to (8) K_3

compute its inverse and transpose.

12(B) Write code to read files in .xlsx format using openpyxl (6) K_3

Module II

13(A) Write Python code to import a table in .xls format into a data frame. Remove all NaN values. (6) K_3

13(B) Write Python code to generate 10 data frames of size 5 × 5 of random numbers and use a *for loop* to concatenate them. Pickle the concatenated dataframe and store it. Write another code to retrieve the dataframe from the pickle. (8) K_3

OR

14(A) Write Python code to read in a table from a pdf file into a pandas dataframe. Write code to remove the first two columns and write the rest of the dataframe as a json file. (8) K_3

14(B) Explain the term pivot table. Create a pivot table from the above dataframe (6) K_3

Module III

15 Write Python code to read in table in .xls format, perform PCA analysis on it and produce the scree plot and loadings for the principal components. (14) K_3

OR

16. Write Python code to perform hierarchial cluster analysis on a pandas dataframe. Explain how dendrograms can be used to classify data. (14) K_3

Module IV

17(A) Assume that you have a dataset with 57 data points of Gaussian distribution with a mean of 4 and standard deviation of 0.5. Using PyMC3, write Python code to compute: (8) K_3

- The posterior distribution
- The prior distribution
- The posterior predictive distribution

.

17(B)	Write a python code to find the Bayesian credible interval in the above question. How is it different from confidence interval.	(6)	K_3

OR

18(A)	Write a python code to evaluate the statistical correlation between variables in 10 × 10 random data set.	(8)	K_3
18(B)	Compute the conjugate of the logarithmic function $f(x) = lnx,\ x > 0.$	(6)	K_3

Module V

19(A)	Explain the use of numba and numexpr in fatser Python execution with examples	(8)	K_3
19(B)	Explain the use of Keras as a frontend for Tensorflow with Python codes	(6)	K_3

OR

20(A)	Explain the use of Ipython-parallel in parallel execution of Python code with examples.	(8)	K_3
20(B)	Explain with Python codes how openCV is used to read and writte images.	(8)	K_3

ECT342	EMBEDDED SYSTEMS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to design an embedded electronic circuit and implement the same.

Prerequisite: ECT 203 Logic Circuit Design, ECT 202 Analog Circuits ,ECT 206 Computer Architecture and Microcontrollers

Course Outcomes: After the completion of the course the student will be able to

CO 1 K2	Understand and gain the basic idea about the embedded system.
CO 2 K3	Able to gain architectural level knowledge about the system and hence to program an embedded system.
CO 3 K3	Apply the knowledge for solving the real life problems with the help of an embedded system.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3	2		1			2				2
CO 2	3	3	3		3			2				2
CO 3	3	3	3		3			2	3			2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember K1	10	10	10
Understand K2	20	20	20
Apply K3	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1) : Understand the embedded system fundamentals and system design (K1).

1. Give the challenges of embedded computing.
2. Give the structural description of embedded system.
3. What are the phases of EDLC ?.

Course Outcome 2 (CO2): Understand the peripheral devices and their interfacing with the processor. (K2)

1. Compare and contrast the PCI bus and PCI-X bus.
2. How the ROM memories are classified? Explain.
3. How the peripheral devices are connected with processors?

Course Outcome 3 (CO3): To understand the ARM processor architecture and pipeline processor organization. (K3)

1. Give the architecture of the ARM processor and explain the registers.
2. Explain the pipelined architecture of ARM processor.
3. Write an ARM assembly language program to print the sum of two numbers.

Course Outcome 4 (CO4): To write programs in assembly and high level languages for ARM processor. (K3)

1. Write a note on Thumb single register in ARM processor.
2. Briefly discuss about the Advanced Microcontroller Bus Architecture (AMBA).
3. What are the data types supported by ARM programming high level languages?

Course Outcome 5 (CO5): To understand the basics of real time operating systems and their use in embedded systems. (K2)

1. What are the functions of a Kernel?
2. Describe the process ," Deadlock"
3. Give the features of a real time operating system.

SYLLABUS

Module 1 : Introduction to Embedded Systems(06 Hours)

1.1 Complex Systems and Microprocessors

Embedding Computers, Characteristics of Embedded Computing Applications, Application of Microprocessors, The Physics of Software, Challenges in Embedded Computing System, Characteristics and quality attributes of an embedded system, Performance in Embedded Computing

1.2 The Embedded System Design Process

Requirements, Specification , Architecture Design, Designing Hardware and Software Components ,System Integration.

1.3 Formalisms for System Design

Structural Description, Behavioral Description, An embedded system design example.

1.4 Embedded product development cycle (EDLC)

Different phases of EDLC, EDLC models

Module 2 : Embedded system interfacing and peripherals (06 Hours)

2.1 Communication devices

Serial Communication Standards and Devices - UART, HDLC and SPI. Serial Bus Protocols - I^2C Bus, CAN Bus and USB Bus. Parallel communication standards ISA, PCI and PCI-X Bus.

2.2 Memory

Memory devices and systems – ROM-Flash, EEPROM,RAM-SRAM, DRAM, Cache memory, memory mapping and addresses, memory management unit– DMA .

2.3 I/O Device

Interrupts--Interrupt sources, recognizing an interrupt, ISR – Device drivers for handling ISR, Shared data problem, Interrupt latency.

Module 3 : ARM Processor fundamentals (07 Hours)

3.1 ARM Processor architecture

The Acorn RISC Machine, Architectural inheritance, The ARM programmer's model, ARM development tools.

3.2 ARM Assembly Language Programming

Data processing instructions, Data transfer instructions, Control flow instructions, writing simple assembly language programs.

3.3 ARM Organization and Implementation

Three stage pipeline ARM organization, Five stage pipeline ARM organization, ARM instruction execution, ARM implementation, The ARM coprocessor interface.

Module 4: ARM Programming (10 Hours)

4.1 Architectural Support for High-Level Languages

Abstraction in software design, Data types, Floating-point data types, The ARM floating-point architecture, Expressions, Conditional statements, Loops, Functions and procedures, Use of memory, Run-time environment.

4.2 The Thumb Instruction Set

The Thumb bit in the CPSR, The Thumb programmer's model, Thumb branch instructions, Thumb software interrupt instruction, Thumb data processing instructions, Thumb single register data transfer instructions, Thumb multiple register data transfer instructions, Thumb breakpoint instruction, Thumb implementation, Thumb applications.

4.3 Architectural Support for System Development

The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA).

4.4 Programming

Assembly and C language programming applications of embedded systems.

Module 5: Real Time Operating Systems (07 Hours)

5.1 Operating system basics

Kernel, types of operating systems.

5.2 Real time operating systems

Tasks, process, threads, multiprocessing and multi-tasking, task scheduling, types, threads and process scheduling, task communication, task synchronization, device drivers, choosing an RTOS.

Text Books

1. 1. Raj kamal, Embedded Systems Architecture, Programming and Design, TMH, 2003
2. K.V. Shibu, Introduction to Embedded Systems, 2e, McGraw Hill Education India, 2016.
3. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, Morgan Kaufman Publishers - Elsevier 3ed, 2008
4. Steve Furber, ARM system-on-chip architecture, Addison Wesley, Second Edition, 2000

Reference Books

1. David E. Simon, An Embedded Software Primer, Pearson Education Asia, First Indian Reprint 2000.
2. Steve Heath, Embedded Systems Design, Newnes – Elsevier 2ed, 2002
3. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide Designing and Optimizing System Software, Morgan Kaufmann Publishers 2004
4. Frank Vahid and Tony Givargis, Embedded Systems Design – A Unified Hardware / Software Introduction, John Wiley, 2002.
5. Tammy Noergaard, Embedded Systems Architecture, A Comprehensive Guide for Engineers and Programmers, Newnes – Elsevier 2ed, 2012
6. Iyer - Embedded Real time Systems, 1e, McGraw Hill Education New Delhi, 2003
7. Lyla B. Das, Embedded Systems: An Integrated Approach, 1/e , Lyla B. Das, Embedded Systems, 2012

Course Contents and Lecture Schedule

No	**Topic**	**No. of Lectures**
1	**Introduction to Embedded Systems**	
1.1	Complex Systems and Microprocessors	2
1.2	The Embedded System Design Process	1
1.3	Formalisms for System Design	2
1.4	Embedded product development cycle (EDLC)	1
2	**Embedded system interfacing and peripherals**	
2.1	Communication devices	3
2.2	Memory	2
2.3	I/O Device	2

3	**ARM Processor fundamentals**	
3.1	ARM Processor architecture	2
3.2	ARM Assembly Language Programming	3
3.3	ARM Organization and Implementation	2
4	**ARM Programming**	
4.1	Architectural Support for High-Level Languages	2
4.2	The Thumb Instruction Set	3
4.3	Architectural Support for System Development	2
4.4	Programming	3
5	**Real Time Operating Systems**	
5.1	Operating system basics	2
5.2	Real time operating systems	5

Simulation Assignments:

1. At least one assignment should be of programming (Both assembly and C languages) of embedded processor with simulation tools like Keil, Eclipse.
2. Another assignment should be an embedded system design mini project.

Programming assignments can be the following

(a) Print "HELLO WORLD" or any text (b) Data transfer, copy operations (c) Arithmetic operations (d) Sorting operations (e) input/output control (f) programs using functions (g) Interrupts and ISR (h) controller design

Mini project can be done in the following areas.

(a) Elevator controller design (b) Chocolate vending machine design (c) Industrial controller using sensors (d) IOT applications using sensors, communication devices and actuators

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT342

Course Name: EMBEDDED SYSTEM DESIGN

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer ALL Questions. Each Question Carries 3 Marks.)

1. Define an embedded system
2. Write any 3 challenges of embedded system design
3. Explain how an RS232 device is interfaced to a processor
4. What is interrupt latency?
5. Write the contents of CPSR register of ARM processor and their use.
6. Draw the five stage pipeline architecture of ARM processor
7. What is the use of thumb instruction set in ARM processor?
8. What a note on ARM memory interface
9. What is a real time operating system?
10. What are tasks, processes and threads? [10 X 3= 30]

PART – B

(Answer one question from each module; each question carries 14 marks)

Module – I

11. (a) What are the characteristics of an embedded system? Explain. [07 Marks]
    (b) Explain the different phases of EDLC. [07 Marks]

OR

12. (a) Write different steps involved in the embedded system design process. [07Marks]

    (b) Explain the structural description of embedded system design. [07 Marks]

Module – II

13. (a) What is serial and parallel port communication? Explain with the help of necessary diagrams. [07 Marks]

(b) What is interrupt? How interrupts are handled in a processor? Explain ISR.[07 Marks]

OR

14. (a) With the help of a diagram show how ROM and RAM are interfaced to a processor. Explain the read/write processes. [07 Marks]

(b) Explain how a memory management unit is used in a processor. What are its uses? What is DMA ? [07 Marks]

Module – III

15. (a) Write a note on ARM processor architecture and its registers. [07 Marks]

(b) Write a note on data processing and data transfer instructions with the help of examples [07 Marks]

OR

16. (a) What is pipeline architecture? Explain how an ARM instruction is executed in a 5 stage pipeline processor with the help of an example. [08 Marks]

(b) Write an ARM assembly language program to print text string “Hello World”. [06 Marks]

Module – IV

17. (a) Explain ARM floating point architecture and discuss how floating point numbers are handled [07 Marks]

(b) Write a note on Thumb single register and multiple register data transfer instructions with the help of examples. [07 Marks]

OR

18. (a) What is Thumb instruction set? Why it is used? Explain Thumb progrmmers model. [07 Marks]

(b) Draw the block diagram of AMBA architecture. What are the different types of buses used in the architecture? [07 Marks]

Module V

19. (a) What are the different services of Kernel? Explain different types of Kernels. [07Marks]

(b) Explain pre-emptive and non-pre-emptive scheduling algorithms with the help of an example. [07 Marks]

OR

20. (a) What are the basic functions of real time Kernel? Explain. [07 Marks]

(b) Write a note on the following (a) shared memory (b) message passing (c) deadlock [07 Marks]

ECT352	DIGITAL IMAGE PROCESSING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to develop the skills for methods of various transformation and analysis of image enhancement, image reconstruction, image compression, image segmentation and image representation.

Prerequisite: ECT 303 Digital Signal Processing

Course Outcomes: After the completion of the course the student will be able to

CO 1	Distinguish / Analyse the various concepts and mathematical transforms necessary for image processing
CO 2	Differentiate and interpret the various image enhancement techniques
CO 3	Illustrate image segmentation algorithm
CO 4	Understand the basic image compression techniques

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3	2		1							2
CO 2	3	3	2		1							2
CO 3	3	3	3		1							2
CO 4	3	3	3		1							2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember K1	10	10	10
Understand K2	20	20	20
Apply K3	20	20	70
Analyse K4			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:
Attendance: 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. The questions must have 50% representation from theory, and 50% representation from logical/numerical/derivation/ proof.

Course Level Assessment Questions

Course Outcome 1 (CO1): Analyze the various concepts and restoration techniques for image processing

1. For the given image check whether pixel P and Q have 8 connectivity.
2. Find filtered image using median filter.
3. Explain Weiner filtering.

Course Outcome 2 (CO2): Differentiate and interpret the various image enhancement techniques

1. Classify different image enhancement process. Differentiate between spatial domain and frequency domain techniques of image enhancement.
2. What is histogram equalisation? Briefly discuss the underlying logic behind histogram equalisation.
3. Apply mean and median filters over a given image.

Course Outcome 3 (CO3): Illustrate image segmentation algorithm

1. Name two basic approaches of image segmentation and mention their differences.
2. How can you decide optimal thresholds when the image contains a background and several foreground objects? Write down a corresponding algorithm.
3. Write down the region growing algorithm. What are its advantages and disadvantages?

Course Outcome 4 (CO4): Analyze basic image compression techniques

1. What do you mean by compression ratio? Do you consider that lower compression ratio ensures better images upon reproduction?
2. How can achievable compression ratio to be determined from image histogram?
3. Mention the steps of lossy and lossless JPEG compression

SYLLABUS

Module 1

Digital Image Fundamentals: Image representation, basic relationship between pixels, elements of DIP system, elements of visual perception-simple image formation model. Vidicon and Digital Camera working principles Brightness, contrast, hue, saturation, mach band effect
Colour image fundamentals-RGB, CMY, HIS models, 2D sampling, quantization.

Module 2

Review of matrix theory: row and column ordering- Toeplitz, Circulant and block matrix
2D Image transforms: DFT, its properties, Walsh transform, Hadamard transform, Haar transform, DCT, KL transform and Singular Value Decomposition.
Image Compression: Need for compression, Basics of lossless compression – bit plane coding, run length encoding and predictive coding, Basics of lossy compression – uniform and non-uniform quantization techniques used in image compression, Concept of transform coding, JPEG Image compression standard.

Module 3

Image Enhancement: Spatial domain methods: point processing- intensity transformations, histogram processing, image subtraction, image averaging. Spatial filtering- smoothing filters, sharpening filters.
Frequency domain methods: low pass filtering, high pass filtering, homomorphic filter

Module 4

Image Restoration: Degradation model, Unconstraint restoration- Lagrange multiplier and constraint restoration
Inverse filtering- removal of blur caused by uniform linear motion, Weiner filtering,
Geometric transformations-spatial transformations

Module 5

Image segmentation: Classification of Image segmentation techniques, region approach, clustering techniques. Segmentation based on thresholding, edge based segmentation. Classification of edges, edge detection, Hough transform, active contour.

Text Books

1. Gonzalez Rafel C, Digital Image Processing, Pearson Education, 2009
2. S Jayaraman, S Esakkirajan, T Veerakumar, Digital image processing, Tata Mc Graw Hill, 2015

Reference Books

1. Jain Anil K , Fundamentals of digital image processing: , PHI,1988
2. Kenneth R Castleman , Digital image processing:, Pearson Education,2/e,2003
3. Pratt William K , Digital Image Processing: , John Wiley,4/e,2007

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Digital Image Fundamentals**	
1.1	Image representation, basic relationship between pixels, elements of DIP system, elements of visual perception-simple image formation model	3
1.2	Vidicon and Digital Camera working principles	1
1.3	Brightness, contrast, hue, saturation, mach band effect	1
1.4	**Colour image fundamentals**-RGB, CMY, HIS models	1
1.5	2D sampling, quantization.	1
2	**Review of matrix theory**	
2.1	Row and column ordering- Toeplitz, Circulant and block matrix	2
2.2	**2D Image transforms** : DFT, its properties, Walsh transform, Hadamard transform, Haar transform	3
2.3	DCT, KL transform and Singular Value Decomposition.	3
2.4	**Image Compression:** Need for compression, Basics of lossless compression – bit plane coding, run length encoding and predictive coding, Basics of lossy compression – uniform and non-uniform quantization techniques used in image compression, Concept of transform coding, JPEG Image compression standard..	2
3	**Image Enhancement**	
3.1	Spatial domain methods: point processing- intensity transformations, histogram processing, image subtraction, image averaging	2
3.2	Spatial filtering- smoothing filters, sharpening filters	1
3.3	Frequency domain methods: low pass filtering, high pass filtering, homomorphic filter.	2
4	**Image Restoration**	
4.1	Degradation model, Unconstraint restoration- Lagrange multiplier and constraint restoration	2
4.2	Inverse filtering- removal of blur caused by uniform linear motion, Weiner filtering	2
4.3	Geometric transformations-spatial transformations	2
5	**Image segmentation**	
5.1	Classification of Image segmentation techniques, region approach, clustering techniques	2
5.2	Segmentation based on Thresholding, edge based segmentation	2
5.3	Classification of edges, edge detection, Hough transform, active contour	3

Simulation Assignments

The following simulations be done in Scilab/ Matlab/ LabView:

1. Read Image data into the workspace.
2. Determine various transforms using matlab functions.
3. Detect and measure circular objects in an image.
4. Adjust the contrast of the given image.
5. Filter images using predefined filter.
6. Create degraded images affected by motion blur and noise by simulating the models for both. Apply inverse filtering and Weiner filtering methods to the simulated images and compare their performance.
7. Detect an object against the background using various edge detection algorithms and compare their performance.
8. Create a histogram for a gray scale image.
9. Create image at various compression level.
10. Use texture segmentation to identify region based on their texture.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT352

Course Name: DIGITAL IMAGE PROCESSING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks.

1. Give mathematical representation of digital images? Write down the names of different formats used. K2
2. Explain mach band effect. K2
3. What is SVD? Explain its applications in digital image processing. K3
4. Write the similarity and difference between Hadamard and Walsh transforms K3
5. What are the advantages and disadvantages of block processing K2
6. Name the role of point operators in image enhancement K2
7. What is median filter? Explain the operation in 2D noise image with salt and pepper noise K3
8. Distinguish between linear and nonlinear image restoration. K3
9. Mention the use of derivative operation in edge detection. K4
10. The Pewitt edge operator is much better than Robert operator. Why? Give the matrix. K3

PART B

Answer any one full questions, from each module carries14marks.

Module 1

1. a) State and explain the 2D sampling theorem. Explain how aliasing errors can be eliminated? (7 marks)

   b) Define the terms brightness, contrast, hue and saturation with respect to a digital image. Explain the terms False contouring and Machband effect. (K1 – CO1) (7 marks)

OR

2. a) Explain elements of visual perception simple image formation model in detail (K1 – CO1) (8 marks)

   b) Explain various color image models and its transformations (K1 - CO1) (6 marks)

Module 2

3. a) Explain the difference between DST and DCT. (K2 - CO1) (4 marks)

   b) Compute the 2D DFT of the 4x4 gray scale image given below. (K3-CO1) (10 marks)

$$f(x, y) = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 \end{bmatrix}.$$

OR

4. a) Construct a Harr transform matrix for N=4. (4 marks) (K3-CO1)

   b) Compute the 8-point DCT for following date X={2,4,6,8,10,6,4,2}. (10 marks)

Module 3

5. a) List histogram image enhancement techniques? Explain each one in detail. (10 marks) K2-CO2

   b) Write a note on color image enhancement. (K2-CO2) (4 marks)

OR

6. a) Describe the following in detail (i) Histogram equalization (ii) LPF and HPF in image enhancement (iii) high boost filters (10 marks)

Module 4

7. a) Assume 4x4 image and filter the image using median filter of 3x3 neighbourhood. Use replicate padding. (K3—CO1) (8 marks)

   b) Explain the digital image restoration. (K1—CO1) (6 marks)

OR

8. a) Explain inverse filtering with necessary equations. (K1-CO1) (6 marks)

   b) Differentiate various noise models. (K2-CO1) (8 marks)

Module 5

9. a) Explain the active contour algorithm for image segmentation any four geometric transformations on an image. (K2-CO3) (7 marks)

   c) Assume 4x4 image and filter the image using median filter of 3x3 neighbourhoods. Use replicate padding (K3—CO1) (7 marks)

OR

10. a) Explain global, adaptive and histogram based thresholding in detail. (7 marks)
    c) Explain Hough transform in detail (7 marks)

ECT362	INTRODUCTION TO MEMS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course introduces students to the rapidly emerging, multi-disciplinary, and exciting field of Micro Electro Mechanical Systems.

Prerequisite: EST130-Basics of Electrical and Electronics Engineering, EST 100-Engineering Mechanics

Course Outcomes

CO1	Describe the working principles of micro sensors and actuators
CO2	Identify commonly used mechanical structures in MEMS
CO3	Explain the application of scaling laws in the design of micro systems
CO4	Identify the typical materials used for fabrication of micro systems
CO5	Explain the principles of standard micro fabrication techniques
CO6	Describe the challenges in the design and fabrication of Micro systems

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										
CO2	3	3										
CO3	3	3										
CO4	3	3	2									
CO5	3	3										
CO6	3	3										

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):Describe the working principles of micro sensors and actuators

1. Explain the principle of operation of two types of micro-accelerometers
2. Explain with relevant examples how the principle of electrostatics may be used for the design of MEMS based sensors and actuators.
3. Explain how smart materials can be used for the design of MEMS based sensors and actuators.

Course Outcome 2 (CO2): Identify commonly used mechanical structures in MEMS

1. Explain the purpose of micro cantilevers in MEMS systems. What is the relevance of spring constant (k) of a mechanical structure in micro system design?
2. Derive the expression for the magnitude of applied bending moment with reference to pure bending of longitudinal beams.
3. Explain how plates and diaphragms can be used for the design

Course Outcome 3(CO3): Explain the application of scaling laws in the design of micro systems

1. Explain force scaling vector, what information does it provide to a MEMS designer?
2. Derive equations for acceleration a, time t and power density P/V based on the Trimmer Force Scaling Vector?
3. Explain why electrostatic actuation is preferred over electromagnetic actuation at the micro-scale.

Course Outcome 4 (CO4): Identify the typical materials used for fabrication of micro systems

1. State the relevant properties of Silicon Carbide and Silicon Nitride for use in Microsystems.
2. Explain why Silicon evolved as the ideal substrate material for MEMS fabrication.
3. Explain with examples the advantages of use of polymers in micro systems fabrication?

Course Outcome 5 (CO5): Explain the principles of standard micro fabrication techniques

1. Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions.
2. Explain the criteria for choice of surface or bulk micromachining techniques in the design of micro systems.
3. Explain with block diagram the steps in LIGA process. State two advantages of LIGA process over other micro machining techniques.

Course Outcome 6 (CO6): Describe the challenges in the design, fabrication and packaging of Micro systems

1. Explain the challenges involved in the packaging of Microsystems as compared to microelectronic devices
2. Discuss the various fabrication challenges associated with surface micromachining.

SYLLABUS

MODULE I

MEMS and Microsystems: Applications – multidisciplinary nature of MEMS – principles and examples of Micro sensors and micro actuators – micro accelerometer –comb drives - Micro grippers – micro motors, micro valves, micro pumps, Shape Memory Alloys.

Actuation and Sensing techniques: Thermal sensors and actuators, Electrostatic sensors and actuators, Piezoelectric sensors and actuators, magnetic actuators

MODULE II

Review of Mechanical concepts: Stress, Strain, Modulus of Elasticity, yield strength, ultimate strength – General stress strain relations – compliance matrix. Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, Diaphragms – Typical applications

Flexural beams: Types of Beams, longitudinal strain under pure bending – Deflection of beams – Spring constant of cantilever – Intrinsic stresses

MODULE III

Scaling laws in miniaturization - scaling in geometry, scaling in rigid body dynamics, Trimmer force scaling vector, scaling in electrostatic and electromagnetic forces, scaling in electricity and fluidic dynamics, scaling in heat conducting and heat convection.

Materials for MEMS – Silicon – Silicon compounds – Silicon Nitride, Silicon Dioxide, Silicon carbide, Poly Silicon, GaAs , Silicon Piezo resistors. Polymers in MEMS – SU-8, PMMA, PDMS, Langmuir – Blodgett Films.

MODULE IV

Micro System fabrication – Photolithography – Ion implantation- Diffusion – Oxidation – Chemical vapour deposition – Etching

Overview of Micro manufacturing – Bulk micro manufacturing, Surface micro machining , LIGA process –Microstereo lithography

MODULE V

Micro system Packaging: general considerations in packaging design – Levels of Micro system packaging. Bonding techniques for MEMS: Surface bonding, Anodic bonding, Silicon - on - Insulator, wire bonding, Sealing – Assembly of micro systems.

Overview of MEMS areas : RF MEMS, BioMEMS, MOEMS, NEMS

Text Books:

1. Chang Liu, Foundations of MEMS, Pearson 2012

2. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, TMH, 2002

Reference Books:

1. Chang C Y and Sze S. M., VLSI Technology, McGraw-Hill, New York, 2000

2. Julian W Gardner, Microsensors: Principles and Applications, John Wiley & Sons, 1994

3. Mark Madou, Fundamentals of Micro fabrication, CRC Press, New York, 1997

4. Stephen D. Senturia, Microsystem design, Springer (India), 2006.

5. Thomas B. Jones, Electromechanics and MEMS, Cambridge University Press, 2001

6. Gregory T.A. Kovacs, Micromachined Transducers Sourcebook, McGraw Hill, 1998

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1.1	Introduction to MEMS and Microsystems	1
1.2	Applications – multidisciplinary nature of MEMS – principles and examples of Micro sensors and micro actuators – micro accelerometer, comb drives -	1
1.3	Micro grippers – micro motors,	1
1.4	micro valves, micro pumps, Shape Memory Alloys.	1
1.5	Actuation and Sensing techniques : Thermal sensors and actuators,	1
1.6	Electrostatic sensors and actuators	1
1.7	Piezoelectric sensors and actuators,	1
1.8	magnetic actuators	1

2.1	Review of Mechanical concepts: Stress, Strain, Modulus of Elasticity, yield strength, ultimate strength	1
2.2	General stress strain relations – compliance matrix.	1
2.3	Overview of commonly used mechanical structures in MEMS - Beams, Cantilevers, Plates, Diaphragms – Typical applications	1
2.4	Flexural beams: Types of Beams, longitudinal strain under pure bending	2
2.5	Deflection of beams – Spring constant of cantilever, Intrinsic stresses	1
3.1	Scaling laws in miniaturization - scaling in geometry, scaling in rigid body dynamics, Trimmer force scaling vector,	2
3.2	scaling in electrostatic and electromagnetic forces	1
3.3	scaling in electricity and fluidic dynamics,	1
3.4	scaling in heat conducting and heat convection	1
3.5	Materials for MEMS – Silicon – Silicon compounds- Silicon Nitride	1
3.6	Silicon Dioxide, Silicon carbide	1
3.7	Poly Silicon, GaAs , Silicon Piezo resistors	1
3.8	Polymers in MEMS – SU-8, PMMA,	1
3.9	PDMS, Langmuir – Blodgett Film	1
4.1	Micro System fabrication,Photolithography– Ion implantation	2
4.2	Diffusion, Oxidation	1
4.3	Chemical vapour deposition, Etching	1
4.4	Overview of Micro manufacturing – Bulk micro manufacturing,	1
4.5	Surface micro machining	1
4.6	LIGA process	1
4.7	Microstereo lithography	1
5.1	Micro system Packaging: general considerations in packaging design	1
5.2	Levels of Micro system packaging	1
5.3	Bonding techniques for MEMS : Surface bonding , Anodic bonding	1
5.4	Silicon - on - Insulator , wire bonding	1
5.5	Sealing – Assembly of micro systems	1
5.6	Overview of MEMS areas : RF MEMS, BioMEMS, MOEMS, NEMS	1

Model Question Paper

A P J Abdul Kalam Technological University
Sixth Semester B Tech Degree Examination
Course: ECT 362 Introduction to MEMS
Time: 3 Hrs Max. Marks: 100

PART A

Answer All Questions

1	State an example to justify the multidisciplinary nature of MEMS	3
2	State three applications of MEMS devices in the automotive industry	3
3	Define normal stress and strain, how it is different from shear stress and strain	3
4	Determine the stress in the longitudinal direction of a Silicon rod with rectangular cross section is pulled on both ends with a force of 10mN. The dimensions of the rod being 1 mm X 100µm X 50µm.	3
5	Define the Trimmer force scaling vector	3
6	State one application each of PDMS and PMMA in MEMS fabrication	3
7	Discuss the criteria for selecting materials for the masks used in etching	3
8	Define etch stop? State the different methods used to stop etching	3
9	State the various levels of micro system packaging	3
10	State two applications of NEMS	3

PART B

Answer one question from each module. Each question carries 14 marks.

Module I

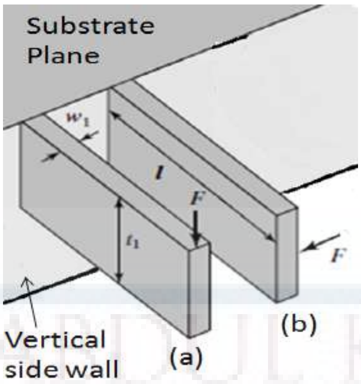
11(A)	Sketch and explain the working of a silicon capacitive accelerometer attached to a comb drive	*6*
11(B)	Explain the operating principle of piezoelectric sensors and actuators with relevant sketches.	*8*

OR

12(A)	Explain the operating principle of thermal bimorphs with neat sketches. State any two applications of thermal sensors.	*8*
12(B)	Explain the principle of operation of the following micro sensors (i) Comb drives (ii) Shape Memory Alloys	*6*

Module II

13(A)	Determine the force constant associated with the two beams (a) and (b) shown in figure below.Which is stiffer, justify with arguments.	*8*



13(B) Explain with neat sketches the longitudinal strain experienced by segment of beam (with rectangular cross-section) under pure bending. *6*

OR

14(A) Explain the general stress strain relationship and arrive at the compliance matrix *8*

14(B) Explain with neat sketches the type of mechanical beams and boundary conditions associated with supports *6*

Module III

15(A) Explain in the light of scaling, assuming a 10 times reduction of size of the actuator. Which of the electrostatic and electromagnetic forces are best suited for micro device actuation. *8*

15(B) State three relevant properties of Silicon Carbide and Silicon Nitride for use in Microsystems *6*

OR

16(A) Explain various scaling laws in miniaturization *6*

16(B) State the constraints in pumping fluids in micro channels. What pumping scheme is usually used in micro fluidics, state one example? *8*

Module IV

17(A) Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions *6*

17(B) Compare and contrast various micro manufacturing techniques *8*

OR

18(A) Describe the various mechanical problems associated with surface micromachining *6*

18(B) Explain the LIGA process associated with MEMS fabrication *8*

Module V

19(A) Explain the following bonding techniques with figures a) Silicon-on-Insulator b) Wire bonding

19(B) Explain the challenges involved in BioMEMS. List three applications of BioMEMS. *8*

OR

20(A)	Explain with diagrams any two applications of RFMEMS	*8*
20(B)	Explain the challenges involved in designing packages for micro systems	*6*

ECT372	QUANTUM COMPUTING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: Quantum computers are not yet built. If such machines become a reality, they will fundamentally change how we perform calculations, and the implications on many applications (including communications and computer security) will be tremendous. This course aims to provide a first introduction to quantum computing with a general understanding of how quantum mechanics can be applied to computational problems. It highlights the paradigm change between conventional computing and quantum computing, and introduce several basic quantum algorithms.

Prerequisite: MAT101 Linear Algebra and Calculus

Course Outcomes: After the completion of the course the student will be able to

CO 1 K2	Explain the basic constructs in linear algebra needed to build the concepts of quantum computing
CO 2 K2	Relate the postulates of quantum mechanics for computation and illustrate/ demonstrate quantum measurement
CO 3 K3	Identify quantum gates and build quantum circuit model in which most of the quantum algorithms are designed.
CO 4 K4	Analyse and design quantum algorithms and grasp the advantage they offer over classical counterparts.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3										2
CO2	3	3										2
CO3	3	3	3									2
CO4	3	3	3	2								2

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	10	50
Analyse	K4		10	20
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the basic constructs in linear algebra needed to build the concepts of quantum computing (K2)

1. Summarise the basic operators and matrices required for understanding the quantum computing concepts.
2. Find the Eigen values and Eigen vectors of Pauli matrices.
3. Explain spectral decomposition and Spectral theorem. State the spectral theorem for Hermitian operator.
4. Show the matrix representation of the tensor products of the Pauli operators

Course Outcome 2 (CO2): Relate the postulates of quantum mechanics for computation and illustrate/ demonstrate quantum measurement (K2)

1. State and explain the postulates of Quantum Mechanics applied to computing.
2. Show the Bloch sphere representation of quantum bits.
3. Find the various states of a given system using state space analysis.
4. Demonstrate the state space representation of composite systems using tensor product.

Course Outcome 3 (CO3): Identify quantum gates and build quantum circuit model in which most of the quantum algorithms are designed (K3)

1. Model universal gates using standard quantum gates.
2. Illustrate the implementation of quantum operation using quantum gates.
3. Construct and prove circuit identities.
4. Construct a circuit for implementing controlled U operations
5. Design quantum circuits that implements projective measurement in the computational basis.

Course Outcome 4 (CO4): Analyse and design quantum algorithms and grasp the advantage they offer over classical counterparts (K4)

1. Design a circuit that implements Quantum Fourier Transform(QFT) for an n-bit input.
2. Construct the phase estimation algorithm from basic principles and design the circuit for phase estimation using QFT.
3. Interpret phase estimation algorithm for the implementation of order finding and factorisation algorithms.

SYLLABUS

Module 1: Basics of Linear Algebra

History and Overview of Quantum Computation and Quantum Information, Linear Algebra Basics, Linear Operators and matrices, The Pauli matrices, Inner Products, Eigen values and Eigen vectors, Hermitian operators and Adjoints, Spectral theorem, Tensor Products.

Module 2: Basics of Quantum Mechanics

State Space Representation - Bloch Sphere, State Evolution – Unitary transformation, Quantum measurement – Projective measurements, Composite systems - Superposition.

Module 3: Quantum Gates and Circuits

Quantum gates – Hadamard gate, NOT gate, controlled-NOT gate, Toffoli gate, Realisation of classical gates with quantum gates – Z Gate, Fredkein Gate, Pauli Matrices – Controlled Swap and Controlled U-operations, Circuit Identities

Module 4: Quantum Measurement

Basic principle of quantum measurement - Principle of deferred measurement, Principle of implicit measurement, Gates with projective measurements, Universal quantum gates, Universality of two level unitary gates.

Module 5: Algorithms

Quantum Fourier Transform (QFT) – Quantum circuit for QFT, Quantum phase estimation, Modular exponentiation, Order finding and factorisation – Deutsch's algorithm.

Text Books

1. M. A. Nielsen and I. L. Chuang, Quantum Computation and Quantum Information, Cambridge, UK, Cambridge University Press, 2010.
2. J. Gruska, Quantum Computing, McGraw Hill, 1999.
3. G. Strang, Linear algebra and its applications (4th Edition), Thomson, 2006.

Reference Books

1. P. Kaye, R. Laflamme, and M. Mosca. An Introduction to Quantum Computing. Oxford, 2007.
2. Eleanor G. Rieffel, Wolfgang H. Polak, “Quantum Computing: A Gentle Introduction,” MIT Press, 2011.
3. Noson Yanofsky and Mirco Mannucci, “Quantum Computing for Computer Scientists”, Cambridge University Press, 2008.
4. Abhijith, J., Adedoyin, Adetokunbo, Ambrosiano, John (and 30 others), “Quantum Algorithm Implementations for Beginners” , arXiv:1804.03719, 2020.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Basics of Linear Algebra**	
1.1	History and Overview of Quantum Computation and Quantum Information	1
1.2	Linear Algebra Basics	1
1.3	Linear Operators and matrices	1
1.4	Pauli matrices	1
1.5	Inner Products, Eigen values and Eigen vectors	1
1.6	Hermitian operators and Adjoints, Spectral theorem	2
1.7	Tensor Products	2
2	**Basics of Quantum Mechanics**	
2.1	State Space Representation - Bloch Sphere	1
2.2	State Evolution – Unitary transformation	2
2.3	Quantum measurement – Projective measurements	2
2.4	Composite systems - Superposition	2
3	**Quantum Gates and Circuits**	
3.1	Quantum gates – Hadamard gate, NOT gate, controlled-NOT gate, Toffoli gate	2
3.2	Realisation of classical gates with quantum gates – Z Gtae, Fredkein Gate	2
3.3	Pauli Matrices – Controlled Swap and Controlled U-operations	2
3.4	Circuit Identities	1
4	**Quantum Measurement**	
4.1	Basic principle of quantum measurement - Principle of deferred measurement, Principle of implicit measurement	1
4.2	Gates with projective measurements	2
4.3	Universal quantum gates	1

4.4	Universality of two level unitary gates	2
5	**Algorithms**	
5.1	Quantum Fourier Transform (QFT)	1
5.2	Quantum circuit for QFT Quantum phase estimation	2
5.3	Modular exponentiation	1
5.4	Order finding and factorisation – Deutsch's algorithm	2

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT372

Course Name: QUANTUM COMPUTING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

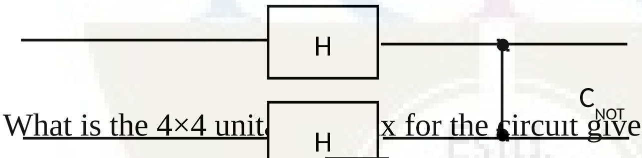
1 Consider the operator from $\mathbb{C}^2 \rightarrow \mathbb{C}^2$ given by T(x,y) = (ix, iy), where $\mathbb{Z}^2 = -1$. Find the matrix representation of the Transformation. K2

2 Write the Eigen values and Eigen vectors of the matrix $\begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$. Is this operator Hermitian? K1

3 Write down the Bloch sphere representation of the Quantum bit $\frac{1}{2}|0\rangle + \frac{j}{\sqrt{2}}|1\rangle$. K1

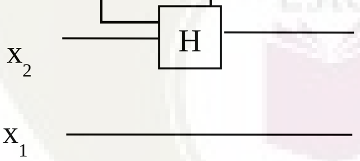
4 Suppose the first bit of a two bit Quantum System whose state given by $\alpha|00\rangle + \beta|01\rangle + \chi|10\rangle + \delta|11\rangle$ is measured K3
   a. What is the probability that the first bit is observed to be 0?
   b. Suppose that the first bit is observed to be 0, then what is the resultant state of the system?

5. Compute the resultant state of the given circuit for input state $|00\rangle$. K3



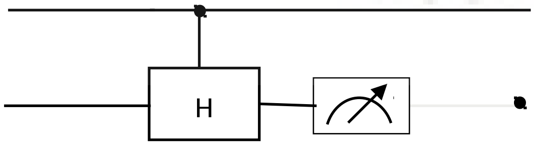
6 What is the 4×4 unit x for the circuit given below K2

.



7 State the two basic principles of quantum measurement and explain it's uses. K1

8 For the given circuit, 0 was observed by measuring the second bit. What is the resultant Quantum State of the first bit? K3



9 Give a decomposition of the controlled-Rk gate into single qubit and C_{NOT} gates. K2

10 Draw the 3 input Quantum Fourier Transform (QFT) circuit. K2

PART – B

Answer one question from each module; each question carries 14 marks.

Module - I

11 a. Find the eigenvectors and eigenvalues of the following four matrices: 7 CO1 K2

$$\sigma_0 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \qquad \sigma_1 = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \qquad \sigma_2 = \begin{bmatrix} 0 & -i \\ i & 0 \end{bmatrix} \qquad \sigma_3 = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$$

b. Give the eigenvalues and eigenvectors of this matrix 7 CO1 K3

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

OR

12 a. A matrix M is Hermitian if $M^{\dagger} = M$. Let M be Hermitian. 7 CO1 K3

i. Prove that all of its eigenvalues are real.

ii. Prove that $v^{\dagger}Mv$ is real, for all vectors v. When $v^{\dagger}Mv > 0$, we say that $M > 0$.

b. Let M be Hermitian, and define 7 CO1 K3

$$U = e^{iM} = \sum_k \frac{(iM)^k}{k!}$$

Prove that $U^{\dagger}U = I$, where I is the identity matrix. For matrix M, let $M^{\dagger} = (M^T)^*$, where M^T is the transpose of M, and * is denotes the complex conjugate of M.

Module - II

13 a. What is a Quantum State. Explain with examples 2 CO2 K2

b. Consider the following two-qubit quantum state, $|\varphi\rangle$. 12 CO2 K3

$$\frac{\sqrt{2}}{3\sqrt{3}}|00\rangle - \frac{1}{\sqrt{6}}|01\rangle + \frac{2i\sqrt{2}}{3\sqrt{3}}|10\rangle + \frac{5i}{3\sqrt{6}}|11\rangle$$

i. What are the probabilities of outcomes 0 and 1 if the first qubit of $|\varphi\rangle$ is measured?

ii. What are the probabilities of outcomes 0 and 1 if the second qubit of $|\varphi\rangle$ is measured?

iii. What is the state of the system after the first qubit of $|\varphi\rangle$ is measured to be a 0?

iv. What is the state of the system if the second qubit of $|\varphi\rangle$ is measured to be a 1?

v. What are the probabilities of outcomes 0 and 1 if the second qubit of the system is measured, after the first qubit of $|\varphi\rangle$ has been measured to be 0?

vi. What are the probabilities of outcomes 0 and 1 if the first qubit of the system is measured, after the second qubit of $|\varphi\rangle$ has been measured to be 1?

OR

14 a. State and explain the four postulates of Quantum Mechanics applied to computing. 8

CO2

K2

b. Which quantum state do we get if we apply (H ⊗ I) CNOT to 6

$$\sqrt{\frac{1}{3}}|00\rangle + \sqrt{\frac{2}{3}}|11\rangle$$

CO2

Here I is the 1-qubit identity operation, H is the 1-qubit Hadamard, and CNOT is the 2-qubit controlled-not operation with the first (=leftmost) qubit being the control. K3

What is the probability of seeing $|11\rangle$ if we measure the resulting state in the computational basis?

Module - III

15 a. Show that XYX = −Y and use this to prove that X $R_y(\theta)$ X = $R_y(-\theta)$. 7

CO3

K3

b. An arbitrary single qubit unitary operator can be written in the form $U = \exp(i\alpha)\ R_{\hat{n}}(\theta)$. for some real numbers α and θ, and a real three-dimensional unit vector $\hat{n}$. 7

CO3

K3

i. Prove this fact.

ii. Find values for α, θ, and $\hat{n}$ giving the Hadamard gate H.

iii. Find values for α, θ, and $\hat{n}$ giving the phase gate.

OR

16 a. It is useful to be able to simplify circuits by inspection, using well-known identities. 7

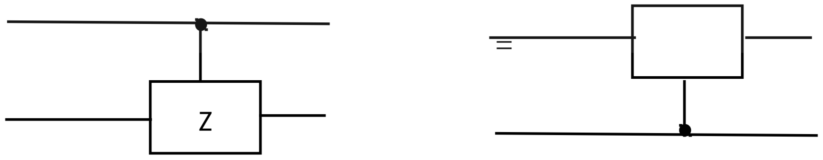
Prove the following three identities:

i. HXH = Z CO3

ii. HY H = −Y K3

iii. HZH = X

b. Show that 7

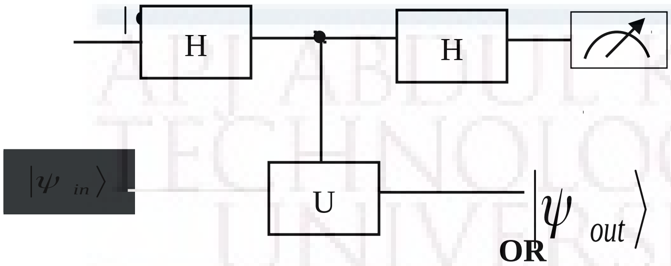


CO3

K3

Module - IV

17 Suppose we have a single qubit operator U with eigenvalues ±1, so that U is both Hermitian and unitary. Suppose we wish to measure the observable U. How can this be implemented by a quantum circuit? Show that the following circuit implements a measurement of U. 14 CO3 K3



OR

18 a. Derive the circuit implementing the controlled-U operation for an arbitrary single qubit U, using only single qubit operations and the CNOT gate. 7 CO3 K4

b. Using just CNOTs and Toffoli gates, construct a quantum circuit to perform the transformation given below. 7 CO3 K4

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

Module - V

19 a. Derive the circuitry for computing a 4-input Quantum Fourier Transform (QFT). 7 CO4 K3

b. The two qubit Quantum Fourier Transform is given by the following matrix. 7 CO4 K3

$$F_2 = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & i & -1 & -i \\ 1 & -1 & 1 & -1 \\ 1 & -i & -1 & i \end{bmatrix}$$

Sketch a circuit for implementing the operator F_2 using any combination of 1-qubit Hadamard gates; 1-qubit Pauli gates; 2-qubit CNOT gates and controlled phase shifts. Briefly explain your circuit.

OR

20	a.	Explain the phase estimation algorithm using Quantum Fourier Transform (QFT). Derive the circuitry for the Quantum Phase estimation.	8 CO4 K3
	b.	Apply Quantum phase estimation to estimate the phase of a T-Gate.	6 CO4 K4

SEMESTER VI

MINOR

ECT382	VLSI CIRCUITS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to impart the knowledge about the fundamentals of Digital Systems, MOSFETs, basic VLSI circuits and Application Specific Integrated Circuits.

Prerequisite: ECT281 Electronic Circuits

Course Outcomes: After the completion of the course the student will be able to:

CO1	Explain the working of various functional building blocks used in digital system design
CO2	Explain Structure and working of MOSFETS and basic VLSI circuits using MOSFET
CO3	Explain the circuit technique used to implement dynamic logic and storage cells
CO4	Explain the application specific integrated circuit design flow and design approached
CO5	Explain the programmable logic cells, programming technologies, different type of i/o cells and different timing constraints in ASIC design

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3								2	3
CO2	3	2	2		1							3
CO3	3	2	2		1							3
CO4	3	3	3		3						3	3
CO5	3	3	3		3						3	3

Assessment Pattern:

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	15	15	30
Understand	K2	25	25	50
Apply	K3	10	10	20
Analyse				
Evaluate				
Create				

Mark distribution:

Total Marks	CIE	ESE	ESE Duration
150	50	100	3Hrs

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

Maximum Marks: 100 **Time: 3 hours**

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. Mark patterns are as per the syllabus with 75% for theory and 25% for logical/numerical problems.

Course Level Assessment Questions.

Course Outcome 1 (CO1):

1. With circuit and truth table, explain the working of a full adder.
2. Explain the use of 2m:1 multiplexer for realizing a logic function od m variables.
3. With circuit and truth table, explain the working of a 4 bit ripple counter

Course Outcome 2 (CO2):

1. Draw the stricture of a n-channel MOSFET and describe its working
2. Explain the static characteristics of NMOS inverter and derive its pull up to pull down impedance ratio
3. Draw the circuit diagram of two input NAND gate in CMOS logic and represent it using its stick diagram

Course Outcome 3 (CO3):

1. Describe the basic principle of dynamic logic with necessary diagrams
2. Explain the working of np domino logic. What is its merits and demerits over domino logic?
3. Explain the working of one transistor Dynamic Memory Cell.

Course Outcome 4 (CO4):

1. Explain and compare the full custom and semicustom IC design methods
2. Describe the Top-Down and Bottom-Up design methodologies using in ASIC design
3. Discuss the Speed power and area considerations in VLSI design

Course Outcome 5 (CO5):

1. Explain a multiplexer based programmable logic cells
2. Describe the programmable array based logic implementation in Altera MAX
3. Define setup time, hold time, propagation delay, clock to output delay

Syllabus

Module 1: Basic Building Blocks in Digital Systems (12 Hrs)

Basic logic gates, binary adder, subtractor, magnitude comparator, decoders, encoders, multiplexers, simple examples for combinational circuits (discuss with respective truth tables) Sequential circuits, Latched and flip-flops, clocked sequential circuits, registers, shift registers, counters (analysis not required)

Module 2: MOSFET Fundamentals and basic VLSI circuits (9 Hrs)

Structure and working principle of MOSFETS, VI characteristics, current equations(derivations not required),
NMOS and CMOS inverter circuits, static characteristics and comparison, implementation of CMOS logic gates, stick diagram representation, Layout Design and Design rules- Lambda rules and micron rules (Definitions only).

Module 3: Dynamic logic Design and Storage Cells (8 Hrs)

Dynamic Logic Design-Pre charge- Evaluate logic, Domino Logic, NP domino logic. Read Only Memory-4x4 MOS ROM Cell Arrays (NOR) Random Access Memory –SRAM-Six transistor CMOS SRAM cell, DRAM –Three transistor and One transistor Dynamic Memory Cell.

Module 4: VLSI Design Methodologies (7 Hrs)

Introduction: Moore slaw .ASIC design, Full custom ASICs, Standard cell based ASICs, Gate array based ASICs, SoCs, FPGA devices, ASIC and FPGA Design flows Top-Down and Bottom-Up design methodologies. Logical and Physical design. Speed power and area considerations in VLSI design

Module 5: FPGA Architecture(8 Hrs)

Programmable logic cells: multiplexer based logic cells(ACT1), lookup table based logic implementation(XC3000 CLB), programmable array based logic implementation (Altera MAX).
ASIC programming technologies: antifuse, SRAM, EPROM, EEPROM
Different types of I/O cells used in programmable ASICs

Timing constraints in ASIC design: setup time, hold time, propagation delay, clock to output delay, critical path (concept only)

Text Books:

1. M. Morris Mano, Digital Design 3/e, Prentice Hall of India, 2002.
2. M. J. S. Smith, Application Specific Integrated Circuits, Pearson Education,2007
3. Sung –Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits- Analysis & Design, McGraw-Hill, Third Ed., 2003

References:

1. Thomas Floys, Digital Fundamentals, 11th edition, Pearson Publication, 2015
2. Neil H.E. Weste, Kamran Eshraghian, Principles of CMOS VLSI Design- A Systems Perspective, Second Edition. Pearson Publication, 2005.
3. Jan M. Rabaey, Digital Integrated Circuits- A Design Perspective, Prentice Hall, Second Edition, 2005.

Course Contents and Lecture Schedule

No	Topic	No. of. Lectures
Module 1: Basic Building Blocks in Digital Systems (12 hours)		
1.1	Basic logic gates,	**1**
1.2	binary adder, subtractor	**2**
1.3	magnitude comparator, decoders, encoders	**1**

1.4	multiplexers, simple examples for combinational circuits	**2**
1.5	Sequential circuits, Latches and flip-flops	**2**
1.6	clocked sequential circuits, registers, shift registers, counters	**4**
Module 2: MOSFET Fundamentals and basic VLSI circuits (9 hours)		
2.1	Structure and working principle of MOSFETS	**1**
2.2	VI characteristics, current equations	**1**
2.3	NMOS and CMOS inverter circuits, static characteristics and comparison	**3**
2.4	Implementation of CMOS logic gates	**2**
2.5	Stick diagram representation, Layout Design and Design rules- Lambda rules and micron rules (Definitions only)	**2**
Module 3: Dynamic logic Design and Storage Cells (7 hours)		
3.1	Dynamic Logic Design-Pre charge- Evaluate logic	**1**
3.2	Domino Logic, NP domino logic	**2**
3.3	ROM, Ram and DRAM	**4**
Module 4: VLSI Design Methodologies. (8 hours)		
4.1	Introduction: Moore slaw .ASIC design,	**1**
4.2	Full custom ASICs, Standard cell based ASICs, Gate array based ASICs, SoCs, FPGA devices	**3**
4.3	ASIC and FPGA Design flows Top-Down and Bottom-Up design methodologies.	**2**
4.4	Logical and Physical design. Speed power and area considerations in VLSI design	**2**
Module 5: FPGA Architecture (9 hours)		
5.1	Programmable logic cells: multiplexer based logic cells(ACT1), lookup table based logic implementation(XC3000 CLB), programmable array based logic implementation (Altera MAX).	**3**
5.2	ASIC programming technologies: antifuse, SRAM, EPROM, EEPROM	**2**
5.3	Different types of I/O cells used in programmable ASICs	**2**
5.4	Timing constraints in ASIC design: setup time, hold time, propagation delay, clock to output delay, critical path	**2**

Model Question Paper

A P J Abdul Kalam Technological University

Sixth Semester B Tech Degree Examination

Course: **ECT 382 VLSI CIRCUITS**

Time: 3 Hrs Max.
Marks: 100

PART A

(*Answer All Questions*)

1	Which are the universal gates and why are they called as universal gates?	(3)
2	Draw the circuit diagram to realize a modulo 15 down counter	(3)
3	Draw VI characteristics of n- channel MOSFET and clearly mark different regions	(3)
4	Define lambda rules and micron rules.	(3)
5	List out the merits and drawbacks of np domino over domino logic	(3)
6	Explain the working of one transistor Dynamic Memory Cell.	(3)
7	Explain Moore slaw in VLSI design	(3)
8	Differentiate between full custom and semicustom design methods in ASIC design.	(3)
9	List different types of I/O cells used in programmable ASICs.	(3)
10	What is mean by critical path in an ASIC?	(3)

PART B

(*Answer one question from each module. Each question carries 14 mark.*)

11 (a)	With circuit and truth table, explain the working of a full adder. Also draw the schematic of 4 bit binary adder using full adder blocks	(8)
(b)	Construct a circuit to convert four bit serial data to parallel data and explain its working.	(6)
	OR	
12 (a)	Realize a 16:1 multiplexer using four bit multiplexers and basic gates. Also explain it using its switching expression	(8)
(b)	Explain the working of JK flip flop with its circuit and truth table	(6)
13 (a)	Draw VI characteristics of n-channel MOSFET and explain it with the current equation	(8)

(b) Draw the circuit diagram of a two input CMOS NAND gate (6)

OR

14 (a) Draw the stick diagram and Layout of a CMOS inverter (8)

(b) Explain any 5 Lambda based design rules (6)

15 (a) Explain the Pre charge- Evaluate phase in the dynamic logic. (6)

(b) Draw a 4x4 MOS ROM Cell Array and explain its working (8)

OR

16 (a) With neat schematic diagram, explain the working of NP domino logic. What is its advantage over domino logic? (8)

(b) Explain the working of a three transistor DRAM cell (6)

17 (a) What is FPGA? What are its applications? With block diagram explain its internal architecture? (7)

(b) Explain ASIC design flow. (7)

OR

18 (a) Explain the Top-Down and Bottom-Up design approaches in FPGA based system designs (8)

(b) List the advantages of SOC (6)

19 (a) Explain the gate array based ASICs with neat diagram (7)

(b) With necessary diagram illustrate antifuse technique used in programmable ASICs (7)

OR

20 (a) Discuss the different types of I/O cells that are used in programmable ASICS and their functions (6)

(b) Define setup time, hold time, propagation delay and clock to output delay (8)

ECT384	DATA NETWORKS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to provide an insight into the concepts of data communication and networking.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1 **K2**	Explain the concepts of data communication, structure of networks and compare OSI and TCP/IP networking models
CO2 **K2**	Explain the responsibilities of the data link layer including framing, addressing, flow control, error control and media access control
CO3 **K2**	Illustrate the functions and protocols of network layer, transport layer and application layer in inter-networking
CO4 **K2**	Discuss congestion control techniques and Quality of Service requirements for a network

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										2
CO 2	3	3	2									2
CO 3	3	3	2									2
CO 4	3	3										2
CO 5	3	3										2

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	20	15	20
Understand	K2	30	35	80
Apply				
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the concepts of data communication, structure of networks and networking models (K2)

1. Describe the various methods of data representation
2. Describe the different topologies of networks
3. Illustrate the functions of each layer in the OSI model

Course Outcome 2 (CO2): Explain the responsibilities of the data link layer including framing, addressing, flow control, error control and media access control (K2)

1. Describe the data link control
2. Explain the controlled access methods
3. Discuss the Pure ALOHA and Slotted ALOHA multiple access methods

Course Outcome 3 (CO3): Illustrate the functions and protocols of network layer, transport layer and application layer in inter-networking (K2)

1. Describe how logical addresses are mapped to physical address using RARP
2. Explain the application layer protocols
3. Explain the distance vector routing protocol

Course Outcome 4 (CO4): Discuss congestion control techniques and Quality of Service requirements for a network(K2)

1. Explain FIFO queuing and Priority queuing
2. Describe the characteristics attributed to a flow
3. Describe the operation of UDP

SYLLABUS

Module 1: An Overview of Data Communications and Networking

Data Communications- Components, Data representation, Data flow- Simplex, Half Duplex, Full Duplex Modes, Networks- Network criteria, Physical Structures- Point to Point Connection, Multipoint Connection, Physical Topology, Switching- Circuit Switched Networks and Datagram Networks, Categories of Networks, Interconnection of Networks, Protocols, Network models – OSI Model, Layers in the OSI Model, TCP/IP Protocol Suite

Module 2: Physical Layer and Data Link Layer

Guided Media and Unguided Transmission Media, Data Link Layer – Framing, Flow and Error Control - Stop and Wait Protocol, Sliding Window Protocol, Error Correction and Detection - Types of Errors, Redundancy, Detection vs Correction, Forward Error Correction vs Retransmission, Check Sum, Networking Devices- Hubs, Bridges, Switches

Module 3: Multiple Access, Ethernet, Wireless LANs

Multiple Access Protocols – Random Access, ALOHA, CSMA, CSMA/CD, CSMA/CA, Controlled Access, Channelization -FDMA, TDMA, CDMA, Ethernet -IEEE standards, Wireless LANs- IEEE 802.11, Bluetooth.

Module 4: Network Layer

Internetworking- Need for Network Layer, Internet as a Datagram Network, Internet as a Connectionless Network, Network Layer Logical Addressing – IPv4 and IPv6 Addressing only, Address Mapping -ARP, RARP, BOOTP, DHCP. Delivery, Forwarding, Routing Protocols - Distance Vector routing.

Module 5: Transport Layer, Congestion Control and Quality of Service

Transport layer – UDP, TCP, Congestion, Congestion Control, Quality of Service, Techniques to Improve QoS. Application Layer- FTP, Telnet, DNS, Electronic Mail

Text Book

Behrouz A Forouzan, Data Communication and Networking, 4/e, Tata McGraw Hill

Reference Books

1. Andrew S. Tanenbaum, Computer Networks, 4/e, PHI (Prentice Hall India).
2. William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004
3. Fred Halsall, Computer Networking and the Internet, 5/e, Pearson Education
4. Larry L Peterson and Bruce S Dave, Computer Networks – A Systems Approach, 5/e, Morgan Kaufmann

5. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6/e, Pearson Education

Course Contents and Lecture Schedule

No	**Topic**	**No. of Lectures**
1	**An Overview of Data Communications and Networking (9 hours)**	
1.1	Components, Data representation, Data flow -Simplex, Half Duplex, Full Duplex modes	1
1.2	Networks- Network criteria, Physical Structures- Point to Point Connection, Multipoint Connection	1
1.3	Switching- Circuit Switched Networks and Datagram Networks,	2
1.4	Categories of networks, Interconnection of networks, Protocols,	1
1.5	Network models – OSI Model, Layers in the OSI model,	3
1.6	TCP/IP Protocol Suite	1
2	**Physical Layer and Data Link Layer(9 hours)**	
2.1	Guided Media and Unguided Transmission Media	1
2.2	Data Link Control- Framing, Flow and Error Control- Stop and Wait Protocol, Sliding Window Protocol	2
2.3	Error Detection and Correction – Types of Errors, Redundancy, Detection vs Correction, Forward Error Correction vs Retransmission	2
2.4	Check Sum	2
2.5	Networking devices -Hubs, Bridges, Switches	2
3	**Multiple Access, Ethernet, Wireless LANs (8 hours)**	
3.1	Random Access, ALOHA, CSMA, CSMA/CD, CSMA/CA	2
3.2	Controlled Access	1
3.3	Channelization -FDMA, TDMA, CDMA	2
3.4	Ethernet -IEEE standards, Wireless LANs- IEEE 802.11, Bluetooth	3
4	**Network Layer (9 hours)**	
4.1	Internetworking- Need for Network Layer, Internet as a Datagram Network, Internet as a Connectionless Network,	1
4.2	Network Layer Logical Addressing -IPv4 and IPv6 Addressing only	2
4.3	Address Mapping -ARP, RARP, BOOTP, DHCP	2
4.4	Delivery, Forwarding	2
4.5	Routing - Distance Vector routing.	2
5	**Transport Layer, Congestion Control and Quality of Service (10 hours)**	
5.1	UDP, TCP	3
5.2	Congestion, Congestion Control	3
5.3	Quality of Service, Techniques to Improve QoS	2
5.4	Application Layer -FTP, Telnet, DNS, Electronic Mail	2

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT384

Course Name: DATA NETWORKS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1 Explain the flow of data between 2 devices CO1,K2

2 Illustrate the factors that determine whether a system is a LAN or a WAN CO1, K2

3 Explain character-oriented protocols CO2, K2

4 Explain how guided media differs from unguided media CO2, K2

5 Compare random access protocol and controlled access protocol CO2, K2

6 Differentiate between BSS and ESS CO2, K2

7 Describe the steps in ARP process CO2, K2

8 Differentiate between a static and dynamic routing table CO3, K2

9 Describe the characteristics attributed to a flow CO4, K2

10 Describe how congestion control is achieved using choke packet CO4, K2

PART – B

Answer one question from each module; each question carries 14 marks.

Module - I

11 Explain the responsibilities of the layers of OSI model. CO1, K2

OR

12 (a) Illustrate the functioning of circuit switched networks and datagram networks CO2, K2

Module - II

13. Explain how bandwidth spreading is achieved using FSSS and DSSS. CO2, K2

OR

14 Illustrate the Stop and Wait Protocol. CO3, K2

Module - III

15	Explain the channelization protocols.	CO2, K2

OR

16	(a)Describe the Bluetooth layers (7 marks)	CO2, K2
	(b) Discuss the Hidden station problem and the exposed station problem in IEEE802.11 (7 marks)	CO2, K2

Module - IV

17	Describe mapping of logical addresses to physical addresses using ARP Protocol	CO3, K2

OR

18	Describe the routing of packets using the distance vector routing protocol (10 marks)	CO3, K2
	(b) Illustrate the functionality of the network layer at the source (4 marks)	CO3, K2

Module - V

19	Describe the ports, user datagram, checksum and operation of UDP protocol	CO4, K2

OR

20	(a) Explain the different techniques to improve the Quality of Service (10 marks)	CO4, K2
	(b) Describe the services of user agent in electronic mail systems (4 marks)	CO3, K2

ECT386	TOPICS IN COMPUTER VISION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to develop the knowledge of various methods, algorithms and applications of computer vision

Prerequisite: **Nil**

Course Outcomes: After the completion of the course the student will be able to

CO1	Apply basic point operators and 2D transforms for digital filtering operations
CO 2	Apply various algorithms for morphological operations and binary shape analysis.
CO3	Understand the theoretical aspects of image formation and 3D camera models and vision system.
CO 4	Apply edge, corner detection methods and optical flow algorithms to locate objects in an image/video.
CO5	Analyse 3D images and motion of objects in a given scene using appropriate algorithms computer vision algorithms for real time practical applications.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2		2					2	2	3
CO 2	3	3	2		2					2	2	3
CO 3	3	3	3		2					2	2	3
CO 4	3	3	3		2					2	2	3
CO 5	3	3	3		2					2	2	3

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember K1	10	10	10
Understand K2	10	10	20
Apply K3	20	20	70
Analyse K4	10	10	
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Apply basic point operators and 2D transforms for digital filtering operations

1. Why histogram transformations are applied in a grey scale image and what output is observed in that case.
2. Find filtered image using LP/HP/Smoothing/Median filter.
3. Describe the working principle of Homomorphic filter.

Course Outcome 2 (CO2): Apply various algorithms for morphological operations and binary shape analysis

1. List different morphological operators and describe about each one in detail.
2. To describe connected component labelling and to apply it in a given image pixel set.
3. Find 8-point connectivity and Chain code of a given image pixel diagram.

Course Outcome 3 (CO3): Understand the theoretical aspects of image formation and 3D camera models and vision system.

1. Differentiate between Monocular and binocular imaging system.
2. Compare and Contrast Orthographic and Perspective Projection methods.
3. Describe image formation and geometric transformations in 3D Camera Models.
4. Write short notes on 3D-Imaging system.
5. Briefly describe a stereo vision system.

Course Outcome 4 (CO4): Apply edge, corner detection methods and optical flow algorithms to locate objects in an image/video.

1. What is the role of edge detection and corner detection in Computer Vision applications?
2. Describe Canny's edge detection algorithm.
3. Mention the steps in Harris corner detection algorithm and explain how it is employed to detect corners in an image.
4. State with necessary mathematical steps, how Hough transform is employed for detecting lines and curves in detecting an image.

Course Outcome 5 (CO5): Analyse 3D images and motion of objects in a given scene using appropriate computer vision algorithms for real time practical applications.

1. Find Eigen values and Eigen Vectors of the following matrix

$$A=\begin{bmatrix} 8 & -8 & -2 \\ 4 & -3 & -2 \\ 3 & -4 & 1 \end{bmatrix}$$

2. Analyse a given video to track a moving object in it.
3. To detect a particular object from the background.
4. To detect signboards/ pedestrian crossings/pedestrians from a moving vehicle.
5. To classify/segment a particular set of image using CV algorithms.
6. Analyse a given image/video using Machine learning/Deep learning algorithms.
7. Use trained networks to analyse a video using ML algorithms.
8. To use Deep neural networks/CNN/YOLOvx, to analyse images/videos

SYLLABUS

Module 1

Review of image processing techniques: Filtering, Point operators-Histogram Based operators, neighbourhood operators, Thresholding - linear filtering – development of filtering masks - 2D Fourier transforms – filtering in frequency domain, Homomorphic filtering

Module 2

Mathematical Operators: Binary shape analysis: Basics of Morphological operations, structuring element, Erosion, Dilation, Opening and Closing, Hit-or-Miss Transform, Connectedness, object labelling and counting , Boundary descriptors – Chain codes.

Module 3

Camera models: Monocular and binocular imaging system, Orthographic and Perspective Projection, Image formation, geometric transformations, Camera Models (Basic idea only), 3D-Imaging system-Stereo Vision.

Module 4

Feature Detection: Edge detection – edges, lines, active contours, Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts, energy-based and Canny's methods.
Corner detection, Harris corner detection algorithm, Line and curve detection, Hough transform
SIFT operators, Shape from X, Shape Matching, Structure from motion.

Module 5

Motion Analysis- Regularization theory, Optical Flow: brightness constancy equation, aperture problem, Horn-Shunck method, Lucas-Kanade method. (Analysis not required) Object Detection and Object classification: SVM, Linear discriminant analysis, Bayes rule, ML.

Face detection, Face Recognition, Eigen faces, 3D face models

Applications of Computer Vision: Context and scene understanding, Real Time applications: Locating road way and road marking, locating road signs and pedestrians.

Text Books

1. E. R .Davies, Computer and Machine Vision -Theory Algorithm and Practicalities, Academic Press, 2012
2. Richard Szeliski, Computer Vision: Algorithms and Applications, ISBN 978-1-84882-935-0, Springer 2011.
3. David Forsyth and Jean Ponce, Computer Vision: A Modern Approach, Pearson India, 2002.

Reference Books

1. Goodfellow, Bengio, and Courville, Deep Learning, MIT Press, 2006.
2. Daniel Lelis Baggio, Khvedchenia Ievgen, Shervin Emam, David Millan Escriva, Naureen Mahmoo, Jason Saragi, Roy Shilkrot, Mastering Open CV with Practical Computer Vision Projects, Packt Publishing Limited, 2012
3. Simon J D Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.
4. R. J. Schalkoff, Digital Image Processing and Computer Vision, John Wiley, 2004.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Review of image processing techniques: filtering.	2
1.2	Point operators- Histogram, neighbourhood operators, thresholding– development of filtering masks	3
1.3	2D Fourier transforms – filtering in frequency domain, homomorphic filtering	3
2	**Mathematical Operators:**	
2.1	Basics of Morphological operations , structuring element	2
2.2	Binary shape analysis : Erosion, Dilation, Opening and Closing, Hit-or-Miss Transform	2
2.3	Connectedness, object labelling and counting	2
2.4	Boundary descriptors –Chain Codes.	2
3	**Camera models**	
3.1	Monocular and binocular imaging system	2
3.2	Orthographic & Perspective Projection	2
3.3	Image formation, geometric transformations, camera Models(Basic idea only)	3
3.4	3D-Imaging system-Stereo Vision	2
4	**Feature Detection:**	
4.1	Edge detection – edges, lines, active contours, Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts, energy-based	4

	and Canny's methods.	
4.2	Corner detection, Harris corner detection algorithm, Line and curve detection, Hough transform	3
4.3	SIFT operators, Shape from X, Shape Matching	3
5	**Motion Analysis**	
5.1	Motion Analysis- Regularization theory, Optical Flow: brightness constancy equation, aperture problem, Horn-Shunck method, Lucas-Kanade method (Analysis not required)	3
5.2	Object Detection and Object classification: SVM, Linear discriminant analysis, Bayes rule, maximum likelihood, Face detection, Face Recognition, Eigen faces, 3D face models	4
5.3	Applications of Computer Vision: Context and scene understanding, Real Time applications: Locating road way and road marking, locating road signs and pedestrians	3

Simulation Assignments

The following simulations can be done in OpenCV/SciLab/ MatLab

1. Design and implementation of basic digital filters.
2. Apply thresholding operations in a digital image.
3. Apply point operators in an image – averaging/smoothing, 2D - masks(3 types),
4. Apply morphological operations in a selected image like fingerprint/ archaeological scripts.
5. Implement filters in 2D-frequency domain using Gaussian/Homomorphic filters in a particular satellite image or forensic image.
6. Write algorithms for connected component labelling in a given image pixel set.
7. Detect a coin/ball against the background using background subtraction and with appropriate edge detection algorithms.
8. Locate corners of a particular image like boxes/ building/TV screen etc
9. Write a program to implement brightness constancy equation.
10. Analyse the optical flow of a given video using Horn-Schunk method or/and Lucas-Kannade method/s.
11. Use PCA for dimensionality reduction in detecting faces using Eigen values.
12. Implement SVM/LDA for a practical application.
13. Create an attendance system by implementing face recognition method, among a set of students.
14. With OpenCV library, implement real time scene analysis for traffic regulation. (cases such as detecting road signs/ pedestrians/track a particular vehicle/ detect traffic lights/detect number plate of a vehicle/ detect accidents/ accident scene analysis etc., etc.).
15. Use ML/DL algorithms to implement object detection/identification/classification, with trained neural networks for applications in medical/agricultural/sports fields.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: EC386

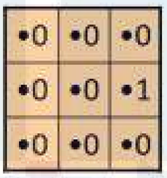
Course Name: TOPICS IN COMPUTER VISION

(Minor)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each carries 3 marks.

1	Compare and Contrast DoG and LoG.	K1
2	An image is convolved with the matrix given below. Express analytically the relation between original and modified image.  •0 •0 •0 •0 •0 •1 •0 •0 •0	K2
3	List any three computer vision applications of object labeling and counting.	K2
4	Describe steps in identifying connected components in 4-connectivity and 8-connectivity cases.	K2
5	Describe the working principle of pin- hole camera	K2
6	Compare and contrast perspective and orthographic projection.	K2
7	Mention the concept of identifying structure from motion.	K2
8	Illustrate how graph cut method is employed for edge detection	K2
9	Define eigen values and eigen vectors.	K2
10	Differentiate between SVM and LDA.	K2
	PART – B Answer one question from each module; each question carries 14 marks.	
	Module - I	
11 a	What is thresholding? Briefly describe different methods of thresholding.	(6) CO1 K1

11 b. Apply 2D-DFT on the given image pixel values (8) CO1 K3

$$\begin{bmatrix} 1 & 2 & 2 & 0 \\ 0 & 1 & 3 & 1 \\ 0 & 1 & 2 & 1 \\ 1 & 2 & 2 & -1 \end{bmatrix},$$

OR

12 a Describe how histogram transformations are applied on a grey scale image and explain what output is observed in each case. (8) CO1 K3

12 b. Describe the working principle of Homomorphic filter, with different mathematical steps involved. (6) CO1 K2

Module - II

13a An image A, and a structuring element B are given. Apply B on A, to find resultant images after the dilation and erosion process. Origin is given as ‘O’; and note that it is not part of the structuring element. (8) CO2 K3

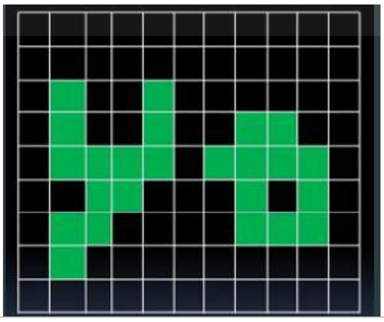
A =

	1	1	1		
	1		1		
	1		1	1	
				1	1
O					

B =

1	O	1

13 b. Using Hoshen–Kopelman algorithm, assign connected component labelling for the given image in the diagram below. (6) CO2 K3



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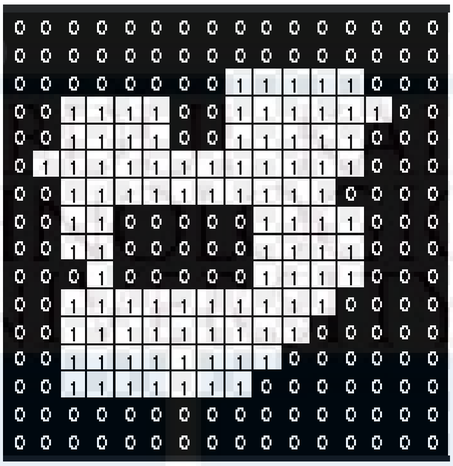
<tr><td>14a</td><td>Apply Hit-or-Miss transform on the given binary image to detect right angle convex corners from left-top to right-bottom.
<table>
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</table>For the given image grid, find out the 8-chain Freeman Code. Also write down the chain number of the code.</td><td>(6)
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<tr><td>15</td><td>Describe image formation and geometric transformations in 3D Camera Models.</td><td>(14)
CO3
K2</td></tr>
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<tr><td>16a</td><td>Briefly describe a stereo vision system.</td><td>(7)
CO3
K2</td></tr>
<tr><td>16 b</td><td>Elucidate on 3D-Imaging Camera system.</td><td>(7)
CO3
K2</td></tr>
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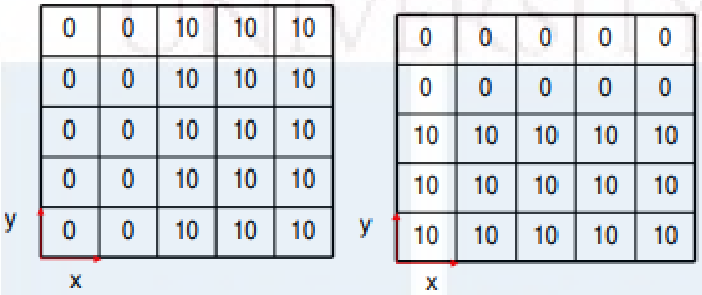
<tr><td></td><td>Module - IV</td><td></td></tr>
<tr><td>17a</td><td>With the help of a general algorithm, narrate how Hough Transform can be employed for interest point detection.</td><td>(6)
CO4
K3</td></tr>
<tr><td>17 b</td><td>Unveil different steps involved in Harris corner detection algorithm and explain how it is employed to detect corners in an image
OR</td><td>(8)
CO4
K3</td></tr>
<tr><td>18 a.</td><td>Apply Sobel and Prewitt masks on the given image grids and compute Gx and Gy gradients of the images.


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CO4
K3</td></tr>
<tr><td>18 b.</td><td>Referring to Canny’s algorithm, describe how it is employed to detect edges of an image.</td><td>(8)
CO4
K3</td></tr>
<tr><td></td><td>Module - V</td><td></td></tr>
<tr><td>19 a</td><td>Derive brightness constancy equation.</td><td>(6)
CO5
K3</td></tr>
<tr><td>19 b</td><td>Describe with algorithmic steps, the Horn-Shunk method used for the estimation of optical flow.</td><td>(8)
CO5
K3</td></tr>
<tr><td>20 a</td><td>Illustrate the concept of dimensionality reduction using Principal Component Analysis (PCA) with all mathematical steps involved.</td><td>(7)
CO5
K3</td></tr>
<tr><td>20b.</td><td>With the help of a flow chart, illustrate an in-vehicle vision system, for locating roadways and pedestrians, as a practical application of computer vision.</td><td>(7)
CO5
K3</td></tr>
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SEMESTER VI

HONOURS

ECT394	ELECTRONIC DESIGN AUTOMATION	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: The course aims to introduce principles behind advanced methods in automation of electronic design.

Prerequisites: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply Search Algorithms and Shortest Path Algorithms to find various graph solutions.
CO 2	Outline VLSI Design Flow and Design Styles and apply partitioning algorithms on graphs representing netlist.
CO 3	Illustrate Design Layout Rules and apply different algorithms for layout compaction.
CO 4	Make use of various algorithms to solve placement and floorplan problems.
CO 5	Utilise different algorithms to solve routing problems.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO 1	3	2										3
CO 2	3	2										3
CO 3	3	2										3
CO 4	3	2										3
CO 5	3	2										3

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember				
Understand	K2	30	30	60
Apply	K3	20	20	40
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

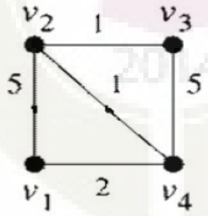
End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14marks.

CO Assessment Questions

CO1: Apply Search Algorithms and Shortest Path Algorithms to find various graph solutions

1.Represent the following graph by Adjacency Matrix.
2. List a DFS ordering of vertices for the graph shown in question 1 with starting node as H.
3. Perform topological sort on the graph in question1 and order the vertices with
Starting node is H.

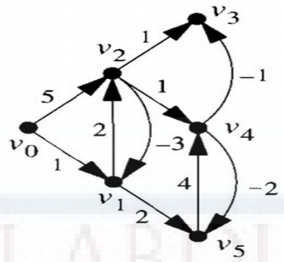
CO2: Outline VLSI Design Flow and Design Styles and apply partitioning algorithms on graphs representing netlist.



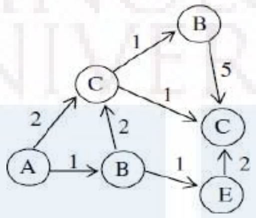
1.Perform KL partitioning on the above graph.You may assume any initial partition of your choice.
2. Draw the flowchart of VLSI Design Flow and explain the different stages

CO3: Illustrate Design Layout Rules and apply different algorithms for layout compaction.

1. For the following graph, find the longest path to all other vertices from vertex v_0, using Bellman-Ford Algorithm.

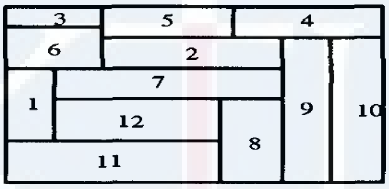


2. Use the Longest Path Algorithm to find the longest path from vertex A, in the following graph



CO4: Make use of various algorithms to solve placement and floorplan problems.

1. Consider the following floorplan.



Draw the floorplan slicing tree and the polar graphs of the above floorplan.

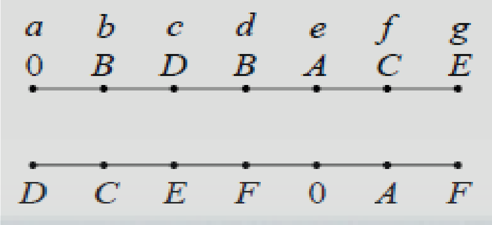
CO5: Utilise different algorithms to solve routing problems.

1.Perform LEE's Algorithm to find shortest path from S to T. Cells marked O indicate obstructions.

	T					
O			O	O	O	
		O				
			O	S		

2. Draw Horizontal and Vertical Constraint Graph for the following Channel Routing

3.



Model Question Paper

APJ Abdul Kalam Technological University

Sixth Semester B Tech Degree Examination

Branch: Electronics and Communication

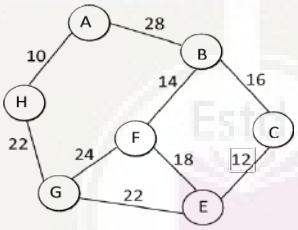
Course: ECT394 Electronic Design Automation

Time: 3 Hrs Max. Marks: 100

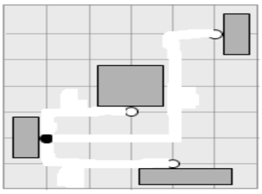
PART A

Answer All Questions

1. Define the following giving an example each (3) (K2)
   (a) Degree of a vertex (b) Subgraph (c) Directed Acyclic Graph (DAG)
2. Represent the following graph by Adjacency Matrix. (3) (K2)



3. Write short note on (a) Full Custom Design (b) Standard Cell Design (3) (K1)
4. Explain any three parameters based on which Partitioning is performed. (3) (K1)
5. What are the minimum distance rules in Design Rules for layout? (3) (K1)
6. Write inequality expressions for minimum distance and maximum distance constraints between two rectangular edges. (3) (K1)
7. For the following placement, calculate the wirelength by (a) Half Perimeter Method (b) Maximum Rectilinear Tree Method (3) (K3)



8. Represent the following floor ce Pair approach. (3) (K3)

9. How is Global Routing different from Detailed Routing? (3) (K1)

10. Define the following terms (a) Reserved Layer Model (b) Channel (c) Dogleg(3)(K1)

PART B

Answer one question from each module. Each question carries 14 marks.

11. (A) List a DFS ordering of vertices for the graph shown in question 2. (7) (K3)
    Starting node is H.
    (B) Perform topological sort on the graph and order the vertices. (7) (K3)
    Starting node is H.

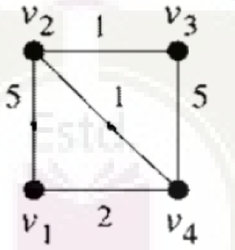
OR

12. (A) List a BFS ordering of vertices for the graph shown in question 2. (10)(K3)
    Starting node is H.
    (B) Give an application related to VLSI of BFS. (4) (K2)

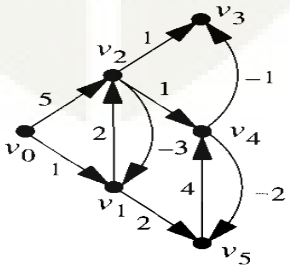
13. Draw the flowchart of VLSI Design Flow and explain the different stages. (14) (K1)

OR

14. Perform KL partitioning on the following graph You may assume any initial (14)(K3)
    partition of your choice.



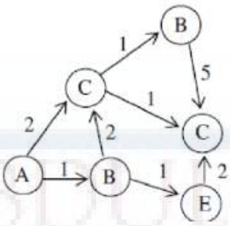
15. (A) For the following graph, find the longest path to all other vertices from (10) (K3)
    vertex v_0, using Bellman-Ford Algorithm.



(B) What is the time complexity of Liao-Wong and Bellman-Ford Algorithms?(4) (K2)

OR

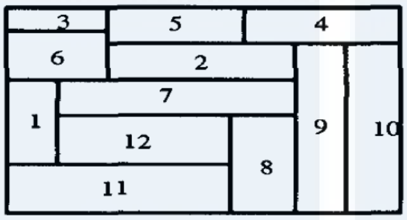
16. (A) Use the Longest Path Algorithm to find the longest path from vertex A, (8) (K3) in the following graph.



(B) What is the limitation of Longest Path Algorithm? (2) (K1)

(C) List two methods to find shortest path using Longest Path Algorithm (4) (K2)

17. Consider the following floorplan.



(A) Draw the floorplan slicing tree of the above floorplan. (6) (K3)

(B) Draw the polar graphs of above floorplan. (8) (K3)

OR

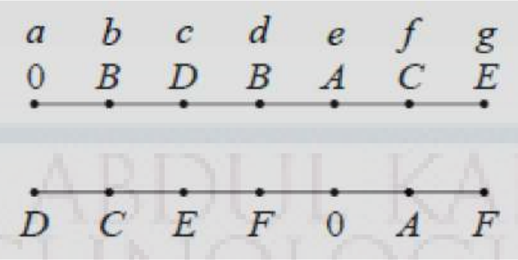
18. Given: Placement *P* with two fixed points *p*1 (100,175) and *p*2 (200,225), (14) (K3) three free blocks *a*-*c* and four nets *N*1-*N*4. *N*1 (*P*1,*a*) *N*2 (*a*,*b*) *N*3 (*b*,*c*) *N*4 (*c*,*P*2). Find the coordinates of blocks (*xa*, *ya*), (*xb*, *yb*) and (*xc*, *yc*).

19. Perform LEE's Algorithm to find shortest path from S to T. Cells marked (14) (K3) O indicate obstructions.

	T					
O			O	O	O	
		O				
			O	S		

OR

20. Draw Horizontal and Vertical Constraint Graph for the following Channel Routing. (14) (K3)



Simulation Assignments

1. Develop C code for all algorithms in Module 1, 2 and 3.
2. A digital circuit can be taken through all steps od VLSI Design Flow (ie. From HDL to Layout) using any standard tool set from Cadence, Synopsis or Mentor Graphics or similar tools

Syllabus

Module 1: Graph Terminology, Search Algorithms and Shortest Path Algorithms:

Graph Terminology: Basic graph theory terminology, Data structures for representation of
Graphs Search Algorithms: Breadth First Search, Depth First Search, Topological Sort
Shortest Path Algorithms: Dijkstra's Shortest-Path Algorithm for single pair shortest path, Floyd Warshall Algorithm for all pair shortest path

Module 2: Design Automation and Partitioning Algorithms:

Design Automation: VLSI Design Flow, VLSI Design Styles
Partitioning: Levels of Partitioning, Parameters for Partitioning, Classification of Partitioning Algorithms, Kernighan-Lin Algorithm, Fiduccia-Mattheyses Algorithm, Simulated Annealing

Module 3: Layout Compaction:

Layout: Layout Layers and Design Rules, Physical Design Optimizations
Compaction: Applications of Compaction, Informal Problem Formulation, Graph Theoretical Formulation, Maximum Distance Constraints, Longest Path algorithm for DAG, Longest path in graph with cycles, Liao-Wong Algorithm, Bellman-Ford Algorithm.

Module 4: Placement and Floorplanning:

Placement: Optimization Objectives, Wirelength Estimation, Weighted Wirelength, Maximum Cut Size, Wire Density
Placement Algorithms: Quadratic Placement
Floorplanning: Optimization Objectives, Slicing Floorplan, Non-Slicing Floorplan
Floorplan Representations: Constraint Graph, Sequence Pair
Floorplan Algorithms: Minimum Area Algorithm

Module 5: Global Routing and Detailed Routing:

Global Routing: Terminology and Definitions, Optimization Goals, Representation of Routing Regions
Maze Routing Algorithms: Lee's Algorithm, Hadlock Algorithm
Detailed Routing: Horizontal and Vertical Constraint Graph
Channel Routing Algorithms: Left-Edge algorithm

Text Books

1. Jin Hu, Jens Lienig, Igor L. Markov, Andrew B. Kahng, VLSI Physical Design: From Graph Partitioning to Timing Closure, Springer, 2011th edition.
2. Gerez,Sabih H., "Algorithms for VLSI Design Automation", John Wiley & Sons, 2006.
3. Sherwani, Naveed A., "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 1999.

Reference Books

1. Sadiq M. Sait and H. Youssef, "VLSI Physical Design Automation: Theory and Practice", World Scientific, 1999.
2. Cormen, Thomas H., Charles E. Leiserson, and Ronald L. Rivest. "Introduction to Algorithms." The MIT Press, 3rd edition, 2009.

Course Contents and Lecture Schedule

No.	Topic	Number of Lectures
1	**Graph Terminology, Search Algorithms and Shortest Path Algorithms:**	
1.1	**Graph Terminology:** Basic graph theory terminology, Data structures for representation of Graphs	2
1.2	**Search Algorithms:** Breadth First Search, Depth First Search, Topological Sort	2
1.3	**Shortest Path Algorithms:** Dijkstra's Shortest-Path Algorithm for single pair shortest path, Floyd Warshall Algorithm for all pair shortest path	4
2	**Design Automation and Partitioning Algorithms:**	
2.1	**Design Automation:** VLSI Design Flow, VLSI Design Styles	3
2.2	**Partitioning:** Levels of Partitioning, Parameters for Partitioning, Classification of Partitioning Algorithms	1
2.3	Kernighan-Lin Algorithm, Fiduccia-Mattheyses Algorithm, Simulated Annealing	5
3	**Layout Compaction:**	

3.1	**Layout:** Layout Layers and Design Rules, Physical Design Optimizations	1
3.2	**Compaction:** Applications of Compaction, Informal Problem Formulation, Graph Theoretical Formulation, Maximum Distance Constraints	1
3.3	Longest Path algorithm for DAG, Longest path in graph with cycles, Liao-Wong Algorithm, Bellman-Ford Algorithm.	7
4	**Placement and Floorplanning:**	
4.1	**Placement:** Optimization Objectives, Wirelength Estimation, Weighted Wirelength, Maximum Cut Size, Wire Density	3
4.2	**Placement Algorithms:** Quadratic Placement	2
4.3	**Floorplanning:** Optimization Objectives, Slicing Floorplan, Non-Slicing Floorplan **Floorplan Representations:** Constraint Graph, Sequence Pair	3
4.4	**Floorplan Algorithms:** Minimum Area Algorithm	3
5	**Global Routing and Detailed Routing:**	
5.1	**Global Routing:** Terminology and Definitions, Optimization Goals, Representation of Routing Regions	1
5.2	**Maze Routing Algorithms:** Lee's Algorithm, Hadlock Algorithm	2
5.3	**Detailed Routing:** Horizontal and Vertical Constraint Graph	3
5.4	**Channel Routing Algorithms:** Left-Edge algorithm	2

ECT396	MIMO AND MULTIUSER COMMUNICATION SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: MIMO systems are rising attention of the academic community and industry because of their potential to increase to capacity and diversity gain proportionally with the number of antennas. OFDM is a promising solution to mitigate the effect of inter symbol interference (ISI) and multipath fading. MIMO OFDM is an attractive air interface solution for multiuser communication and effectively deployed in wireless local area networks, fifth Generation (5G) wireless cellular standards.

Prerequisite: MAT 204 Probability and Random Process, ECT 305 Analog and Digital Communication.

Course Outcomes: At the end of the course, the students will be able to

CO 1	Describe digital communication over multipath channels
CO 2	Analyse the performance of multiuser communication techniques over generalized fading channel.
CO 3	Describe the concept of MIMO systems and determine the capacity of MIMO channel
CO 4	Introduce OFDM and associated timing and frequency synchronization in MIMO receiver
CO 5	To explain the theory of MIMO multiuser communication systems.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3		2									
CO 2	3	3	2									
CO 3	3											
CO 4	3		2									
CO 5	3											

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember				
Understand	K2	30	30	60
Apply	K3	20	20	40
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Define doppler spread.
2. Distinguish between flat fading and frequency selective fading
3. Derive the relation between Power spectra and channel correlation.

Course Outcome 2 (CO2)

1. State and infer the capacity of different multiple access techniques.
2. Describe CDMA signal and channel model.
3. Derive the autocorrelation matrix of CDMA multiuser Asynchronous transmission.

Course Outcome 3 (CO3)

1. Determine the channel capacity of SISO and MIMO systems.
2. Determine the channel capacity of MIMO system when CSI is known to the transmitter side.
3. Compare the detection performance of MLSE and ZF equalizer.

Course Outcome 4 (CO4)

1. Describe FFT based implementation of OFDM.
2. Analyze the effect of symbol time offset in OFDM systems.
3. Describe the synchronization using cyclic prefix to OFDM systems.

Course Outcome 5 (CO5)

1. Distinguish between array gain and diversity gain.
2. Define spatial multiplexing.
3. Draw the general block diagram of MIMO system.
4. Write the motivation behind using multiuser communication in wireless scenario.

MODEL QUESTION PAPER

APJ ABDULKALAM TECHNOLOGICAL
UNIVERSITY MODEL QUESTION PAPER
ECT396 MIMO AND MULIUSER COMMUNICATION SYSTEMS

Time: 3 hours **Max.Marks:100**

PARTA

Answer ***all*** questions. Each question carries ***3marks***.

1. Distinguish between frequency selective and frequency non selective fading.
2. Define Doppler spread.
3. State the capacity of FDMA
4. Mention the applications of TDMA and CDMA
5. Draw the channel model for SIMO system.
6. Explain the significance of Ergodic capacity.
7. What are the gains available in MIMO systems?
8. Define spatial multiplexing.
9. Define inter symbol interference.
10. Write short notes on OFDMA.

PARTB

Answer ***anyone*** question from each module. Each question carries ***14marks.***

MODULE I

11. (a) Draw and explain the Tapped delay line channel model used in frequency selective slowly fading channel . (10 marks)
    (b) Distinguish between fast and slow fading. (4 marks)

12. A multipath fading channel has a multipath spread of 1s and a Doppler spread of 0.01 Hz. The total channel bandwidth at band pass available for signal transmission is 10 Hz. To mitigate the effect of ISI select the pulse duration 10s.
    (a) Calculate the coherence bandwidth and coherence time. (5 marks)
    (b) Is the channel is frequency selective or not? Justify your answer. (5 marks)
    (c) Is the channel fading slowly or rapidly? Justify your answer. (4 marks)

MODULE II

13. (a) Briefly describe FDMA and TDMA. (8 marks)
    (b) State and infer the capacity of single user CDMA detection scheme. (6 marks)

14. (a) With the aid of Gaussian PDF derive the Maximum Likelihood (ML) criteria of CDMA decorrelation receiver. (10 marks)

MODULE II

15. (a) Determine the channel capacity of MIMO system when CSI is known to the transmitter side and when CSI is not available at transmitter side. (10 marks)
(b) Distinguish between outage probability and outage capacity. (4 marks)
16. (a) State the significance of Ergodic capacity. (5 marks)
(b) Determine the capacity of deterministic MIMO channel assuming AWGN capacity. (9 marks)

MODULE IV

17. (a) What is sphere decoding? (4 marks)
(b) Compare the detection performance of ZF and MMSE signal detection techniques in MIMO receiver. (10 marks)
18. (a) Compare array gain and diversity gain. (4 marks)
(b) Briefly describe receive and transmit antenna diversity. (10 marks)

MODULE V

19. (a) Consider a transmitter sends digital information by use of Msignal waveforms $\{s_m(t), m = 1,2,...., M\}$ over an AWGN channel. The channel is assumed to be corrupt the signal by the addition of white Gaussian noise. Write down the expression for received signal in the interval $0 \leq t \leq T$and draw the model for received signal passed through the channel. (4 marks)
(b) Describe the FFT based implementation of OFDM system. (10 marks)
20. (a) State and prove Nyquist condition for zero ISI. (4 marks)
(b) Describe the synchronization technique using cyclic prefix in OFDM systems. (10 marks)

SYLLABUS

Module 1 – Digital Communication over Fading Multipath Channels
Multipath fading, Coherence time, Coherence bandwidth, Doppler spread, Characterization of fading multipath channels, Statistical model for fading channels (Rayleigh and Rice distribution), Relation between channel correlation and Power spectral density, Signal characteristics on the choice of channel model (frequency selective and frequency nonselective fading), Frequency nonselective slowly fading channel, Frequency selective slowly fading channel, Fast fading, Rake receiver.

Module 2 – Multiuser Communications
Types of multiple access techniques (FDMA,TDMA and CDMA), Capacity of multiple access methods (*Inference only*). Single user detection, Multiuser detection, CDMA signal and channel model, CDMA optimum receiver (Synchronous transmission, Asynchronous transmission), Suboptimum detectors (Single user detector and Decorrelation receiver). Practical applications of multiple access techniques.

Module 3 – MIMO System

Signal and channel model for SISO,SIMO,MISO and MIMO, Capacity of frequency flat deterministic MIMO channel (both channel unknown and known to the transmitter), SIMO channel capacity, MISO channel capacity, Capacity of random MIMO channels, Ergodic capacity, Outage capacity, Capacity of frequency selective MIMO channels (both channel unknown and known to the transmitter)

Module 4 – Diversity and Receiver

Array gain, Diversity gain, Spatial multiplexing, Receive antenna diversity, Transmit antenna diversity, SISO receiver (MLSE, ZF and Decision feedback equalizer), SIMO receiver, MIMO receiver (both Optimal and suboptimal), Sphere decoding.

Module 5 – OFDM

Review of AWGN channel and band limited ISI channel, Introduction to multicarrier systems, FFT based multicarrier system, Mitigation of subcarrier fading, SISO-OFDM, MIMO-OFDM, Coarse time synchronization, Fine time synchronization, Coarse frequency synchronization, OFDMA, Wireless standards (WiMAX, and 3GPP LTE)

Note: Mathematical model and analysis to be covered for the entire topic.

Text Books

1. "Digital Communications", John G Proakis, 4/e, McGraw-Hill.
2. "Fundamentals of Wireless Communications", David Tse and Pramod Viswanath, Cambridge University Press, 2005.
3. "Introduction to Space Time Wireless Communications", A Paulraj, Nabar and D Gore Cambridge University Press, 2003.
4. "MIMO OFDM Wireless Communications with MATLAB", Y S Cho, J Kim, Won Yong Yang, Chung G Kang, John Wiley& sons private Ltd, 2010.

Reference Books

5. "Space Time Block Coding for Wireless Communications", Erik G Larsson, Cambrdige University Press, 2003.

6. "MIMO Wireless Communications", E Biglieri, R Calderbank, A Constantinides, A Goldsmith, A Paulraj, Cambridge University Press.
7. "Digital Communications", Simon Haykin, John Wiley & Sons Pvt Ltd. 2001.
   "Wireless Communications" Andrea Goldsmith, Cambridge University Press 2005

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Digital Communication over Fading Multipath Channels**	
1.1	Multipath fading, Coherence time, Coherence bandwidth, Doppler spread	1
1.2	Characterization of fading multipath channels, Statistical model for fading channels (Rayleigh and Rice distribution), Relation between channel correlation and Power spectral density	4
1.3	Signal characteristics on the choice of channel model (frequency selective and frequency nonselective fading), Frequency nonselective slowly fading channel, Frequency selective slowly fading channel	3
1.4	Fast fading, Rake receiver	2
2	**Multiuser Communications**	
2.1	Types of multiple access techniques (FDMA,TDMA and CDMA), Capacity of multiple access methods (without proof, Inference only).	2
2.2	Single user detection, Multiuser detection	1
2.3	CDMA signal and channel model, CDMA optimum receiver (Synchronous transmission, Asynchronous transmission),	2
2.4	Suboptimum detectors (Single user detector and Decorrelation receiver).	1
2.5	Practical applications of multiple access techniques.	1
3	**MIMO System**	
3.1	Signal and channel model for SISO, SIMO, MISO and MIMO	2
3.2	Capacity of frequency flat deterministic MIMO channel (both channel unknown and known to the transmitter), SIMO channel capacity, MISO channel capacity	4
3.3	Capacity of random MIMO channels	1
3.4	Ergodic capacity, Outage capacity, Capacity of frequency selective MIMO channels (both channel unknown and known to the transmitter)	2
4	**Diversity and Receiver**	
4.1	Array gain, Diversity gain, Spatial multiplexing.	1
4.2	Receive antenna diversity, Transmit antenna diversity	1
4.3	SISO receiver (MLSE, ZF and Decision feedback equalizer)	2
4.4	SIMO receiver	1
4.5	MIMO receiver (both Optimal and suboptimal), Sphere decoding.	3
5	**OFDM**	
5.1	Review of AWGN channel and band limited ISI channel	1
5.2	Introduction to multicarrier systems, FFT based multicarrier system	2

5.3	Mitigation of subcarrier fading, SISO-OFDM, MIMO-OFDM	2
5.4	Coarse time synchronization, Fine time synchronization, Coarse frequency synchronization	3
5.5	OFDMA, Wireless standards (WiMAX, and 3GPP LTE)	2

SIMULATION ASSIGNMENTS

The following simulation assignments can be done with Python/ MATLAB/ SCILAB /LabVIEW

1 Frequency Non-selective Slowly Fading Channel

- Generate binary PSK and binary FSK signals for transmission over a frequency non-selective slowly fading channel.
- Obtain the received equivalent lowpass signal of the transmitted signal using equation 13.3-1. Also plot the BER-SNR curve for coherent binary PSK and FSK detector using equations 13.3-2 and 13.3-3 respectively in page 846 in *Digital Communications by John G Proakis, 4/e*, for fixed attenuation value, α fixed and follows Rayleigh distribution case.
- Plot the BER-SNR curve for coherent binary PSK and FSK detector using equations 13.3-13 in page 848 in *Digital Communications by John G Proakis, 4/e* for α followingRayleigh distribution.
- Compare the BER-SNR curve for AWGN and Rayleigh fading channel.

2 CDMA Transmitter and Receiver

- Create 2 random binary sequence of 100 bit each as data blocks of 2 users.
- Generate the composite transmitted signal, s(t) for 3 users using equations 16.3-7 in page 1037 in *Digital Communications by John G Proakis, 4/e.*
- Add AWGN of different variances to generate the received signal, r(t).
- Realize the optimum multiuser receiver for synchronous transmission shown in Fig. 16.3-1 in page 1040 in *Digital Communications by John G Proakis, 4/e*
- Observe the decoded bits for AWGN of different variances.

3 Capacity of MIMO Channels

- Create MIMO channel transfer matrix, H of size M_R x M_T, where M_R and M_T represents number of receive and transmit antennas respectively.
- Compute the capacity of SISO, SIMO, MISO and MIMO channels for different values of SNR using equations in page 138 in *Introduction to Space Time Wireless Communications by A Paulraj, Nabar and D Gore.*

- Plot Capacity-SNR curve for different channels and compare.

4 Performance of SISO Receiver

- Realize the signal model for SISO frequency selective fading channel given in equation 7.5 in page 138 in *Introduction to Space Time Wireless Communications by A Paulraj, Nabar and D Gore.*

- Transmit a sequence of symbols based on signal model.
- Obtain the estimated symbol sequence using MLSE receiver based on equation 7.8 in page 139 in *Introduction to Space Time Wireless Communications by A Paulraj, Nabar and D Gore.*

5 OFDM Communication System

- Realize the block diagram of OFDM communication system shown in Fig 11.2-4 in page 750 in *Digital Communications by John G Proakis, 4/e.*

- Create a random bit vector of arbitrary length. Realize the OFDM transmitter by mapping the message bits into a sequence of QAM symbols and convert it into N parallel streams.

- Each of N symbols from serial-to-parallel (S/P) conversion is carried out by the different subcarrier. Realize the multicarrier modulation by computing IFFT.

- Add cyclic prefix, realize parallel to serial converter and DAC to generate the transmitted signal.

Transmit the signal through a fading channel.

- Realize OFDM receiver by first removing cyclic prefix followed by serial to parallel conversion, FFT computation, signal detection and parallel to serial conversion.

- Plot the BER-SNR curve and analyse.

ECT398	**DETECTION AND ESTIMATION THEORY**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		VAC	**3**	**1**	**0**	**4**

Preamble: This course aims to impart the fundamentals of detection and estimation theory in engineering applications

Prerequisite: MAT 101 Linear Algebra and Calculus
MAT 204 Probability, Random Process, and Numerical Methods
ECT 204 Signals and Systems

Course Outcomes: After the completion of the course the student will be able to

CO1 K2	Understand the fundamentals of statistical detection and estimation principles used in various engineering problems.
CO2 K3	Apply various types of statistical decision rules in engineering applications.
CO3 K3	Apply different types of estimation algorithms in engineering applications.

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember			
Understand K2	30	30	60
Apply K3	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the fundamentals of statistical detection and estimation principles used in various engineering problems. (K2)

1. Differentiate estimation and detection techniques.
2. Differentiate classical approach and bayesian approch in detection theory (or estimation).
3. Enumerate different applications which are using estimation and detection techniques.
4. Give the mathematical formulation of estimation and detection methods.
5. Draw receiver operating characteristics with all details
6. Give the significance of Bayes risk
7. How multiple hypothesis testing is done.
8. Give the significance of linear models in estimation and detection theory.
9. Significance of Cramer-Rao Lower Bound in estimation.
10. Differentiate MAP and ML methods in estimation (or detection).

Course Outcome 2 (CO2): Apply various types of statistical decision rules in engineering applications. (K3)

1. Describe Neyman-Pearson theorem (or Bayes risk or minimization of probability of error) and apply it to any binary hypothesis (eg. Signal in white Gaussian noise)
2. Derive/Obtain the matched filters for the detection of deterministic signals
3. Derive/Obtain the estimator-correlator for the detection of random signals

Course Outcome 3 (CO3): Apply different types of estimation algorithms in engineering applications. (K3)

1. Derive/Obtain the Minimum variance unbiased estimator (or best linear unbiased estimator) for any simple examples (eg. DC Signal in white Gaussian noise)
2. Derive/Obtain the Maximum likelihood estimator (or least squares estimator or minimum mean square error estimator) for any simple examples (eg. DC Signal in white Gaussian noise)
3. Using Bayesian approach, obtain an estimator for any simple examples.

SYLLABUS

Module 1 : Introduction to Detection and Estimation Theory

Fundamentals of detection theory, the mathematical detection problem. Fundamentals of estimation theory, the mathematical estimation problem. Review of Gaussian distribution. Application examples.

Module 2 : Statistical Detection Theory I

Hypothesis testing, classical approach, Neyman-Pearson theorem, likelihood ratio test, receiver operating characteristics, Bayesian approach, minimum probability of error, Bayes risk, multiple hypothesis testing.

Module 3 : Statistical Detection Theory II

Detection of deterministic signals, matched filters, detection of random signals, estimator-correlator, linear model, application examples.

Module 4 : Statistical Estimation Theory I

Minimum variance unbiased estimation, basics of Cramer-Rao Lower Bound, linear models, best linear unbiased estimation, application examples.

Module 5 : Statistical Estimation Theory II

Maximum likelihood estimation, least squares, Bayesian philosophy, minimum mean square error estimation, application examples.

Text Books

1. S.M. Kay, “Fundamentals of Statistical Signal Processing” Vol I: Estimation Theory, Pearson, 3/e, 2010.

2. S.M. Kay, “Fundamentals of Statistical Signal Processing” Vol II: Detection Theory, Pearson, 3/e, 2010.

Reference Books

1. H. L. Van Trees, “Detection, Estimation, and Modulation Theory”, Vol. I, John Wiley & Sons, 1968

2. Monson H. Hayes ,“Statistical Digital Signal Processing and Modelling" by, John Wiley & Sons, 2002.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Detection and Estimation Theory**	
1.1	Fundamentals of detection theory, review of probability and random variable	2
1.2	The mathematical detection problem	2
1.3	Fundamentals of estimation theory	1
1.4	The mathematical estimation problem	2
1.5	Review of Gaussian distribution. Application examples.	2
2	**Statistical Detection Theory I**	
2.1	Hypothesis testing	2
2.2	Classical approach, Neyman-Pearson theorem	2
2.3	Likelihood ratio test, Receiver operating characteristics	2
2.4	Bayesian approach, minimum probability of error, Bayes risk	2
2.5	Multiple hypothesis testing.	1
3	**Statistical Detection Theory II**	
3.1	Detection of deterministic signals	1
3.2	Matched filters	2
3.3	Detection of random signals	2
3.4	Estimator-correlator	2
3.5	Linear model, application examples.	2
4	**Statistical Estimation Theory I**	
4.1	Minimum variance unbiased estimation	2
4.2	Basics of Cramer-Rao Lower Bound	2
4.3	Linear models	2
4.4	Best linear unbiased estimation	2
4.5	Application examples	1
5	**Statistical Estimation Theory II**	
5.1	Maximum likelihood estimation	2
5.2	Least squares solution	2
5.3	Bayesian philosophy	2
5.4	Minimum mean square error estimation	2
5.5	Application examples	1

Simulation Assignments (using MATLAB or Python)

1. Generate and familiarize PDF and CDF of Normal distribution.

2. Generate DC level in White Gaussian Noise.

3. Simulate a Neyman-Pearson Detector.

4. Simulate a Maximum Likelihood Estimator.

5. Simulate a Best Linear Unbiased Estimator.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

Max. Marks: 100 **ECT 398- Detection and Estimation Theory** Duration: 3 hrs

PART A

*(Answer **all** questions. Each question carries 3 marks each).*

1. Enumerate different applications which are using estimation and detection techniques. (3)
2. Differentiate estimation and detection techniques. (3)
3. Differentiate classical approach and bayesian approch in detection theory. (3)
4. Give the mathematical formulation of detection methods. (3)
5. Draw receiver operating characteristics with all details (3)
6. Give the significance of Bayes risk (3)
7. Give the significance of linear models in estimation theory. (3)
8. Significance of Cramer-Rao Lower Bound in estimation. (3)
9. What is Minimum Variance Unbiased Estimation? (3)
10. Differentiate MAP and ML methods in estimation. (3)

PART B

*(Answer any **one** question from each module. Each question carries 14 marks each.)*

Note:
(1) Notation $x \sim \mathcal{N}(\mu, \sigma^2)$ denotes x is normally distributed with mean μ and variance σ^2.
(2)Also, bold small letters indicate vectors and bold capital letters indicate matrices.

11. Obtain the mathematical formulation of estimation method with an example. (14)

OR

12. Using radar system as an example, differentiate estimation and detection techniques. (14)

13. Design Neyman-Pearson detector for the unknown level A in White Gaussian Noise with variance σ^2. (14)

OR

14. Describe the Bayesian approaches in the design of detectors. (14)

15. Obtain Matched Filter detector for N-sample deterministic signal in noise, $w[n] \sim \mathcal{N}(0, \sigma_n^2)$ where $w[n]$'s are uncorrelated. (14)

OR

16. Describe estimator-correlator in the detection of random signals. (14)

17. Consider the multiple observations (14)

$$x[n] = A + w[n]; \quad n = 0, 1, \ldots, N-1$$

where $w[n] \sim \mathcal{N}(0, \sigma^2)$. Determine CRLB for A?

OR

18. Derive the Best Linear Unbiased Estimator for the multiple observations (14)

$$x[n] = A + w[n]; \quad n = 0, 1, \ldots, N-1$$

where A is an unknown level to be estimated and $w[n]$ is White Noise with unspecified PDF and variance σ^2.

19. Derive the Maximum Likelihood Estimator for the multiple observations (14)

$$x[n] = A + w[n]; \quad n = 0, 1, \ldots, N-1$$

where A is an unknown level to be estimated and $w[n]$ is White Gaussian Noise with known variance σ^2.

OR

20. Prove that the optimal estimator which minimizes the Bayesian Mean Square Error is the mean of the posterior PDF. (14)

MCN401	INDUSTRIAL SAFETY ENGINERING	CATEGORY	L	T	P	CREDIT
		MCN	2	1	0	-

Preamble: The course is intended to give knowledge of various safety management principles, various safety systems, various machine guarding devices, hazard identification techniques, energy sources, systems & applications and the need in the present context. Learners will be able to compare different hazard identification tools and choose the most appropriate based on the nature of industry. It aims to equip students in working with projects and to take up research work in connected areas

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Describe the theories of accident causation and preventive measures of industrial accidents. (Cognitive Knowledge level: **Understand**)
CO2	Explain about personal protective equipment, its selection, safety performance & indicators and importance of housekeeping. (Cognitive Knowledge level: **Understand**)
CO3	Explain different issues in construction industries. (Cognitive Knowledge level: **Understand**)
CO4	Describe various hazards associated with different machines and mechanical material handling. (Cognitive Knowledge level: **Understand**)
CO5	Utilise different hazard identification tools in different industries with the knowledge of different types of chemical hazards. (Cognitive Knowledge level: **Apply**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2				2	2	2				1
CO2	2	1	2		1	1	1	1				1
CO3	2	2	2		1	1	1	1	1	1		1
CO4	2	2	2		1	1	1	1	1	1		1
CO5	2	2	2	1	1	1	1	1	1	1		1

Abstract POs defined by National Board of Accreditation			
PO1	Engineering Knowledge	**PO7**	Environment and Sustainability
PO2	Problem Analysis	**PO8**	Ethics
PO3	Design/Development of solutions	**PO9**	Individual and team work
PO4	Conduct investigations of complex problems	**PO10**	Communication
PO5	Modern tool usage	**PO11**	Project Management and Finance
PO6	The Engineer and Society	**PO12**	Life long learning

Assessment Pattern

	Continuous Assessment Tests		**End Semester Examination**
	1	**2**	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment - Test : 25 marks

Continuous Assessment - Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

MCN401- Industrial Safety Engineering (35 hrs)

Module I (Safety introduction- 5 hrs)

Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy. Safety Officer-responsibilities, authority. Safety committee-need, types, advantages.

Module II (Personal protection in work environment- 7 hrs)

Personal protection in the work environment, Types of PPEs, Personal protective equipment- respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits. Typical industrial models and methodology. Entry into confined spaces.

Module III (Safety issues in construction- 7 hrs)

Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space – Temporary Structures. Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.

Module IV (Safety hazards in machines- 8 hrs)

Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding. Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements-wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries.

Module V (Hazard identification and analysis- 8 hrs)

Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard and Operability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up. Control of Chemical Hazards, Hazardous properties of chemicals, Material Safety Data Sheets (MSDS).

Text Books:

1. R.K Jain (2000) Industrial Safety, Health and Environment management systems, Khanna Publications.
2. Paul S V (2000), Safety management System and Documentation training Programme handbook, CBS Publication.
3. Krishnan, N.V. (1997). *Safety management in Industry*. Jaico Publishing House, New Delhi.
4. John V. Grimaldi and Rollin H.Simonds. (1989) *Safety management*. All India Traveller Book Seller, Delhi.
5. Ronald P. Blake. (1973). *Industrial safety*. Prentice Hall, New Delhi.
6. Alan Waring. (1996). *Safety management system*. Chapman & Hall, England.
7. Vaid, K.N., (1988). Construction safety management. National Institute of Construction Management and Research, Mumbai.
8. AIChE/CCPS. (1992). *Guidelines for Hazard Evaluation Proce*dures. (second edition). Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York.

Course Level Assessment Questions:

Course Outcome 1 (CO1):

1. Which are the various accident causation theories? Explain.
2. Define terms: Accident, Reportable accident, Dangerous occurrence.

Course Outcome 2 (CO2):

1. Discuss different types of personal protective equipment
2. Discuss about how to compare the safety performance of two industries.
3. Discuss the significance of work permit system in accident prevention.

Course Outcome 3 (CO3):

1. Distinguish ladders and scaffolds along with their safety features.
2. Discuss the safety requirement for a confined space entry.
3. Explain the important provision in the National Building Code.

Course Outcome 4 (CO4):

1. Explain the various principles used in machine guarding.
2. Explain the issues in mechanical material handling.

Course Outcome 5 (CO5):

1. Selection of different types of fire extinguishers accordance to type of fire.
2. Conduct a HAZOP study for a batch rector of your choice.
3. Determine different types of Chemical hazards associated with industries

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

VII SEMESTER B. TECH DEGREE EXAMINATION

MCN401- INDUSTRIAL SAFETY ENGINEERING

Maximum: 100 Marks **Duration: 3 hours**

PART A

Answer all questions, each question carries 3 marks

1. Differentiate Unsafe act and Unsafe conditions with suitable examples
2. Discuss the significance of a safety committee in improving the safety performance of an industry
3. Which are the different types of permit? Highlight its suitability.
4. Which are five 'S' used in housekeeping?
5. List the various safety features of ladders.
6. How safety of the workers can be ensured during a demolition operations.
7. Which are the hazards associated with manual material handling?
8. Discuss the safety issues of Gas welding operations.
9. Differentiate Hazard and Risk.
10. Why MSDS is mandatory for chemical products.

(10 X 3 = 30 Marks)

PART B

Answer one full question from each module

Module 1

11. List the various accident causation theories and explain any one in details. (14 Marks)

12. a) Discuss the significance of safety policy in reducing the accidents. (4 Marks)

b) Safety and productivity are the two sides of a coin'. Are you agreeing with this statement? Explain with your arguments. (10 Marks)

Module 2

13. a) Classify the personal protective equipment. List the suitability of at least fifteen types of PPEs. (10 Marks)

b) How will you calculate the frequency rate? Explain with an example. (4 Marks)

14. a) How will you compare the safety performance of two industries? Explain with suitable example. (10 Marks)
    b) Which are the steps to be followed in confined space entry to protect the life a worker. (4 Marks)

Module 3

15. Discuss the safety and fire protection facilities required for a high rise building as per National building code. (14 Marks)
16. a) Identify the various hazards during the different stages of building construction. (7 Marks)
    b) Discuss the important types of ergonomic hazards associated with industries.(7 Marks)

Module 4

17. Which are the various types of machine guarding devices used industries. Discuss the suitability of each machine guarding devices. (14 Marks)
18. With suitable sketches briefly explain seven defects of wire ropes. (14 Marks)

Module 5

19. What is Hazard and Operability Analysis? How do you conduct a HAZOP analysis? (14 Marks)
20. Discuss about different types of chemical hazards. (14 Marks)

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures/ Tutorials L-T
1	**Introduction to Industrial safety Engineering**	
1.1	Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence. Reportable accidents	1
1.2	Theories of accident causation. Safety organization.	2
1.3	Role of management, supervisors, workmen, unions, government and voluntary agencies in safety.	3
1.4	Safety Officer-responsibilities, authority.	4
1.5	Safety committee-need, types, advantages.	5
2	**Personal protection in the work environment**	
2.1	Types of PPEs, respiratory and non-respiratory equipment.	6
2.2	Standards related to PPEs	7
2.3	Monitoring Safety Performance: Frequency rate, severity rate	8,
2.4	Monitoring Safety Performance: incidence rate, activity rate.	9
2.5	Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping.	10
2.6	Work permit system- objectives, hot work and cold work permits.	11
2.7	Typical industrial models and methodology. Entry into confined spaces.	12
3	**Introduction to construction industry and safety**	
3.1	Excavation and filling – Under-water works – Under-pinning & Shoring	13
3.2	Ladders & Scaffolds – Tunneling	14
3.3	Blasting –Demolition – Confined space	15
3.4	Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety.	16
3.5	Relevance of ergonomics in construction safety.	17
3.6	Ergonomics Hazards	18

3.7	Musculoskeletal Disorders and Cumulative Trauma Disorders.	19
4	**Machinery safeguard**	
4.1	Point-of-Operation, Principle of machine guarding -	20
4.2	Types of guards and devices.	21
4.3	Safety in Power Presses, primary & secondary operations - shearing -bending - rolling – drawing.	22
4.4	Safety in turning, boring, milling, planning and grinding.	23
4.5	Welding and Cutting-Safety Precautions of Gas welding and Arc Welding,	24
4.6	Cutting and Finishing.	25
4.7	Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking.	26
4.8	Material Handling equipment-operation & maintenance. Maintenance of common elements-wire rope, chains slings, hooks, clamps	27
5	**Hazard identification**	
5.1	Hazard and risk, Types of hazards – Classification of Fire	28
5.2	Types of Fire extinguishers fire, explosion and toxic gas release.	29
5.3	Inventory analysis, Fire and explosion hazard rating of process plants	30
5.4	The Dow Fire and Explosion Hazard Index.	31
5.5	Preliminary hazard analysis, Hazard and Operability study (HAZOP)	32
5.6	Chemical hazard- Classifications, Control of Chemical Hazards.	33
5.7	Hazardous properties of chemicals	34
5.8	Material Safety Data Sheets (MSDS).	35

SEMESTER VII

ECT401	MICROWAVES AND ANTENNAS	CATEGORY	L	T	P	CREDIT
		PCC	2	1	0	3

Preamble: This course aims to impart knowledge on the basic parameters of antenna, design and workingofvariousbroad band antennas,arraysand itsradiationpatterns.It also introduces various microwave sources, their principle of operation and study of various microwave hybrid circuits and microwave semiconductor devices.

Prerequisite: ECT 302 ELECTROMAGNETICS

Course Out Comes: After the completion of the course the student will be able to:

CO1-K2	Understand the basic conceptofantennas anditsparameters.
CO2-K3	Analyzethe far filed pattern of Short dipole and Half wave dipole antenna.
CO3-K3	Design of various broad band antennas, arrays and its radiation patterns.
CO4-K2	Illustratethe principle of operation of cavity resonators and various microwave sources.
CO5-K2	Explain various microwave hybrid circuits and microwave semiconductor devices.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		1								2
CO2	3	3	3	1	2							2
CO3	3	3	3	1	3							2
CO4	3	3	2	1								2
CO5	3	3	2	1								2

Assessment Pattern:

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember			
Understand K2	20	20	40
Apply K3	30	30	60
Analyse			
Evaluate			
Create			

Mark distribution:

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 Hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

Maximum Marks: 100 **Time: 3 hours**

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 subdivisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define isotropic radiator and derive the expression for its electric field strength.
2. Explain the terms
   i) Antenna temperature ii) Antenna efficiency iii) Beam efficiency
   iv) Radiation pattern v) Antenna Polarization
3. Show that the directivity of a half wave dipole is 4 (from the expression for average power).
4. Find the radiation intensity of a current element with corresponding field strength in the direction of maximum radiation of $E_m = \frac{60}{r\sqrt{80}} \; V/m$

Course Outcome 2 (CO2):

1. Show that the directivity of a half wave dipole is 4 (from the expression for average power).
2. Derive expressions for the Far Field components and Radiation Resistance and Directivity of a short dipole antenna.
3. State and Prove Reciprocity Theorem.

Course Outcome 3 (CO3):

1. Derive the relation for normalized electrical field in the case of 'n' isotropic array sources $En= (AF)_n$.
2. Explain the working of a horn antenna. Write down the expression for gain, HPBW and BWFN.
3. Design an Endfire Array and plot its radiation pattern.
4. Design a LPDA with τ = 0.85, σ = 0.03 for the frequency range 15-45 MHz.

Course Outcome 4 (CO4):

1. Determine the resonant frequency of an air filled rectangular cavity operating in the dominant mode with dimensions as,a=4cm, b=5cm and d=6cm.
2. Derive power output and efficiency of a reflex klystron.
3. What is the significance of slow wave structures used in microwave circuits?Explain different slow wave structures with neat sketches.
4. With neat diagram explain the operation of a travelling wave tube.
5. With the help of figures explain the bunching process of an 8-cavity cylindrical magnetron.

Course Outcome 5 (CO5):

1. Explain S-parameters and its properties.
2. With a schematic describe the operation of a four port circulator. Obtain the simplified S matrix of a perfectly matched, lossless four port circulator.
3. Explain RWH theory of Gunn Oscillation.
4. Define Gunn Effect and with the help of figures explain different modes of operation of Gunn diode.

Syllabus

Module	Course contents	Hours
I	**Basic antenna parameters:** gain, directivity, beam width and effective aperture calculations, effective height, wave polarization, radiation resistance, radiation efficiency, antenna field zones. Duality and Principles of reciprocity, Helmholtz theorem (derivation required), Field, directivity and radiation resistance of a short dipole and half wave dipole (far field derivation).	7
II	**Broad band antenna:** Principle of Log periodic antenna array and design, Helical antenna: types and design. Designof Microstrip RectangularPatchantennas and feeding methods. Principles of Horn, Parabolic dish antenna (expression for E, H and Gain without derivation), Mobile phone antenna – Inverted F antenna.	6
III	**Arrays of point sources**, field of two isotropic point sources, principle of pattern multiplication, linear arrays of 'n' isotropic point sources. Array factor, Grating lobes.DesignofBroadside,End fire andDolph Chebyshevarrays. Concept of Phase array.	8
IV	**Microwaves:**Introduction, advantages, Cavity Resonators- Derivation of resonance frequency of Rectangular cavity. **Single cavity klystron- Reflex Klystron** Oscillators: Derivation of Power output, efficiency and admittance. **Magnetron oscillators:** Cylindrical magnetron, Cyclotron angular frequency, Power output and efficiency.**Travelling Wave Tube:** Slow wave structures, Helix TWT,Amplification process, Derivation of convection current, axialelectric field, wave modes and gain.	8

V	**Microwave Hybrid circuits**: Scattering parameters, Waveguide Tees- Magic tees, Hybrid rings.Formulation of S-matrix.Directional couplers: Two hole directional couplers, S-matrix. Circulators and Isolators. Phase Shifter. **Microwave Semiconductor Devices**: Amplifiers using MESFET. Principle of Gunn diodes: Different modes, Principle of operation Gunn Diode Oscillators.	6

Text Books:

1. Balanis, Antenna Theory and Design, 3/e, Wiley Publications.
2. John D. Krauss, Antennas for all Applications, 3/e, TMH.
3. K D Prasad, Antenna and Wave Propagation, Satyaprakash Publications
4. Samuel Y. Liao, Microwave Devices and Circuits, 3/e, Pearson Education, 2003.
5. Robert E. Collin, Foundation of Microwave Engineering, 2/e, Wiley India, 2012.

References:

1. Collin R.E, Antennas & Radio Wave Propagation, McGraw Hill. 1985.
2. Jordan E.C. & K. G. Balmain, Electromagnetic Waves & Radiating Systems, 2/e, PHI.
3. Raju G.S.N., Antenna and Wave Propagation, Pearson, 2013.
4. Sisir K.Das& Annapurna Das, Antenna and Wave Propagation, McGraw Hill,2012
5. Thomas A.Milligan, Modern Antenna Design, IEEE PRESS, 2/e, Wiley Inter science.
6. Das, Microwave Engineering, 3/e, McGraw Hill Education India Education , 2014
7. David M. Pozar, Microwave Engineering,4/e, Wiley India, 2012.

Course Contents and Lecture Schedule.

No	Topic	No.of. Lectures
	Module I	
1.1	Basicantennaparameters (all parameters and related simple problems), Relation between parameters (derivation required)	**2**
1.2	Principlesofreciprocity (proof required), Duality. Conceptofretardedpotential	**1**
1.3	Helmholtz theorem (derivation required)	
1.4	Derivation of Field, directivity and radiation resistance of a short dipole	**2**
1.5	Derivation of Field, directivity and radiation resistance of a half wave dipole.	**2**
	Module II	
2.1	Principle of Log periodic antenna array and design, Helical antenna: types and design	**2**
2.2	Design of Rectangular Patch antennas and feeding techniques	**2**
2.3	Principles of Horn,Parabolic dish antenna, (expression for E, H, G without derivation).	**1**
2.4	Mobile phone antenna – Inverted F antenna.	**1**
	Module III	

3.1	Arrays of point sources, field of two isotropic point sources, principle of pattern multiplication	**2**
3.2	Linear arrays of 'n' isotropic point sources. Grating lobes. Array factor (derivation)	**2**
3.3	Design of Broadside, End fire and Dolph Chebyshev arrays.	**3**
3.4	Concept of Phase array.	**1**
	Module IV	
4.1	**Microwaves:**Introduction, advantages, Cavity Resonators-Types, Derivation of resonance frequency of Rectangular cavity (problems required)	**1**
4.2	**Single cavity klystron- Reflex Klystron** Oscillators: Derivation of Power output, efficiency and admittance.(problems required)	**2**
4.3	**Magnetron oscillators:** Cylindrical magnetron, Cyclotron angular frequency, Power output and efficiency.(problems required)	**2**
4.4	**Travelling Wave Tube:** Slow wave structures, Helix TWT,Amplification process, Derivation of convection current, axialelectric field, wave modes and gain. (problems required)	**3**
	Module V	
5.1	**Microwave Hybrid circuits**: Scattering parameters, Waveguide Tees- Magic tees, Hybrid rings.Formulation of S-matrix.	**1**
5.2	Directional couplers: Two hole directional couplers, S-matrix. Circulators and Isolators. Phase Shifter.	**2**
5.3	**Microwave Semiconductor Devices**: Amplifiers using MESFET.	**1**
5.4	Principle of Gunn diodes: Different modes, Principle of operation Gunn Diode Oscillators.	**2**

Simulation Assignments (ECT 401)

The following simulation assignments can be done with MATLAB/HFSS/CST Microwave Studioor any Open software.

- Simulation of radiation pattern of
  a) Microstrip patch antenna
  b) Arrays
  c) Helical antenna

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B. TECH DEGREE EXAMINATION

Course Code: ECT401

Course Name: MICROWAVES AND ANTENNAS

Max. Marks:100 Duration: 3 Hours

PART A

(*Answer All Questions*)

1	Derive an expression for aperture area of an antenna.	(3)
2	(i) Obtain the radiation resistance of a thin dipole antenna of length λ/15.	(3)
	(ii) Find HPBW of an antenna which has a field given by: $E(\theta) = Cos^2\theta, for\ \ 0 \le \theta \le 90^0$.	
3	Why Log Periodic antenna is called as Frequency Independent antenna, explain?	(3)
4	Briefly explain about Inverted F antenna.	(3)
5	Explain (i) Pattern Multiplication (ii) Grating lobes	(3)
6	Demonstrate the working principle of Phase Arrays.	(3)
7	Derive the resonant frequency of a rectangular cavity resonator.	(3)
8	What are re-entrant cavities? Show that they support infinite number of resonant frequencies.	(3)
9	Explain with figure a ferrite isolator can support only forward direction waves.	(3)
10	Write a short note on Phase shifter.	(3)

PART B

(*Answer one question from each module. Each question carries 14 marks*)

MODULE I

11 a)	Define the terms (i) Retarded potential (ii) Antenna field zones	(4)
b)	Derive expressions for the Far Field components and Radiation Resistance and Directivity of a short dipole antenna.	(10)
	OR	
12a)	State and prove Helmholtz theorem	(7)
b)	(i) Compute the radiation resistance, power radiated and efficiency of an antenna having total resistance of 50Ω and effective height of 69.96m and a current of 50A (rms) at 0.480MHz. (ii) Calculate the effective aperture of a short dipole antenna operating at 100 MHz.	(7)

MODULE II

13 a) Explain the working of a parabolic dish antenna. Write down the expression for gain, HPBW and BWFN. (6)

b) Design a rectangular microstrip antenna using a dielectric substrate with dielectric constant of 2.2, h = 0.1588 cm so as to resonate at 10 GHz. (8)

OR

14 a) Explain the working of a Log periodic dipole array and explain its design steps. (7)

b) Explain axial mode helical antenna. Write down the expression for gain, HPBW,BWFN and radiation resistance of axial mode helical antenna. (7)

MODULE III

15 Derive expression for array factor of N isotropic sources for end-fire array and also the expression for major lobe, minor lobes and Nulls of the array. (14)

OR

16 a) Explain Chebyshev array and write down the expression for array factor. (7)

b) Design a Broadside Array and plot its radiation pattern. (7)

MODULE IV

17a) A reflex klystron operates under the following conditions: Vo=500V, Rsh =10KΩ, fr= 8 GHz, L=1 mm, e/m = l.759 x 1011 (MKS system) The tube is oscillating at fr at the peak of the n = 2 or mode. Assume that the transit time through the gap and beam loading to be neglected. Determine: - (7)

(a) The value of the repeller voltage Vr.

(b) The direct current necessary to give a microwave gap voltage of 200V.

(c) The electronic efficiency under this condition.

b) Assuming pi mode of oscillations explain how a magnetron can sustain its oscillations using the cross field. (7)

OR

18 a) Show that the axial electric field of TWT varies with convection current. (7)

b) Explain the electronic admittance of the gap in the case of reflex klystron. With admittance diagram explain the condition required for oscillation in a reflex Klystron. (7)

MODULE V

19 a) Explain the working of a microwave amplifiers using MESFET (8)

b) Explain the constructional features of two-hole directional coupler and derive the S Matrix. (6)

OR

20 a) Draw the J-E characteristics of Gunn diode and explain its operation. (10)

b) Discuss the constructional features of magic tees and derive its S Matrix. Why are they called so? (4)

ECL411	ELECTROMAGNETICS LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This course aims to

(i) Provide practical experience in design and analysis of few electronic devices and circuits used for Microwave and Optical communication engineering.

(ii) Familiarize students with simulation of basic Antenna experiments with simulation tools.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Familiarize the basic Microwave components and to analyse few microwave measurements and its parameters.
CO2	Understand the principles of fiber-optic communications and the different kind of losses, signal distortion and other signal degradation factors.
CO3	Design and simulate basic antenna experiments with simulation tools.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3						3			3
CO2	3	3	3						3			3
CO3	3	3	3	2	3				3			3

Assessment Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test): 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work : 15 Marks
(b) Implementing the work/ Conducting the experiment : 10 Marks
(c) Performance,result and inference (usage of equipments and troubleshooting) : 25 Marks
(d) Vivavoce : 20 Marks
(e) Record : 5 Marks

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

Course Level Assessment Questions (Examples only):

Course Outcome 1 (CO1): Microwave Experiments

1) Verify the relation $\lambda_c = 2a$.
2) Find the unknown impedance of the given load using Transmission line equation and verify using Smith chart.
3) Compare the reflection coefficient of the given horn antenna and matched termination.
4) Find the coupling coefficient of the given Directional Coupler.
5) Plot Reflex Klystron repeller mode characteristics.
6) Find the threshold voltage of Gunn diode from its characteristics.

Course Outcome 2 (CO2): Optical Experiments

1) Find the numerical aperture and V number of the given fiber.
2) Obtain the bending loss and attenuation loss of the given fiber.
3) Plot the V-I characteristics of Laser diode.
4) Plot the V-I characteristics of LED.

List of Experiments:

I. MICROWAVE EXPERIMENTS (Minimum Four Experiments are mandatory)

1. Reflex Klystron Mode Characteristics.
2. GUNN diode characteristics.
3. VSWR and Frequency measurement.
4. Verify the relation between Guide wave length, free space wave length and cut off wave length for rectangular wave guide.

5. Unknown load impedance measurement using smith chart and verification using transmission line equation.
6. Measurement of Magic Tee characteristics.
7. Directional Coupler Characteristics.
8. Crystal Index Measurement.

II. OPTICAL EXPERIMENTS (Minimum Three Experiments are mandatory)

1. Setting up of Fiber optic Digital link.
2. Measurement of Numerical Aperture of a fiber.
3. Study of losses in Optical fiber.
4. Voltage vs. Current (V-I) characteristics of Laser Diode.
5. Voltage vs. Current (V-I) characteristics of LED.
6. Characteristics of Photodiode

III. ANTENNA EXPERIMENTS (Minimum Three Experiments are mandatory)

1. Familiarization of any antenna simulation software.
2. Simulation of Dipole Antenna.
3. Simulation of Patch Antenna.
4. Simulation of Antenna Array.
5. Study of Vector Network Analyzer.
6. Antenna Pattern Measurement

Text Books

1. Samuel Y. Liao, Microwave Devices and Circuits, 3/e, Pearson Education, 2003.
2. Gred Keiser Optical Fiber Communication 5/e Mc Graw Hill, 2013
3. Balanis, Antenna Theory and Design, 3/e, Wiley Publications.

References

1. John D. Krauss, Antennas for all Applications, 3/e, TMH.
2. Thomas A. Milligan, Modern Antenna Design, IEEE PRESS, 2/e, Wiley Inter science.
3. N.O. Sadiku and S.V. Kulkarni, *Principles of Electromagnetics*, Sixth Edition, Oxford University Press, India, 2015 (Asian adaptation of 'M.N.O. Sadiku, Elements of Electromagnetics, Sixth International Edition, Oxford University Press')

ECQ413	SEMINAR	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble: The course 'Seminar' is intended to enable a B.Tech graduate to read, understand, present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar guide. This course can help the learner to experience how a presentation can be made about a selected academic document and also empower her/him to prepare a technical report.

Course Objectives:

- To do literature survey in a selected area ofstudy.
- To understand an academic document from the literate and to give a presentation about it.
- To prepare a technical report.

Course Outcomes [COs] : After successful completion of the course, the students will be able to:

CO1	Identify academic documents from the literature which are related to her/his areas of interest (Cognitive knowledge level: **Apply**).
CO2	Read and apprehend an academic document from the literature which is related to her/ his areas of interest (Cognitive knowledge level: **Analyze**).
CO3	Prepare a presentation about an academic document (Cognitive knowledge level: **Create**).
CO4	Give a presentation about an academic document (Cognitive knowledge level: **Apply**).
CO5	Prepare a technical report (Cognitive knowledge level: **Create**).

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1		2	1					3
CO2	3	3	2	3		2	1					3
CO3	3	2			3			1		2		3
CO4	3				2			1		3		3
CO5	3	3	3	3	2	2		2		3		3

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

General Guidelines

- The Department shall form an Internal Evaluation Committee (IEC) for the seminar with academic coordinator for that program as the Chairperson/Chairman and seminar coordinator & seminar guide as members. During the seminar presentation of a student, all members of IEC shall be present.
- Formation of IEC and guide allotment shall be completed within a week after the University examination (or last working day) of the previous semester.
- Guide shall provide required input to their students regarding the selection of topic/ paper.
- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.
- The IEC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

Evaluation pattern

Total marks: 100, only CIE, minimum required to pass 50

Seminar Guide: 20 marks (Background Knowledge – 10 (The guide shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).

Seminar Coordinator: 20 marks (Seminar Diary – 10 (Each student shall maintain a seminar diary and the guide shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

Presentation: 40 marks to be awarded by the IEC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

Report: 20 marks to be awarded by the IEC (check for technical content, overall quality, templates followed, adequacy of references etc.).

ECD415	PROJECT PHASE I	CATEGORY	L	T	P	CREDIT
		PWS	0	0	6	2

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

- To apply engineering knowledge in practical problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs] : After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE I

Phase 1 Target

- Literature study/survey of published literature on the assigned topic
- Formulation of objectives
- Formulation of hypothesis/ design/ methodology
- Formulation of work plan and task allocation.
- Block level design documentation
- Seeking project funds from various agencies
- Preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility study
- Preparation of Phase 1 report

Evaluation Guidelines & Rubrics

Total: 100 marks (Minimum required to pass: 50 marks).

- Project progress evaluation by guide: 30 Marks.
- Interim evaluation by the Evaluation Committee: 20 Marks.
- Final Evaluation by the Evaluation Committee: 30 Marks.
- Project Phase - I Report (By Evaluation Committee): 20 Marks.

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor).

Evaluation by the Guide

The guide/supervisor shall monitor the progress being carried out by the project groups on a regular basis. In case it is found that progress is unsatisfactory it shall be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Topic Selection: innovativeness, social relevance etc. (2)

Problem definition: Identification of the social, environmental and ethical issues of the project problem. (2)

Purpose and need of the project: Detailed and extensive explanation of the purpose and need of the project. (3)

Project Objectives: All objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are clearly specified. (2)

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (3)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (7)

EVALUATION RUBRICS for PROJECT Phase I: Interim Evaluation

No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-a	Topic identification, selection, formulation of objectives and/or literature survey. (Group assessment) [CO1]	10	The team has failed to come with a relevant topic in time. Needed full assistance to find a topic from the guide. They do not respond to suggestions from the evaluation committee and/or the guide. No literature review was conducted. The team tried to gather easy information without verifying the authenticity. No objectives formed yet.	The team has identified a topic. The originally selected topic lacks substance and needs to be revised. There were suggestions given to improve the relevance and quality of the project topic. Only a few relevant references were consulted/ studied and there is no clear evidence to show the team's understanding on the same. Some objectives identified, but not clear enough.	Good evidence of the group thinking and brainstorming on what they are going to build. The results of the brainstorming are documented and the selection of topic is relevant. The review of related references was good, but there is scope of improvement. Objectives formed with good clarity, however some objectives are not realistic enough.	The group has brainstormed in an excellent manner on what they were going to build. The topic selected is highly relevant, real world problem and is potentially innovative. The group shows extreme interest in the topic and has conducted extensive literature survey in connection with the topic. The team has come up with clear objectives which are feasible.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-b	Project Planning, Scheduling and Resource/ Tasks Identification and allocation. (Group assessment) [CO4]	10	No evidence of planning or scheduling of the project. The students did not plan what they were going to build or plan on what materials / resources to use in the project. The students do not have any idea on the budget required. The team has not yet decided on who does what. No project journal kept.	Some evidence of a primary plan. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no details. Some evidence on task allocation among the team members.	Good evidence of planning done. Materials were listed and thought out, but the plan wasn't quite complete. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is not complete in all respect / detailed. There is better task allocation and individual members understand about their tasks. There is room for improvement.	Excellent evidence of enterprising and extensive project planning. Gantt charts were used to depict detailed project scheduling. A project management/version control tool is used to track the project, which shows familiarity with modern tools. All materials / resources were identified and listed and anticipation of procuring time is done. Detailed budgeting is done. All tasks were identified and incorporated in the schedule. A well-kept project journal shows evidence for all the above, in addition to the interaction with the project guide. Each member knows well about their individual tasks.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

Phase 1 Interim Evaluation Total Marks: 20

EVALUATION RUBRICS for PROJECT Phase I: Final Evaluation

Sl. No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-c	Formulation of Design and/or Methodology and Progress. (Group assessment) [CO1]	5	None of the team members show any evidence of knowledge about the design and the methodology adopted till now/ to be adopted in the later stages. The team has not progressed from the previous stage of evaluation.	The students have some knowledge on the design procedure to be adopted, and the methodologies. However, the team has not made much progress in the design, and yet to catch up with the project plan.	The students are comfortable with design methods adopted, and they have made some progress as per the plan. The methodologies are understood to a large extent.	Shows clear evidence of having a well- defined design methodology and adherence to it. Excellent knowledge in design procedure and its adaptation. Adherence to project plan is commendable.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
1-d	Individual and Teamwork Leadership (Individual assessment) [CO3]	10	The student does not show any interest in the project activities, and is a passive member.	The student show some interest and participates in some of the activities. However, the activities are mostly easy and superficial in nature.	The student shows very good interest in project, and takes up tasks and attempts to complete them. Shows excellent responsibility and team skills. Supports the other members well.	The student takes a leadership position and supports the other team members and leads the project. Shows clear evidence of leadership.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-e	Preliminary Analysis/ Modeling / Simulation/ Experiment / Design/ Feasibility study [CO1]	10	The team has not done any preliminary work with respect to the analysis/modeling/ simulation/experiment/design/feasibility study/ algorithm development.	The team has started doing some preliminary work with respect to the project. The students however are not prepared enough for the work and they need to improve a lot.	There is some evidence to show that the team has done good amount of preliminary investigation and design/ analysis/ modeling etc. They can improve further.	Strong evidence for excellent progress in the project. The team has completed the required preliminary work already and are poised to finish the phase I in an excellent manner. They have shown results to prove their progress.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

1-f	Documentation and presentation. (Individual & group assessment). [CO6]	5	The team did not document the work at all. The project journal/diary is not presented. The presentation was shallow in content and dull in appearance. The individual student has no idea on the presentation of his/her part.	Some documentation is done, but not extensive. Interaction with the guide is minimal. Presentation include some points of interest, but overall quality needs to be improved. Individual performance to be improved.	Most of the project details were documented well enough. There is scope for improvement. The presentation is satisfactory. Individual performance is good.	The project stages are extensively documented in the report. Professional documentation tools like LaTeX were used to document the progress of the project along with the project journal. The documentation structure is well-planned and can easily grow into the project report. The presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
Total		**30**	**Phase - I Final Evaluation Marks: 30**			

EVALUATION RUBRICS for PROJECT Phase I: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-g	Report [CO6]	20	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly Unacknowledged content. Lack of effort in preparation is evident.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report.	Project report shows evidence of systematic documentation. Report is following the standard format and there are only a few issues. Organization of the report is good. Most of references are cited properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows standard styles.
			(0 - 7 Marks)	(8 - 12 Marks)	(13 - 19 Marks)	(20 Marks)
Phase - I Project Report Marks: 20						

SEMESTER VII

PROGRAM ELECTIVE II

ECT413	OPTICAL FIBER COMMUNICATION	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to introduce the concepts of light transmission through optical fibers and introduce the working of optical components.

Prerequisite: Basic concepts of Solid State Devices

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the working and classification of optical fibers in terms of propagation modes
CO 2	Solve problems of transmission characteristics and losses in optical fiber
CO 3	Explain the constructional features and the characteristics of optical sources and detectors
CO4	Describe the operations of optical amplifiers
CO5	Understand the concept of WDM, FSO and LiFi

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	1									1
CO 2	3	3	2									1
CO 3	3	3	2									1
CO 4	3	3	1									1
CO 5	3	3	2									1

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyse	K4			
Evaluate				
Create				

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance	: 10marks
Continuous Assessment Test(2numbers)	: 25 marks
Assignment/Quiz/Course project	: 15marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Know the classification and working of optical fiber with different modes of signal propagation

1. Illustrate the types of optical fibers with refractive index profiles.
2. Define Photonic Crystal Fibers and list the types.
3. What is the necessity of cladding for an optical fiber?

Course Outcome 2 (CO2): Understand the transmission characteristics and losses in optical fiber

1. Describe the various attenuation losses incurred by light signal while transmitting through a fiber.
2. What is meant by group velocity dispersion?
3. An optical fiber has an attenuation coefficient of 0.5dB/km at 1310nm. Find the optical power at 25km if 500μW of optical power is launched into the fiber.

Course Outcome 3 (CO3): Describe the constructional features and the characteristics of optical sources and detectors

1. What is a heterojunction? How it increases the radiance and efficiency of LEDs?
2. Draw the basic block diagram of an optical receiver and explain.

Course Outcome 4 (CO4): Describe the performance of optical amplifiers

1. What are salient features of semiconductor optical amplifiers?
2. Explain the amplification mechanism with energy level diagram in an EDFA.

Course Outcome 5 (CO5): Know the concept of WDM, FSO and LiFi

1. What are the underlying principles of the WDM techniques?
2. Explain in detail diffraction gratings.
3. Write a note on optical Add / Drop multiplexers.

SYLLABUS

Module 1:

Optical fiber Communications: The general system, Advantages of optical fiber communication, Optical fiber waveguides: Ray theory transmission, Modes in planar guide, Phase and group velocity
Fibres: Types and refractive index profiles, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index. Fibre materials, photonic crystal fibre, index guiding PCF, photonic band-gap fibres, fibre cables.

Module 2:

Transmission characteristics of optical fiber: Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber.
Optical Fiber Connectors: Fiber alignment and joint loss, Fiber splices, Fiber connectors, Fiber couplers.

Module 3:

Optical sources:LEDs and LDs, structures, characteristics,modulators using LEDs and LDs. coupling with fibres, noise in Laser diodes, Amplified Spontaneous Emission noise, effects of Laser diode noise in fibre communications
Optical detectors: Types and characteristics, structure and workingof PIN and AP, noise in detectors, comparison of performance.Optical receivers, Ideal photo receiver and quantum limit ofdetection.

Module 4:

Optical Amplifiers:basic concept, applications, types, doped fibre amplifiers, EDFA, basic theory, structure and working, Semiconductor laser amplifier, Raman amplifiers, TDFA, amplifier configurations, performance comparison.

Module 5:

The WDM concept, WDM standards, WDM components, couplers, splitters, Add/ Drop multiplexers, gratings, tunable filters. Introduction to free space optics, LiFi technology and VLC. Optical Time Domain Reflectometer (OTDR) – fault detection length and refractive index measurements.

Text Books

1. Gerd Keiser, Optical Fiber Communications, 5/e, McGraw Hill, 2013.
2. Mishra and Ugale, Fibre optic Communication, Wiley, 2013.

Reference Books

1. Chakrabarthi, Optical Fibre Communication, McGraw Hill, 2015.
2. Hebbar, Optical fibre communication, Elsevier, 2014
3. John M Senior- Optical communications, 3/e, Pearson, 2009.
4. Joseph C. Palais, Fibre Optic Communications, 5/e Pearson, 2013.
5. Keiser, Optical Communication Essentials (SIE), 1/e McGraw Hill Education New Delhi, 2008.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Optical fiber Communications**	**(8)**
1.1	The general system, Advantages of optical fiber communication	1
1.2	Optical fiber waveguides: Ray theory transmission	1
1.3	Modes in planar guide, Phase and group velocity	1
1.4	Fibres: Types and refractive index profiles, Step index fibers, Graded index fibers, Single mode fibers	2
1.5	Cutoff wavelength, Mode field diameter, effective refractive index	1
1.6	Fibre materials, photonic crystal fibre, index guiding PCF, photonic band-gap fibres, fibre cables.	2
2	**Transmission characteristics of optical fiber:**	**(7)**
2.1	Attenuation, Material absorption losses	1
2.2	Linear scattering losses	1
2.3	Nonlinear scattering losses, Fiber bend loss	1
2.4	Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber	2
2.5	Optical Fiber Connectors: Fiber alignment and joint loss	1
2.6	Fiber splices, Fiber connectors, Fiber couplers	1
3	**Optical sources and detectors:**	**(8)**
3.1	LEDs and LDs, structures, characteristics, modulators using LEDs and LDs	2
3.2	coupling with fibres, noise in Laser diodes	1
3.3	Amplified Spontaneous Emission noise, effects of Laser diode noise in fibre communications	1
3.4	Optical detectors: Types and characteristics, structure and working of PIN and AP	2
3.5	noise in detectors, comparison of performance	1
3.6	Optical receivers, Ideal photo receiver and quantum limit of detection.	1
4	**Optical Amplifiers:**	**(6)**
4.1	basic concept, applications, types	1
4.2	doped fibre amplifiers, EDFA, basic theory, structure and working	2
4.3	Semiconductor laser amplifier	1
4.4	Raman amplifiers, TDFA	1
4.5	amplifier configurations, performance comparison	1
5	**The WDM concept**	**(6)**
5.1	WDM standards, WDM components	1
5.2	couplers, splitters, Add/ Drop multiplexers	1
5.3	gratings, tunable filters	1
5.4	Introduction to free space optics, LiFi technology and VLC	1

5.5	Optical Time Domain Reflectometer (OTDR) – fault detection length and refractive index measurements.	2
	Total	**35**

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT413

Program: Electronics and Communication Engineering

Course Name: Optical Fiber Communication

Max.Marks: 100 Duration: 3Hours

PART- A

Answer ALL Questions. Each Carries 3 mark.

1. Define acceptance angle and critical angle. K1
2. What is the necessity of cladding for an optical fiber? K3
3. What is meant by group velocity dispersion? K2
4. Explain intermodal dispersion? K2
5. Differentiate between spontaneous and stimulated emission. K1
6. Draw the three key transition process involved in LASER action. K1
7. Compare EDFA and TDFA. K2
8. What is the principle of Raman amplifiers? K2
9. Define FSO concept. List the advantages. K2
10. Write short note on LiFi technology. K2

PART – B

Answer one question from each module; each question carries 14 marks.

Module – I

11. a)	With block diagram explain a general light wave system. What are the advantages of optical communication?	7	CO1	K2
11. b)	i) Define Photonic Crystal Fibers . ii) Consider an optical fiber of 50 µm diameter, core index n1 = 1.5, and cladding index n2 = 1.49 for operation at λ = 1.31 µm. How many modes does this fiber support?	7	CO1	K2
	OR			
12.a)	Illustrate the types of optical fibers with refractive index profiles.	6	CO1	K2
12.b)	Explain the following : (i) Acceptance angle (ii) Numerical aperture	8	CO1	K2

	If for a given optical fiber the refractive index of cladding and core are 1.45 and 1.47 respectively, calculate the numerical aperture and angle of acceptance in air.			

Module – II

13. a)	Explain macro bending and micro bending losses with a neat diagram.	10	CO2	K2
13. b)	An optical fiber has an attenuation coefficient of 0.5dB/km at 1310nm. Find the optical power at 25km if 500µW of optical power is launched into the fiber.	4	CO2	K3
	OR			
14.a)	Describe the various attenuation losses incurred by light signal while transmitting through a fiber.	9	CO2	K2
14.b)	Given an optical fiber of 50 µm diameter, core index of 1.5, and cladding index 1.49 for operation at λ = 1.31 µm, What would be the pulse spread due to modal dispersion over a distance of 10 km?	5	CO2	K2

Module-III

15 a)	With neat sketch explain the working of pin photodiode and APD	10	CO3	K2
15 b)	What is meant by responsivity? How it is related to quantum efficiency?	4	CO3	K3
	OR			
16a	What is a heterojunction? How it increases the radiance and efficiency of LEDs?	7	CO3	K3
16b	Draw the basic block diagram of an optical receiver and explain.	7	CO3	K2

Module-IV

17 a)	Explain the amplification mechanism with energy level diagram in an EDFA.	8	CO4	K2
17 b)	Compare the performance of different optical amplifiers	6	CO4	K2
	OR			
18 a)	Explain the working of semiconductor optical amplifiers. What are salient features of semiconductor optical amplifiers?	7	CO4	K2
18 b)	What are different amplifier configurations? Explain the basic working principle of optical amplifiers.	7	CO4	K2

Module-V

19 a)	With neat sketch explain WDM scheme.	7	CO5	K2
19 b)	Illustrate the working principle of diffraction gratings.	7	CO5	K2
	OR			
20 a)	Explain with block diagram the working of optical add / drop multiplexer. Explain why it is required in optical communication system.	7	CO5	K2
20 b)	How does an OTDR works? Explain the fault detection and refractive index measurement.	7	CO5	K2

ECT423	COMPUTER NETWORKS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

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Preamble: The course aims to expose students to computer networks taking a top-down approach of viewing from the layer of user applications and zooming into link layer protocols. The principles of various protocols used in every layer are studied in detail. A brief introduction to mathematical modelling of queues with an application to a single example is included.

Prerequisite: MAT 204 Probability, Random Process and Numerical Methods

Course Outcomes: After the completion of the course the student will be able to

CO1 K2	Describe the protocols used in web and email applications.
CO2 K4	Analyse problems pertaining to reliable data transfer, flow control and congestion over a TCP network.
CO3 K3	Apply Dijkstra's algorithm and distance-vector algorithm in the context of routing over computer networks.
CO4 K4	Analyze the performance of collision avoidance algorithms in random access protocols such as ALOHA.
CO5 K4	Analyze the delay performance of an ARQ system using standard queueing models.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3									2
CO 2	3	3	3									2
CO 3	3	3	3									2
CO 4	3	3	3									2
CO 5												

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember			
Understand K2	10	10	30
Apply K3	20	20	40
Analyse K4	20	20	30
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. Mark patterns are as per the syllabus with 60 % for theory and 40% for logical/numerical problems, derivation and proof.

Course Level Assessment Questions

Course Outcome 1 (CO1): Describe the protocols used in web and email applications.

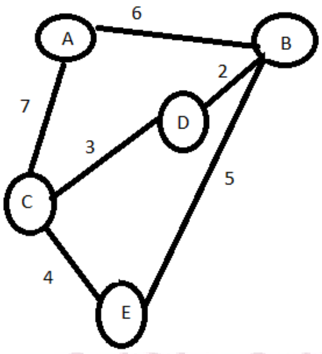
1. Describe the HTTP message format
2. Compare and contrast two application layer protocols SMTP and HTTP

Course Outcome 2 (CO2: Analyse problems pertaining to reliale data transfer, flow control and congestion over a TCP network.

1. Why is it that voice and video traffic is often sent over TCP rather than UDP in today's Internet?
2. Suppose two TCP connections are present over some bottleneck link of rate R bps. Both connections have a huge file to send (in the same direction over the bottleneck link). The transmissions of the files start at the same time. What transmission rate would TCP like to give to each of the connections?

Course Outcome 3 (CO3): Apply Dijkstra's algorithm and distance-vector algorithm in the context of routing over computer networks.

1. Consider the following network. Compute the shortest-path from the node D to all other nodes using Dijkstra's shortest path algorithm. (Numbers indicated shows the link costs).



2. Consider a router that interconnects three subnets: Subnet 1, Subnet 2, and Subnet 3. Suppose all of the interfaces in each of these three subnets are required to have the prefix 223.1.17/24. Also suppose that Subnet 1 is required to support at least 60 interfaces, Subnet 2 is to support at least 90 interfaces, and Subnet 3 is to support at least 12 interfaces. Provide three network addresses (of the form a.b.c.d/x) that satisfy these constraints.

Course Outcome 4 (CO4): Analyze the performance of link-layer protocols in general, random access protocols in particular in terms of efficiency and collision avoidance capability.

1. Describe how slotted ALOHA achieves multiple access.
2. Distinguish between TDM, FDM and random access.

Course Outcome 5 (CO5): Analyze the delay performance of an ARQ system using standard queueing models.

1. Consider a network where packets arrive via N different nodes with different arrivate rates. Illustrate the use of Littles law in this scenario to calcualte the average packet delay inside the network.
2. Customers arrive in a restaurant at a rate of 5 per minute, and wait to receive their order for an average of 5 minutes. Customers eat in the restaurant with a probability of 0.5, and carry their order out without eating with probability 0.5. What is the average number of customers in the restaurant?

SYLLABUS

Module	Course contents	Hours
I	**Components of computer networks** Components of computer network, Applications of computer network – the Internet, Definition of protocol. Protocal standardization. **Network edges, Network core and Network links** Client and server hosts, connectionless and connection-oriented services provided to hosts, circuit-switched versus packet-swtiched network cores, FDM, TDM versus statistical multiplexing, Datagram versus Virtual-circuit networks. Access and physical media. **Delay and loss in packet-swtiched networks** Types of delay, Packet loss. Layered Architecture: Protocol layering, Internet protocol stack, Message encapsulation. **Application Layer** Communication between processes, Web application: HTTP, Mssage format, Email application: SMTP, Message format, MIME, POP3, IMAP and Web-based email. Domain Name System (DNS)	8
II	**Transport Layer** Multiplexing and demultiplexing: connectionless and connection-oriented. UDP. Procols for reliable data transfer: ARQ protocols, stop-and-wait protocol, alternating-bit protocol, Go-back-N, Selective Repeat. **TCP** Connection, segment structure, RTT estimate, Flow control. **Congestion Control** General approaches. TCP congestion control.	7
III	**Network Layer** Datagram versus virtual-circuit network service, Router architecture, IPv4: datagram format, addressing, address assignement – manual and DHCP, NAT. ICMP. IPv6. **Routing Algorithms** Link-State (Dijkstra's) Algorithm, Distance-vector algorithm. Routing in Internet – RIP, OSPF, BGP. Broadcast and Multicast.	7
IV	**Link Layer** Services of link layer**,** Error detection and corretion – checksum, CRC. Multiple access protocols – Channel partitioning, random access, taking-turns. ALOHA – pure and slotted, efficiency, CSMA, CSMA/CA, CSMA/CD. Link layer addressing: MAC address, ARP, DHCP. Ethernet. Link virtualization: ATM, MPLS	7

V	**Wireless Networks** IEEE 802.11 wireless LAN **Queueing models in computer networks** Littles theorem and examples. Review of Poisson process. M/G/1 Queue. Delay analysis of Go-Back-N ARQ system.	8

Text Books

1. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 3rd edition, Pearson
2. D. Bertsekas, RG Gallager, Data Networks, Prentice Hal

Reference Books

1. Larry L. Peterson, Bruce S. Davie, Computer Networks – A Systems Approach, Morgan Kauffman
2. N. Abramson, F. Kuo, Computer Communication Networks, Prentice Hall
3. A. S. Tanenbaum, D. J. Wetherall, Computer Networks, Pearson
4. A. Kumar, D. Manjunath, J. Kuri, Communication Networking – An Analytical Approach, Morgan Kauffman Series.

Course content and Lecture plan

No	TOPIC	No of Lectures
	MODULE 1	
1.1	Components of computer networks, Applications, Protocol, Protocol standrdization	1
1.2	Hosts, connectionless and connection-oriented, circuit-switching versus packet-swtiching in network core design, FDM, TDM versus statistical multiplexing,	1
1.3	Datagram versus Virtual-circuit networks. Examples of access networks, and examples of physical media.	1
1.4	Types of delay, Packet loss.	1
1.5	Layered Architecture, Protocol layering, Internet protocol stack, Message encapsulation.	1
1.6	Communication between processes, HTTP, Mssage format	1
1.7	Email application: SMTP, Message format, MIME, POP3, IMAP and Web-based email.	1
1.8	Domain Name System (DNS)	1
	MODULE II	
2.1	Services of transport layer, Multiplexing and demultiplexing. Connectionless and connection-oriented transport. UDP.	1
2.2	Procols for reliable data transfer: ARQ protocols, stop-and-wait protocol, alternating-bit protocol, Go-back-N, Selective Repeat.	3

2.3	TCP Connection, TCP segment, RTT, Flow control.	1
2.4	Congestion, Congestion control. TCP congestion control.	2
MODULE III		
3.1	Services of Network Layer,Recap of Datagram versus virtual-circuit network service, Router.	1
3.2	IPv4 addressing, Address assignement – manual and DHCP, NAT. ICMP. IPv6.	2
3.3	Link-State (Dijkstra's) Algorithm, Distance-vector algorithm.	2
3.4	Routing in Internet – RIP, OSPF, BGP. Distinction between Broadcast and Multicast routing.	2
MODULE IV		
4.1	Services of link layer**,** Parity checks, checksum, CRC.	1
4.2	Multiple access protocols – Channel partitioning, random access, taking-turns.	1
4.3	ALOHA – pure and slotted, efficiency, CSMA, CSMA/CA, CSMA/CD.	2
4.4	Link layer addressing: MAC address, ARP, DHCP.	1
4.5	Ethernet	1
4.6	Link virtualization: ATM, MPLS	1
MODULE V		
5.1	IEEE 802.11 wireless LAN	1
5.2	Mathematical modeling of queues/buffers.	1
5.3	Littles theorem and examples.	2
5.4	Review of Poisson process. M/G/1 Queue	1
5.5	Delay analysis of Go-Back-N ARQ system.	3

Simulation Assignments

Assignment 1:

1. Understanding protocols using Wireshark.
2. Wireshark is a standard network packet analyzer tool which can be used to analyze how the different protocol layers work (by adding headers and other meta information) to an application layer message.
3. Students can download Wireshark for their OS from https://www.wireshark.org/download.html
4. Sample packet traces can be obtained from https://wiki.wireshark.org/SampleCaptures or https://gitlab.com/wireshark/wireshark/-/wikis/SampleCaptures. Examples such as TCP, DHCP, DNS can be viewed.
5. https://gaia.cs.umass.edu/kurose_ross/wireshark.php

Assignment 2: (requires Python/Matlab)

1. Programming/Implementation of Dijsktra's and distance vector algorithm for shortest path on a graph.
2. Representation of networks in a programming language – Sstudents can use NetworkX library in Python for this.
3. Generation of random graphs (students can use inbuilt functions of NetworkX – see for example https://networkx.org/documentation/stable/reference/generators.html)
4. Visualization of the generated graphs can be done using https://networkx.org/documentation/stable/reference/drawing.html
5. Use inbuilt shortest path functions to obtain a baseline to test self-written code https://networkx.org/documentation/stable/reference/algorithms/shortest_paths.html)
6. Implementation of Dijsktra's algorithm (see https://en.wikipedia.org/wiki/Dijkstra%27s_algorithm)
7. Implementation of Bellman Ford's algorithm (https://en.wikipedia.org/wiki/Distance-vector_routing_protocol)
8. Compare your answers with that of the inbuilt functions.
9. Do the assignment following the instructions here: https://media.pearsoncmg.com/aw/aw_kurose_network_3/labs/lab6/lab6.html

Assignment 3: (understanding TCP)

1. Fully fledged simulation using NS3 can be given as a demonstration by the instructor https://www.cse.iitb.ac.in/~mythili/teaching/cs224m_autumn2017/tcpsimpa/index.html
2. Do the assignment following the instructions here: https://media.pearsoncmg.com/aw/aw_kurose_network_3/labs/lab5/lab5.html
3. Do the assignment following the instructions here: https://media.pearsoncmg.com/ph/esm/ecs_kurose_compnetwork_8/cw/#interactiveanimations
4. Do the assignment following the instructions here: https://media.pearsoncmg.com/ph/esm/ecs_kurose_compnetwork_8/cw/content/interactiveanimations/tcp-congestion/index.html

Assignment 4: (basic queueing model and Little's law)

1. Assignment 4 in the attached collection is a good to understand Littles law. https://drive.google.com/file/d/1CXauy0ehYno1ih6Zwllc_2XFLIe7cH6s/view

2. Do the assignment following the instructions here: https://media.pearsoncmg.com/ph/esm/ecs_kurose_compnetwork_8/cw/content/interactiveanimations/queuing-loss-applet/index.html

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

VII SEMESTER B. TECH DEGREE EXAMINATION, (**Model Question Paper**)

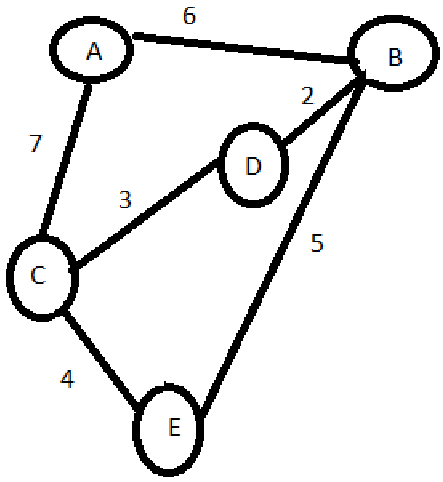
Course Code: ECT423

Course Name: COMPUTER NETWORKS

Max. Marks: 100 Duration: 3 Hours

	PART A **Answer all questions, each carries3marks**	
1	Compare and contrast circuit switching and packet switching.	3
2	Explain the concept of FTTH internet access.	3
3	How does the process-to-process delivery service is achieved in transport layer?	3
4	Describe stop-and-wait protocol for reliable data transfer.	3
5	Give the basic blocks in router architecture.	3
6	What are the different error reporting messages in ICMP?	3
7	Explain the frame structure of Ethernet.	3
8	Compare and contrast different random-access protocols.	3
9	Customers arrive in a restaurant at a rate of 5 per minute, and wait to receive their order for an average of 5 minutes. Customers eat in the restaurant with a probability of 0.5, and carry their order out without eating with probability 0.5. What is the average number of customers in the restaurant?	3
10	Define M/G/1 queue.	3
	PART B **Answer any one full question from each module carries14marks.**	
	MODULE 1	
11(a)	How layered architecture helps in the efficient communication between hosts?	4
11(b)	Explain the functions performed by the layers in the internet protocol stack.	10
	OR	

12(a)	Two hosts A and B separated by a distance of *m* meters, connected by a single link of rate *R* bps. The speed of propagation along the link is *s* m/s and host A is to send a packet of size *L* bits to host B. i) Express the propagation delay ($\square_{\square}$) in terms of *m* and *s*. ii) Express the transmission delay $\square_{\square}$) in terms of *L* and *R*. iii) If m=1000meters, $s=2.9 \times 10^8$m/s, L=100bits. Find the transmission rate of the link. (Assuming $\square_{\square} = \square_{\square}$)	8
12(b)	Describe any one of the mail access protocols.	6
	MODULE II	
13(a)	Explain how TCP provides a flow control service to its applications.	5
13(b)	Compare and contrast TCP and UDP. Also explain the TCP segment structure.	9
	OR	
14(a)	Host A and B are communicating over a TCP connection, and Host B has already received from A all bytes up through byte 248. Suppose Host A then sends two segments to Host B back-to-back. The first and second segments contain 40 and 60 bytes respectively. In the first segment, the sequence number is 249, the source port number is 503, and the destination port number is 80. Host B sends an acknowledgement whenever it receives a segment from Host A. i) In the second segment, sent from Host A to B, what are the sequence number, source port number, and destination port number? ii) If the second segment arrives before the first segment, in the acknowledgement of the first arriving segment. What is the acknowledgement number? iii) If the first segment arrives before the second segment, in the acknowledgement of the first arriving segment, what is the acknowledgement number, the source port number, and the destination port number?	7
14(b)	With the help of a neat diagram explain the operation of selective repeat ARQ.	7
	MODULE III	
15(a)	Explain the datagram format in IPv4	7
15(b)	Describe the Internet's address assignment strategy using classless interdomain routing.	7
	OR	
16(a)	Describe the process of assigning IP address to a host in an organization using DHCP protocol.	5
16(b)	Consider the following network. Compute the shortest-path from the node D to all other nodes using Dijkstra's shortest path algorithm. (Numbers indicated shows the link costs).	9

		
	MODULE IV	
17(a)	Explain the multiple access protocol used in IEEE 802.3.	7
17(b)	Explain the error detection mechanism using CRC with an example.	7
	OR	
18(a)	Derive the efficiency of slotted ALOHA.	7
18(b)	Explain how the physical address of a host is being mapped from its IP address using address resolution protocol.	7
	MODULE V	
19(a)	State and prove Littles theorem.	7
19(b)	Explain the IEEE 802.11 MAC protocol.	7
	OR	
20(a)	Derive an expression for the average packet delay in a Go-Back-N ARQ system.	7
20(b)	Describe how a wireless station associates with an access point (AP) as per IEEE 802.11 protocol.	7

ECT433	OPTO-ELECTRONIC DEVICES	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to develop an insight over the working principles and performance parameters of various optoelectronics devices used for optical networks and communication.

Prerequisite:ECT 201 Solid State Devices

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand physics of optical processes in semiconductors.
CO 2	Distinguish different optical sources used in optoelectronic applications.
CO 3	Analyse different types of photodetectors based on their performance parameters
CO 4	Explain various optical modulators and optoelectronic devices.
CO 5	Explain various optical devices used for optical communication.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2									
CO 2	3	3	3		1							
CO 3	3	3	3		1							
CO 4	3	3	2	2	2	2						
CO 5	3	3	2	2	2	2						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern:
There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand physics of optical processes in semiconductors.

1. Explain radiative and non radiative recombination
2. Describe Band to Band Recombination
3. Explain various Light Production mechanisms

Course Outcome 2 (CO2): Distinguish different optical sources used in optoelectronic applications

1. Explain the principle of operation of LED and LASER .
2. Explain DFB and DBR LASERS

Course Outcome 3 (CO3): Analyse different types of photodetectors based on their performance parameters

1. Describe the characteristics of APD
2. Explain the different type of Noise and its effect in the performance of Photodetectors

Course Outcome 4 (CO4): Explain various optical modulators and optoelectronic devices.

1. Explain the principle of operation of Electro-Optic Modulators and Acousto-Optic Modulators.
2. Explain different types of solar cells and its characteristics

Course Outcome 5 (CO5): Explain various optical devices used for optical communication.

1. Explain Fiber Bragg Grating and its refractive index profile.
2. Describe Optical Bistable Devices. Explain various methods for achieving optical bistability

SYLLABUS

Module 1 – Fundamentals of Semiconductor Optoelectronics

Optical processes in semiconductors: electron-hole generation and recombination, Absorption, Auger recombination, Heat generation and dissipation, Heat sources.Various light production mechanisms,Indirect band gap materials, Semiconductors used for optical Applications, Basic principle of LED and LASER, Spontaneous emission and Stimulated Emission, Coherence of sources.

Module 2 – Optical Sources

Construction and Operation of LEDs, Heterojunctios, Surface Emitter and Edge Emitter LEDs, Characteristics of LEDs, LASERs, Threshold Condition for lasing, Line Broadening Mechanisms, Fabry-Perot Lasers, Distributed Feedback(DFB) Lasers, Distributed Bragg Reflector(DBR) Lasers, Vertical Cavity Surface Emitting Lasers (VCSELs), In-Fibre Lasers.

Module 3 – Optical Detectors

Principle of Photo Detection,Working of LDR, PN diode, PIN diode, Avalanche Photodiode (APD), Characteristics of APD, Resonant Cavity Photo detector, Photo Transistor, Quantum efficiency, Responsivity, Noise in Photo detectors, Thermal Noise, Dark Current, Shot Noise, Quantum limit of Optical Detection.

Module 4 – Optoelectronic Devices and Modulators

Optoelectronic ICs, Advantages, Liquid Crystal Display, Structure, TFT display, Structure, Polymer LED, Organic LED, Optical Modulators using PN junction, Electro-Optic Modulators, Acousto-Optic Modulators, Raman-Nath Modulators, Optical switching and Logic devices,Optical Memory.

Solar Cells: basic working principle, VI Characteristics, Different types of solar cells, Dye sensitized solar cells (DSSC), Perovskite Solar cells.

Module 5 – Optical Devices in Optoelectronic Networks

Introduction to optical components, Splitters and Couplers, Directional Couplers, Fiber Bragg Gratings, Multiplexers, Attenuators, Isolators, Circulators, Fixed Filters, Tunable Filters, Add Drop Multiplexers, Waveguide Grating Routers, Optical Cross Connects, Wavelength Convertors, Optical Bistable Devices.

Text Book

1. Pallab Bhattacharya: Semiconductor Optoelectronic Devices, Pearson, 2009

References

1. Mark Csele, Fundamentals of Light Sources and Lasers, Wiley-Interscience, 2004
2. W.Koechner,M.Bass, Solid State Lasers, Springer, 2003
3. Yariv, Photonics Optical Electronics in modern communication, 6/e ,Oxford University Press,2006.
4. Harry J R Dutton, Understanding Optical Communications, IBM 1/e 1998
5. Alastair Buckley, Organic Light-Emitting Diodes, Woodhead, 2013
6. Stephen J Fonash, Solar Cell Device Physics, Elsevier 2/e, 2010

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Fundamentals of Semiconductor Optoelectronics**	
1.1	Optical processes in semiconductors: electron-hole generation and recombination, Absorption.	1
1.2	Auger recombination, Heat generation and dissipation, Heat sources.	2
1.3	Various light production mechanisms	1
1.4	Indirect band gap materials, Semiconductors used for optical Applications	1
1.5	Basic principle of LED and LASER, Spontaneous emission and Stimulated Emission, Coherence of sources.	2
2	**Optical Sources**	
2.1	Construction and Operation of LEDs, Heterojunctios	1
2.2	Surface Emitter and Edge Emitter LEDs, Characteristics of LEDs	1
2.3	LASERs, Threshold Condition for lasing, Line Broadening Mechanisms	1
2.4	Fabry-Perot Lasers, Distributed Feedback(DFB) Lasers	1
2.5	Distributed Bragg Reflector (DBR) Lasers, Vertical Cavity Surface Emitting Lasers (VCSELs), In-Fibre Lasers.	2
3	**Optical Detectors**	
3.1	Principle of Photo Detection, Working of LDR, PN diode, PIN diode	1
3.2	Avalanche Photodiode (APD), Characteristics of APD	1
3.3	Resonant Cavity Photo detector, Photo Transistor	1
3.4	Quantum efficiency, Responsivity	1
3.5	Noise in Photo detectors, Thermal Noise, Dark Current, Shot Noise, Quantum limit of Optical Detection	2
4	**Optoelectronic Devices and Modulators**	
4.1	Optoelectronic ICs, Advantages	1
4.2	Liquid Crystal Display, Structure, TFT display, Structure	1
4.3	Polymer LED, Organic LED, Optical Modulators using PN junction	1
4.4	Electro-Optic Modulators, Acousto-Optic Modulators, Raman-Nath Modulators	2
4.5	Optical switching and Logic devices, Optical Memory	2
4.6	Solar Cells: basic working principle, VI Characteristics, Different types of solar cells	1
4.7	Dye sensitized solar cells (DSSC), Perovskite Solar cells	1
5	**Optical Devices in Optoelectronic Networks**	
5.1	Introduction to optical components, Splitters and Couplers,	1
5.2	Directional Couplers, Fiber Bragg Gratings, Multiplexers, Attenuators,	3

	Isolators, Circulators, Fixed Filters, Tunable Filters	
5.3	Add Drop Multiplexers, Waveguide Grating Routers, Optical Cross Connects	2
5.4	Wavelength Convertors, Optical Bistable Devices	1

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

MODEL QUESTION PAPER

ECT433 OPTO-ELECTRONIC DEVICES

Time: 3 hours Max. Marks:100

PART A

*Answer **all** questions. Each question carries **3 marks**.*

1. State the differences between Spontaneous emission and Stimulated emission.
2. Find the wavelength of light emitted by GaAs LED. Take band gap of GaAs to be 1.44eV at 300K
3. Explain surface emitter LED.
4. Explain any one line broadening mechanism in LASER Sources.
5. Calculate the photo current generated for an incident optical signal strength 600 nW on a PIN photodiode with responsivity 7.5 A/W
6. What is meant by dark current?
7. What is electro-optic effect?
8. Discuss the principle of optical memory.
9. List the different types of Wavelength division multiplexers and demultiplexers used of optical field access.
10. Explain the working principle of circulators.

PART B
MODULE - 1

11.	a.	Distinguish between radiative and non-radiative recombinations	7
	b.	Briefly explain what is meant by coherence of optical sources	7

OR

12.	a.	Discuss the various light production mechanisms in materials	7

	b.	Explain the basic principle of LED.	7

MODULE - 2

13	a.	With the help of a suitable diagram, explain the working principle of DFB Laser.	9
	b.	List the various features and characteristics of LEDs	5

OR

14	a.	With neat diagram, explain the principle of Surface Emitting LEDs and compare its features with edge emitting LEDs.	6
	b.	.A Light Emitting Diode gives 500µw output power when minority carrier lifetime is 4ns.Determine the output optical power when LED is modulated with 50MHz frequency with rms current equal to same dc current	8

MODULE - 3

15	a.	Explain various noise mechanisms in optical detectors	5
	b.	Discuss the construction and working principle of PIN photodiode.	9

OR

16	a.	Elucidate different techniques commonly used for measuring high speed response of photodetectors	6
	b.	Calculate the photocurrent density of a Si p-i-n photodiode with 8 µm i-region when 0.87 µm light power density 0.5W/cm^2 is incident upon it. It is assumed the top illuminated surface is coated with anti-reflection coating. Given that absorption coefficient at 0.87 µm is 600.	8

MODULE - 4

17	a.	What is meant by acousto-optic effect? Explain Raman-Nath modulator.	9
	b.	Explain the working principle of organic LEDs.	5

OR

18	a.	Write a short note on Perovskite Solar cells	5
	b.	Describe the structure of Polymer LED. List the advantages and disadvantages of Polymer LED.	9

MODULE - 5

19	a.	Discuss the principle of tunable filters.	8
	b.	Explain the principle and working of waveguide grating routers	6

OR

20	a.	Explain different types of fixed optical filters.	9
	b.	Calculate the physical grating period required for FBG for rejecting 980 nm optical signals. Take average refractive index of the core = 1.45	5

ECT443	INSTRUMENTATION	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to introduce the basic concepts of electronic measuring instruments for measuring physical variables using transducers and to familiarize the concepts of the control systems PLC,DCS and SCADA.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Interpret the basic concepts of measuring instruments, its classification, and selection criteria, static and dynamic characteristics.
CO 2	Understand the principle, construction and working of transducers for measuring physical variables.
CO 3	Comprehend the principle, construction and working of various electronic measuring instruments.
CO 4	Explainthe hardware architecture for PLC, DCS and SCADA.
CO 5	Apply PLC programming for selected industrial processes.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	3	3										
CO 2	3	3	3									
CO 3	3	3	3									
CO 4	3	3										
CO 5	3	3	3									

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	**2**	
Remember	10	10	20
Understand	30	20	50
Apply	10	20	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	:	10marks
Continuous Assessment Test (2numbers)	:	25 marks
Assignment	:	15marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Basics of measuring instruments

1. Explain the difference between accuracy and precision.
2. With neat block diagram explain the functional elements of a measuring instrument.
3. Explain the following static characteristics of a measuring instruments in details :- Sensitivity, Resolution, Selectivity, Linearity

Course Outcome 2 (CO2): Basics of transducers

1. Explain the working of a piezoelectric transducer.
2. Explain the principle of Hall Effect. How a proximity sensor works on the basis of Hall Effect?
3. Explain the construction, working principle, application, advantages and disadvantages of LVDT.

Course Outcome 3 (CO3): Basics of Electronics measuring instruments

1. With neat block diagram explain the working of a DSO
2. Explain ramp type digital voltmeter
3. With neat sketch explain the working of a frequency counter

Course Outcome 4 (CO4): Basics of PLC, DCS, SCADA

1. Explain the hardware components of a DCS
2. What are the various Input Output devices connected to a PLC?
3. Explain in details the SCADA architecture

Course Outcome 5 (CO5): PLC Programming

1. Two motors are to be controlled in a sequence. The second motor starts 30 seconds after the starting of first motor by a push switch. Develop a PLC ladder diagram for the following

cases and describe the circuit.
Case (A): Only one motor operates at a time.
Case (B): Both the motor gets off together after 50 seconds.

Syllabus

Module 1

Introduction to measuring instruments

Generalized Configurations and Functional elements of Instrumentation systems, Need for Measurement Systems, Classification of Types of Measuring instruments. Static and Dynamic characteristics of measuring instruments. Sensors and Transducers: - Need, Classification and selection criteria.

Module 2

Transducer

Principles of operation, construction, theory, advantages and disadvantages, applications of-
Resistive Transducers: Potentiometers, strain gauges, (metallic and semi-conductor type), Resistance Thermometer, Thermistors.
Inductive Transducers: LVDT (Linear variable differential transformer).
Capacitive Transducers:various capacitive transducers based upon familiar equation of capacitance (capacitive microphone)
Active Transducers: Thermocouple, Piezo-electric transducer, Hall Effect transducer,Flow meter

Module 3

Electronic Measuring Instruments

Digital storage oscilloscope,Working principle and applications of waveform analyser, digital frequency meter, harmonic distortion meter, harmonic analyser, spectrum analyser and logic state analyserIEEE - 488 General Purpose Interface Bus (GPIB) Instruments with application.EMI, Grounding and Shielding

Module 4

PLC, DCS and SCADA

PLC Basics: An Overall looks at PLCs, General PLC Programming Procedures, Devices to which PLC Inputs and Outputs are connected.
Distributed Control System: Meaning and necessity of distributed control; hardware components of DCS; DCS software.
Introduction to SCADA: SCADA overview, SCADA Architecture – Monolithic, Distributed and Networked, SCADA Protocols- IEC 60870-5-101, DNP-3, Profibus, Modbus

Module 5

PLC Programming

Basic PLC Programming : Programming ON/OFF Inputs, Creating Ladder diagrams, Register Basics, PLC Timers and Counters, PLC Arithmetic functions, Number comparison functions, Data handling Functions: Skip function and applications; master control relay function and applications; jump with non-return and return; data table, register and other move functions, PLC functions with BITS.

Text Book

1. Ernest Doebelin, Dhanesh N. Manik, 'Doebelin's Measurement Systems', McGraw Hill, 7th Edition, 2019
2. Kalsi HS, "Electronic Instrumentation," Tata McGraw Hill, Third Edition
3. John R Hackworth, Frederick D Hackworth, Jr, "Programmable Logic controllers Programming Methods and Applications", Pearson Education.

Reference

1. Sawhney AK, "Electrical and Electronics Measurements and Instrumentation," Dhanpat Rai and Sons
2. John W Webb, Ronald A. Reis, "Programmable Logic Controllers- Principles and applications", PHI , ND, 2006

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to measuring instruments**	
1.1	Generalised Configurations and Functional elements of Instrumentation systems	1
1.2	Need for Measurement Systems, Classification of Types of Measuring instruments, Static and Dynamic characteristics of measuring instruments	3
1.3	Sensors and Transducers: - Need, Classification and selection criteria.	1
2	**Transducers**	
2.1	Principles of operation, construction, theory, advantages and disadvantages, applications of- **Resistive Transducers:** Potentiometers, strain gauges, (metallic and semi-conductor type), Resistance Thermometer, Thermistors.	3
2.2	Principles of operation, construction, theory, advantages and disadvantages, applications of- **Inductive Transducers:** LVDT (Linear variable differential transformer).	2
2.3	Principles of operation, construction, theory, advantages and disadvantages, applications of- **Capacitive Transducers:**various Capacitive transducers based upon familiar equation of capacitance (capacitive microphone)	2

2.4	Principles of operation, construction, theory, advantages and disadvantages, applications of-, **Active Transducers:** Thermocouple, Piezo-electric transducer, Hall effect transducer, Flow meter	2
3	**Electronic Measuring Instruments**	
3.1	Digital storage oscilloscope:- Working, Applications	1
3.2	Working principle and applications of waveform analyzer, digital frequency meter, harmonic distortion meter, harmonic analyser, spectrum analyser and logic state analyser	3
3.3	IEEE - 488 General Purpose Interface Bus (GPIB) Instruments with application	1
3.4	EMI, Grounding and Shielding	1
4	**PLC,DCS,SCADA**	
4.1	**PLC Basics:** An Overall looks at PLCs, General PLC Programming Procedures, Devices to which PLC Inputs and Outputs are connected.	2
4.2	**Distributed Control System:** Meaning and necessity of distributed control; hardware components of DCS; DCS software	2
4.3	**Introduction to SCADA:** SCADA overview, SCADA Architecture – Monolithic, Distributed and Networked, SCADA Protocols- IEC 60870-5-101, DNP-3, Modbus, Profibus	2
5	**PLC Programming**	
5.1	Basic PLC Programming : Programming ON/OFF Inputs, Creating Ladder diagrams, Register Basics	2
5.2	PLC Timers and Counters, PLC Arithmetic functions, Data handling Functions: Skip function and applications	3
5.3	master control relay function and applications; jump with non-return and return;	2
5.4	Data table, register and other move functions, PLC functions with BITS	2

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B TECH DEGREE EXAMINATION
BRANCH: ELECTRONICS AND COMMUNICATION

COURSE: ECT443 INSTRUMENTATION

Time:3 Hrs. **Max. Marks:100**

PART A
Answer All Questions

1 Explain the difference between accuracy and precision. (3) K_2
2 Compare transducer and sensor. (3) K_2
3 Explain the working of a piezoelectric transducer. (3) K_2
4 Differentiate between RTD and thermocouple. (3) K_2
5 Explain the need for grounding and shielding (3) K_2
6 What are the applications of a DSO? (3) K_3
7 What are the essential elements of a PLC system? (3) K_2
8 Explain any two applications of SCADA. (3) K_2
9 With suitable example explain latching in PLC Ladder logic (3) K_3
10 Draw the ladder diagram for the following logic functions. (3) K_3
(i) XOR (ii) NAND (iii) NOR

PART B
Answer one question from each module. Each question carries 14 mark.

Module I

11(A) With neat block diagram explain the functional elements of a measuring instrument. (8) K_2
11(B) Explain the parameters for selection of a transducer. (6) K_2

OR

12(A) Explain the following static characteristics of a measuring instruments in details:- Sensitivity, Resolution, Selectivity, Linearity (8) K_2
12(B) How are transducers classified? (6) K_2

Module II

13(A) Derive the expression for finding gauge factor of a strain gauge (8) K_3
13(B) Explain the principle of Hall effect. How a proximity sensor works on the basis of Hall effect? (6) K_2

OR

14	Explain the construction , working principle, application, advantages and disadvantages of LVDT	(14)	K_2

Module III

15(A)	With neat block diagram explain the working of a DSO	(7)	K_2
15(B)	Explain the working principle of a frequency analyzer	(7)	K_2

OR

16(A)	With neat sketch explainthe working of a frequency counter	(8)	K_2
16(B)	Explain the working principle of a Logic State analyzer	(6)	K_2

Module IV

17(A)	Explain the hardware components of a DCS	(8)	K_2
17(B)	What are the various Input Output devices connected to a PLC?	(6)	K_2

OR

18(A)	Explain in details the SCADA architecture	(8)	K_2
18(B)	Differentiate between Profibus and Modbus	(6)	K_2

Module V

19	Two motors are to be controlled in a sequence. The second motor starts 30 seconds after the starting of first motor by a push switch. Develop a PLC ladder diagram for the following cases and describe the circuit. Case (A): Only one motor operates at a time. Case (B): Both the motor gets off together after 50 seconds.	(14)	K_3

OR

20	Saw, Fan and oil pump all go ON when a start button is pressed. If the saw has operated less than 20s, the oil pump should go off when the saw is turned off and the fan is to run for an additional 5s after the shutdown of the saw. If the saw has operated for more than 20s, the fan should remain on until reset by a separate fan reset button and the oil pump should remain on for an additional 10 s after the saw is turned off. Write a program that will implement this process.	(14)	K_3

ECT453	ERROR CONTROL CODES	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to give an insight into the various codes used for error control in data transmission

Course Outcomes: On completion of the course the student will be able to

CO 1 **K3**	Describethe principles of block codes, types and their bounds
CO2 **K3**	Illustrate the principles of cyclic codes and Galois Fields, encoding and decoding of binary BCH codes and algorithms for finding the error location polynomial
CO 3 **K3**	Demonstrate encoding, decoding and error locationof Reed Solomon codes and Reed Muller codes
CO 4 **K3**	Illustrate the encoding and decoding of Convolution Codes and Turbo Codes
CO 5 **K3**	Describe the encoding, decoding and applications of LDPC Codes
CO 6 **K3**	Discuss the concepts of polar codes and its applications in 5G

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2									2
CO 2	3	3	2									2
CO 3	3	3	2									2
CO 4	3	3	2									2
CO 5	3	3	2									2
CO6	3	3	2									2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember K1	10	10	10
Understand K2	20	20	20
Apply K3	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Describethe principles of block codes, types and their bounds

1. Define Code Rate, Hamming Distance and Error detection and correction capabilities of Block codes
2. Construct Hamming Codes for a given Generator Matrix
3. State and prove Gilbert Varshamov bound

Course Outcome 2 (CO2): Illustrate the principles of cyclic codes and Galois Fields, encoding and decoding of binary BCH codes and algorithms for finding the error location polynomial

1. Design a (n,k) cyclic code in systematic form using a given generator polynomial g(X)
2. Determine all the conjugacy classes in an extended GF with respect to a give GF
3. Describe the Chein search algorithm for finding the error locator polynomial for Binary BCH Codes

Course Outcome 3 (CO3): Demonstrate encoding, decoding and error location of Reed Solomon codes and Reed Muller codes

1. Differentiate between the BCH and Vandermonde viewpoints of Reed Solomon Codes
2. Explain Sudan's algorithm for decoding RS codes
3. Devise an encoding circuit for RM (1, m) code

Course Outcome 4 (CO4): Illustrate the encoding and decoding of Convolution Codes and Turbo Codes

1. Construct an encoder, state diagram and trellis for a convolution encoder using a given generator polynomial.
2. Decode convolution codes using Viterbi decoder
3. Construct a Turbo encoder for a given generator polynomial

Course Outcome 5 (CO5): Describe the encoding, decoding and applications of LDPC Codes

1. Determine if a given matrix satisfies the conditions of the parity check matrix of an LDPC code.
2. Construct the Tanner graph for a given LDPC code. Determine the girth of the Tanner graph

3Discuss the message passing decoding over binary erasure channels

Course Outcome 6 (CO6): Discuss the encoding, decoding and applications in 5G of polar codes

1. Explain the basic ideas of polarization
2. Discuss polarization of BEC channels
3. Explain how polar codes can be applied in 5G

SYLLABUS

Error Control Codes

Module 1: Block Codes and Bounds.

Error Control Coding – Relevance of error control codes in Communication System, concepts of Code rate, Hamming Distance, Minimum Distance, Error detecting and correcting capability.

Repetition Codes, Hamming Codes, Review of Groups, Fields, Vector Spaces. Linear Block Codes - Generator matrix, Parity Check Matrix. Dual Codes, Error Detection and Correction over hard output channels. Dual of binary Hamming codes. Maximum Likelihood Decoding

Simple bounds on block codes - Singleton bound, Hamming Bound, Gilbert-Varshamov bound. Maximum-distance-separable (MDS) codes.

Module 2: Cyclic Codes

Review of basic concepts of cyclic codes – generator matrix, parity-check matrix. Polynomial view point. Encoding, systematic encoding, syndrome decoding.

Galois Fields -- Irreducible and Primitive Polynomials, Primitive elements, Field extension, Conjugate elements and Minimal Polynomials. Cyclotomic cosets.

BCH Codes - Design, BCH Bound, Decoding BCH codes – Decoding BCH – the general outline, computation of the syndrome, error locator polynomial, Chien Search algorithm, Finding the error locator polynomial. Berlekamp Massey Algorithm. Burst-error correction capability of BCH codes.

Module 3: Reed-Solomon and Reed-Muller Codes

Reed Solomon Codes – BCH code viewpoint. Vandermonde matrix view point. MDS property. Generalized Reed-Solomon codes. Application of BCH decoding algorithms to Reed-Solomon decoding. Sudan's algorithm for decoding. Use of RS codes in disks and cloud storage.

Reed Muller Codes, Encoding and decoding of RM (1, m) codes. Majority-logic decoding of Reed-Muller codes.

Module 4: Convolutional and Turbo Codes

Convolution Codes, State Diagram, Systematic Encoders, Decoding of Convolution Codes – Viterbi algorithm, Turbo Codes, Encoding parallel concatenated codes.

Module 5: LDPC and Polar Codes

Low Density Parity Codes, Construction, Tanner Graphs, Message passing decoding. Example of message passing decoding over binary erasure channels. Message passing of LLR and decoding over AWGN channels.

Polar Codes – Introduction, polarization of BEC channels, Polar transform and frozen bits. LDPC and Polar codes in 5G.

Textbooks and References

1. Shu Lin, D. J Costello Jr. Error Control Coding: Fundaments and Applications, Prentice Hall

2. Ron M Roth, Introduction to Coding Theory, Cambridge University Press

3. Todd K. Moon, Error Correction Coding: Mathematical Methods and Algorithms, Wiley.

4. T. Richardson, R. Urbanke, Modern Coding Theory, Cambridge University Press

5. H. Pfister, A Brief Introduction to Polar Codes, Lec. Notes

6. O. Gazi, Polar Codes: A Non-Trivial Approach to Channel Coding, Springer, 2018.

7. A. Thangaraj, LDPC and Polar Codes in 5G Standard, NPTEL Course

Course Contents and Lecture Schedule

S.No	Topic	No. of Lectures
1	**Module 1: Block Codes and Bounds.**	
1.1	Error Control Coding – Relevance of error control codes in Communication System, concepts of Code rate, Hamming Distance, Minimum Distance, Error detecting and correcting capability.	2
1.2	Repetition Codes, Hamming Codes, Review of Groups, Fields, Vector Spaces. Linear Block Codes - Generator matrix, Parity Check Matrix. Dual Codes, Error Detection and Correction over hard output channels. Dual of binary Hamming codes. Maximum Likelihood Decoding	2
1.3	Simple bounds on block codes - Singleton bound, Hamming Bound, Gilbert-Varshamov bound. Maximum-distance-separable (MDS) codes.	2
2	**Module 2: Cyclic Codes**	
2.1	Review of basic concepts of cyclic codes – generator matrix, parity-check matrix. Polynomial view point. Encoding, systematic encoding, syndrome decoding.	2
2.2	Galois Fields -- Irreducible and Primitive Polynomials, Primitive elements, Field extension, Conjugate elements and Minimal Polynomials. Cyclotomic cosets.	2
2.3	BCH Codes - Design, BCH Bound, Decoding BCH codes – Decoding BCH – the general outline, computation of the syndrome, error locator polynomial, Chien Search algorithm, Finding the error locator polynomial. Berlekamp Massey Algorithm. Burst-error correction capability of BCH codes.	4
3	**Module 3: Reed-Solomon and Reed-Muller Codes**	
3.1	Reed Solomon Codes – BCH code viewpoint. Vandermonde matrix view point. MDS property. Generalized Reed-Solomon codes. Application of BCH decoding algorithms to Reed-Solomon decoding. Sudan's algorithm for decoding. Use of RS codes in disks and cloud storage.	4
3.2	Reed Muller Codes, Encoding and decoding of RM (1, m) codes. Majority-logic decoding of Reed-Muller codes.	3
4	**Module 4: Convolutional and Turbo Codes**	
4.1	Convolution Codes, State Diagram, Systematic Encoders, Decoding of Convolution Codes – Viterbi algorithm	4
4.2	Turbo Codes, Encoding parallel concatenated codes.	3
5	**Module 5: LDPC and Polar Codes**	

5.1	Low Density Parity Codes, Construction, Tanner Graphs, Message passing decoding. Example of message passing decoding over binary erasure channels. Message passing of LLR and decoding over AWGN channels.	4
5.2	Polar Codes – Introduction, polarization of BEC channels, Polar transform and frozen bits. LDPC and Polar codes in 5G.	3

Simulation Assignments

Using GAP,

a) Determine if a given polynomial is reducible
b) Generate Hamming codes, Reed Muller Codes
c) Generate the Standard Array of a given code C
d) Generate the generator matrix of a given code C
e) Generate the parity check matrix of a given code C
f) Determine the Hamming Distance and minimum distance of a given code C

Similar exercises may be given

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B. TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT453

Course Name: ERROR CONTROL CODES

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	Generate all the code polynomials for the (7,4) Hamming Code generator polynomial $g(x) = 1+x+x^3$	K3
2	Define (a) MDS Code (b) Minimum Distance (c) Repetition Code	K1
3	Determine if x^5+x^3+1 is irreducible over GF (2)	K3
4	Illustrate the general outline for decoding BCH codes	K2
5	Prove that the minimum distance of an (n,k) RS code is n-k+1	K2
6	Construct the Generator matrix of a RM(1,3) code	K3
7	Describe a catastrophic encoder	K2
8	Discuss the applications of turbo codes in 5G	K2
9	Explain the method of construction of LDPC Codes	K2
10	Describe the applications of polar codes in 5G	K2
	PART – B Answer one question from each module; each question carries 14 marks.	
	Module - I	
11 a.	Define and prove Hamming bound and Gilbert Varshamov bounds	7 CO1 K2
b.	For the (7,4) Hamming code generator polynomial $g(x) = 1+x+x^3$, generate all possible code polynomials c(x). Determine the parity check matrix h(x) for this code. Calculate the miniumum distance of the Hamming code generated	7 CO1 K3
	OR	
12	Consider a systematic block code whose parity check equations are: $p_1 = m_1+m_2+m_4$ $p_2 = m_1+m_3+m_4$ $p_3 = m_1+m_2+m_3$ $p_4 = m_2+m_3+m_4$ where m_i are the message digits and p_i are the check digits a) Find the generator matrix and parity check matrix for this code	14 CO1 K3

	b) How many errors can the code correct? c) Is the vector 10101010 a code word?	
	Module - II	
13 a	For a binary, narrow sense, triple error correcting BCH code of length 15, constructed using the polynomial x^4+x+1 (a) Compute a generator polynomial for this code (b) Determine the rate of the code (c) Construct the parity check matrix and generator matrix for this code	7 CO2 K3
b	Define and prove the BCH bound	7 CO2 K2
	OR	
14a	Construct the systematic encoder for cyclic codes and explain its working	7 CO2 K2
b	Describe the Chien search algorithm for BCH codes	7 CO2 K2
	Module - III	
15 a	Explain Sudan's algorithm for Reed Solomon Codes	7 CO3 K2
b	Differentiate between the BCH Viewpoint and Vandermondeviewpoints of Reed Solomon Codes	7 CO3 K2
	OR	
16	Form the generator matrix of the first order RM code RM (1,3) of length 8. What is the minimum distance of the code? Determine its parity check sums and devise a majority logic decoder for the code. Decode the received vector r = (01000101)	14 CO3 K3
	Module - IV	
17	For the R=1/2 convolution encoder with $G(x) = [1+x^2+x^3 \;\; 1+x+x^3]$ (a) Draw a hardware realization of the encoder (b) Determine the convolution generator matrix G (c) For the input sequence m = [1,0,1,1,0,1,1] determine the coded output sequence (d) Draw the state diagram (e) Draw the trellis (f) Is this a catastrophic realization? Justify your answer	14 CO4 K2
	OR	
18 a.	Illustrate Turbo encoding without and with puncturing	7 CO4 K2
b.	Explain the Viterbi algorithm and the schematic of add compare select hardware	7

	implementation	CO4 K2
	Module - V	
19 a.	For the parity check matrix $\begin{bmatrix} 1 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 1 & 0 & 1 \end{bmatrix}$ (a) Construct the Tanner graph for the code (b) Determine the girth of the minimum girth cycle (c) Determine the number of cycles of length 6 (d) Determine a generator matrix for this code	8 CO5 K3
b.	Explain message passing decoding of LDPC codes over binary erasure channels	6 CO5 K2
	OR	
20 a	Describe the basic ideas of polarization	6 CO6 K2
b	Explain channel polarization for N=2 channel	8 CO6 K2

ECT463	MACHINE LEARNING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to impart the fundamentals of machine learning techniques.

Prerequisite: MAT 101 Linear Algebra and Calculus
MAT 204 Probability, Random Process, and Numerical Methods

Course Outcomes: After the completion of the course the student will be able to

CO1 K2	Understand the basics of machine learning and different types.
CO2 K3	Differentiate regression and classification, apply Bayes' decision theory in classification
CO3 K3	Apply linear algebra and statistical methods in discriminant based algorithms
CO4 K2	Understand the basics of unsupervised learning and non-metric methods
CO5 K2	Understand ensemble methods, dimensionality reduction, evaluation, model selection.

Mapping of course outcomes with program outcomes

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO11	PO12
CO 1	3											
CO 2	3	3	3	3	3							
CO 3	3	3	3	3	3							
CO 4	3											
CO 5	3			3	3							

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember				
Understand	K2	30	30	60
Apply	K3	20	20	40
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the basics of machine learning and different types. (K2)

1. Differentiate supervised and unsupervised learning using examples.

2. Understand different terms and methods used in machine learning.

Course Outcome 2 (CO2): Differentiate regression and classification, apply Bayes' decision theory in classification (K3)

1. Differentiate regression and classification using examples

2. To apply Bayes' decision theory in classification for normal distributions

Course Outcome 3 (CO3): Apply linear algebra and statistical methods in discriminant based algorithms (K3)

1. Use statistical methods to obtain perceptron algorithm

2. Use support vector machines for separable classes and non separable classes

Course Outcome 4 (CO4): Understand the basics of unsupervised learning, ensemble methods and non-metric methods (K2)

1. Explain unsupervised learning with examples

2. Differentiate boosting and bagging.

3. Describe decision trees with examples.

Course Outcome 5 (CO5): Understand dimensionality reduction, evaluation and model selection techniques (K2)

1. Significance of dimensionality reduction.

2. Describe principal component analysis, Fischer's discriminant analysis.

3. Explain ROC curves, evaluation measures, validation set, bias-variance trade-off.

SYLLABUS

Module I

Basics of machine learning, supervised and unsupervised learning, examples, features, feature vector, training set, target vector, test set, feature extraction, over-fitting, curse of dimensionality. Review of probability theory, Gaussian distribution, decision theory.

Module II

Regression: linear regression, error functions in regression, multivariate regression, regression applications, bias and variance. Classification : Bayes' decision theory, discriminant functions and decision surfaces, Bayesian classification for normal distributions, classification applications.

Module III

Linear discriminant based algorithm: perceptron, gradient descent method, perceptron algorithm, support vector machines, separable classes, non-separable classes, multiclass case.

Module IV :

Unsupervised learning: Clustering, examples, criterion functions for clustering, proximity measures, algorithms for clustering. Ensemble methods: boosting, bagging. Basics of decision trees, random forest, examples.

Module V :

Dimensionality reduction: principal component analysis, Fischer's discriminant analysis. Evaluation and model Selection: ROC curves, evaluation measures, validation set, bias-variance trade-off. Confusion matrix, recall, precision, accuracy.

Text Books:

1. Bishop, C. M. "Pattern Recognition and Machine Learning" Springer, New York, 2006.
2. Theodoridis, S. and Koutroumbas, K. "Pattern Recognition". Academic Press, San Diego, 2003.

References:

1. Hastie, T., Tibshirani, R. and Friedman, J. "The Elements of Statistical Learning". Springer. 2001.
2. Duda, R.O., Hart, P.E., and Stork, D.G. "Pattern Classification". Wiley, New York, 2001.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module I**	
1.1	Basics of machine learning, supervised and unsupervised learning, examples,	2
1.2	features, feature vector, training set, target vector, test set	2
1.3	feature extraction, over-fitting, curse of dimensionality.	1
1.4	Review of probability theory, Gaussian distribution, decision theory.	2
2	**Module II**	
2.1	Regression: linear regression, error functions in regression	2
2.2	multivariate regression, regression applications, bias and variance.	2
2.3	Classification : Bayes' decision theory,	1
2.4	discriminant functions and decision surfaces,	1
2.5	Bayesian classification for normal distributions, classification applications.	2
3	**Module III**	
3.1	Linear discriminant based algorithm: perceptron,	1
3.2	gradient descent method, perceptron algorithm,	2
3.3	support vector machines ,	1
3.4	SVM for separable classes and non-separable classes, multiclass case.	2
4	**Module IV**	
4.1	Unsupervised learning: Clustering, examples, criterion functions for	2

	clustering,	
4.2	proximity measures, algorithms for clustering.	2
4.3	Ensemble methods: boosting, bagging.	1
4.4	Basics of decision trees, random forest, examples.	2
5	**Module V**	
5.1	Dimensionality reduction: principal component analysis,	2
5.2	Fischer's discriminant analysis.	1
5.3	Evaluation and model selection: ROC curves, evaluation measures,	2
5.4	validation set, bias-variance trade-off.	1
5.5	confusion matrix, recall, precision, accuracy.	1

Simulation Assignments (using Python or Matlab)

- Working with Probability Distributions, Gaussian pdf generation
- Regression examples
- Classification examples
- Perceptron
- SVM
- Unsupervised learning techniques to find natural groupings and patterns in data
- Dimensionality reduction techniques

Model Question Paper

APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER

ECT463 MACHINE LEARNING

Time: 3 hours **Max. Marks:100**

PART A

Answer ***all*** questions. Each question carries ***3 marks***.

1. Explain machine learning with examples.
2. Explain over-fitting in machine learning
3. Explain regression with examples
4. State Bayes decision theory
5. Draw a simple perceptron model
6. How SVM is used for multiclass problem?
7. Explain clustering with examples.
8. Explain decision trees with examples.
9. Explain ROC curves.
10. Explain bias-variance trade-off.

PART B

Answer ***anyone*** question from each module. Each question carries ***14 marks.***

MODULE I

11. (a) Explain the terms features, training set, target vector, and test set (8 marks)
    (b) Distinguish supervised and unsupervised machine learning with examples. (6 marks)

OR

12. (a) Explain a multi-variate Gaussian distribution along with its parameters (6 marks)
    (b) Explain curse of dimensionality in machine learning? (8 marks)

MODULE II

13. (a) Differentiate regression and classification with examples (8 marks)
    (b) Explain bias and variance for regression (6 marks)

OR

14. (a) Obtain the decision surface for an equi-probable two class system, where the probability density functions of l-dimensional feature vectors in both classes are normally distributed. (8 marks)
    (b) Show that the Bayesian classifier is optimal with respect to minimizing the classification error probability. (6 marks)

MODULE III

13. (a) Give a step by step description of the perceptron algorithm in classification. (8 marks)

(b) Explain the significance of gradient descent method in machine learning algorithms. (6 marks)

OR

14. (a) Obtain the cost function for optimization in SVM for separable classes. (8 marks)

(b) How SVM is used in non-separable classes? (6 marks)

MODULE IV

13. (a) Explain different criterion functions for clustering (8 marks)

(b) Give a description of different clustering algorithms (6 marks)

OR

14. (a) Explain different ensemble methods in classification. (8 marks)

(b) Illustrate random forest algorithm. (6 marks)

MODULE V

13. (a) Explain the significance of dimensionality reduction in machine learning. (6 marks)

(b) Describe Fisher Discriminant Analysis. (8 marks)

OR

14. (a) How performance evaluation and model selection is done in machine learning (8 marks)

(b) Explain confusion matrix, recall, precision, and accuracy. (6 marks)

ECT473	DSP ARCHITECTURES	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: The aim of the course is to give an overview of the commonly used DSP algorithms, their applications and various techniques for the algorithmic and architecture level optimisations through various algorithm to architecture mapping which can lead to efficient hardware implementations. The course also introduces the basic features in Digital Signal Processors, DSP Architecture with case studies, the latest architectural trends in DSPs and their programming tools.

Prerequisite: ECT 303 Digital Signal Processing

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify the basic resource constraints in a practical DSP system and solve them using various techniques/transformations that map the DSP algorithms to efficient architectures.
CO 2	Illustrate various single core and multicore Digital Signal Processor architectures and identify the optimal processor for solving real life signal processing problems.
CO 3	Develop algorithms to solve signal processing problems using the latest hardware platforms and software tools.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3	3	3								2
CO 2	3	3	3	3								2
CO 3	3	3	3	3	3			1	2	2	1	2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember K1	10	10	10
Understand K2	20	10	20
Apply K3	10	20	50
Analyse	10	10	20
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Identify the basic resource constraints in a practical DSP system and solve them using various techniques/transformations that map the DSP algorithms to efficient architectures.

1. Compare and contrast various DSP Algorithm representations
2. Demonstrate the algorithmic representation of typical DSP algorithms (Convolution, Various Filters, Transforms and filterbanks etc.) using Block Diagram, Signal Flow Graph, Data Flow Graph and Dependence Graph.
3. Explain the popular filter structures for efficient hardware implementations.
4. Define Loop bound, Iteration bound, critical path and explain their significance in the design of hardware systems.
5. Apply various algorithms to compute the iteration bound of a given Data Flow Graph (DFG).
6. Design efficient architectures for implementing DSP algorithms using pipelining, parallel processing, folding and unfolding techniques that meets various requirements such as low computational complexity, power and area.

Course Outcome 2 (CO2): Illustrate various single core and multicore Digital Signal Processor architectures and identify the optimal processor for solving real life signal processing problems.

1. Explain the basic architectural features of Digital Signal Processors
2. Explain the role of ILP in designing Digital Signal Processor architectures.
3. Compare and contrast Harvard and VLIW architectures of DSPs.

4. Explain the architecture of various single and multicore DSPs.
5. Give a brief description of the peripherals available for implementing DSP tasks in various single and multicore DSPs.

Course Outcome 3 (CO3): Develop algorithms to solve signal processing problems using the latest hardware platforms and software tools.

1. Explain various steps involved in implementing a signal processing task using CSS.
2. Explain the role of Open CL in the development of portable codes that take advantage of the parallel computing power of modern electronic hardwares,
3. Explain the role of Open MP Application Programming Interface (API) and Inter-Processor Communication (IPC) in implementing DSP applications in realtime.

SYLLABUS

Module 1: Basics ofDSP Algorithm Representation to Architecture Mapping

DSP Algorithm representations –Block Diagram, Signal Flow Graph, Data Flow Graph, Dependence Graph;

Introduction to Filter structures- Recursive, Non-recursive and Lattice structures;

Fundamentals of DSP algorithm to architecture mapping - Loop bound, Iteration Bound, Critical Path, Algorithms for computing Iteration Bound – Longest Path Matrix Algorithm, Minimum Cycle Mean Algorithm.

Module 2: Transformations for Improved DSP Architectures

VLSI performance measures - area, power, and speed; Transformations for improved DSP architectures: Pipelining - Pipelining of FIR filters, Concept of Fine Grain Pipelining; Parallel Processing – Designing Parallel FIR systems, Pipelining and Parallel Processing for low power. Folding and Unfolding Transformations and its applications.

Module 3: Single Core DSP Architectures

Introduction to General Purpose Processors (GPP), Microcontroller Units (MCU), Digital Signal Processors (DSP) – comparison and Applications. The key features of a Digital Signal Processors – Dedicated hardware units, circular buffers, Modified bus structures and Memory access schemes. Introduction to Harvard, Super Harvard DSP architectures, Concept of Instruction Level Parallelism, VLIW Architecture and Single Instruction Multiple Data (SIMD) processor architecture.

Case Study: Introduction to a popular DSP from Texas Instruments, The TMS320C67xxSeries Processor - CPU Architecture - CPU Data Paths and Control - Timers - Internal Data/ Program Memory - External Memory Interface.

Module 4: Homogeneous Multicore DSPs

Introduction to multicore processors and their applications, A brief comparison between DSP SoCs, Field-Programmable Gate Arrays (FPGAs), Graphic Processors and CPUs.

Introduction to Multicore DSP Architectures: The TMS320C66x architecture: The CPU, Overview of the peripherals, Useful instructions, Overview of the memory organization.

Module 5: Programming the DSPs

Introduction to Code Composer Studio (CCS) software development tool and the TMS320C6678 EVM kit. Introduction to OpenMP Application Programming Interface (API) and Open Computing Language (OpenCL). Implementation of simple DSP algorithms – Dot Product.

Latest architectural trends in digital signal processing: Introduction to Heterogeneous Multicore DSP Architecture and FPGA SoCs.

Text Books

1. Keshab K. Parhi, "VLSI Signal Processing Systems, Design and Implementation", John Wiley &Sons,1999
2. Naim Dahnoun, “Multicore DSP: from algorithms to real-time implementation on the TMS320C66x SoC”. John Wiley & Sons, 2018.
3. Steven W. Smith, “The Scientist and Engineer’s Guide to Digital Signal Processing” Second Edition, California Technical Publishing , 1999.
4. Reference Link for Overview of Latest Processor Architectures–
   Digital signal processors (DSPs) | Overview | Processors | TI.com,
   https://training.ti.com/system/files/docs/c66x-corepac-instruction-set-reference-guide.pdf

Reference Books

1. Rulph Chassaing, “Digital Signal Processing and Applications with the C6713 and C6416 DSK”, John Wiley & Sons, 2005.
2. Sen M. Kuo, Woon-Seng S. Gan, Digal Signal Processors: Architectures, Implementations, and Applications, Prentice Hall, 2004.
3. Lars Wanhammar, DSP Integrated Circuits, Academic Press, 1999.
4. B Venkataramani, M Bhaskar, “Digital Signal Processors: Architecture, Programming and Applications”, 2nd Ed., Tata McGraw-Hill Education, 2002.
5. A. Kharin, S. Vityazev and V. Vityazev, "Teaching multi-core DSP implementation on EVM C6678 board," 2017 25th European Signal Processing Conference (EUSIPCO), 2017, pp. 2359-2363, doi: 10.23919/EUSIPCO.2017.8081632

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Basics of DSP Algorithm Representation to Architecture Mapping**	
1.1	DSP Algorithm representations –Block Diagram, Signal Flow Graph, Data Flow Graph, Dependence Graph.	2
1.2	Introduction to Filter structures- Recursive, Non-recursive and Lattice structures.	1
1.3	Fundamentals of DSP algorithm to architecture mapping - Loop bound, Iteration Bound, Critical Path,	2
1.4	Algorithms for computing Iteration Bound – Longest Path Matrix	2

	Algorithm, Minimum Cycle Mean Algorithm.	
2	**Transformations for Improved DSP Architectures**	
2.1	VLSI performance measures - area, power, and speed	1
2.2	Pipelining - Pipelining of FIR filters, Concept of Fine Grain Pipelining.	2
2.3	Parallel Processing – Designing Parallel FIR systems.	2
2.4	Pipelining and Parallel Processing for low power.	1
2.5	Folding and Unfolding Transformations and its applications.	3
3	**Single Core DSP Architectures**	
3.1	Introduction to General Purpose Processors (GPP), Microcontroller Units (MCU), Digital Signal Processors (DSP) - comparison and Applications.	1
3.2	The key features of a Digital Signal Processors – Dedicated hardware units, Circular Buffers, Modified bus structures and Memory access schemes.	1
3.3	Introduction to Harvard, Super HarvardDSP architectures, Concept of Instruction Level Parallelism, VLIW Architecture and Single Instruction Multiple Data (SIMD) processor architecture.	1
3.4	Case Study: Introduction to a popular DSP from Texas Instruments, The TMS320C67xx Series Processor- CPU Architecture - CPU Data Paths and Control - Timers – Multichannel Buffered Serial Ports (McBSPs)- Internal Data/ Program Memory - External Memory Interface.	4
4	**Homogeneous Multicore DSPs**	
4.1	Introduction to multicore processors and their applications, A brief comparison between DSP SoCs, Field-Programmable Gate Arrays (FPGAs), Graphic Processors and CPUs	1
4.2	Introduction to Multicore DSP Architectures: The TMS320C66x architecture: The CPU, Overview of the peripherals, Useful instructions, Overview of the memory organization.	5
5	**Programming the DSPs**	
5.1	Introduction to Code Composer Studio (CCS) software development tool and the TMS320C6678 EVM kit.	2
5.2	Introduction to Open MP Application Programming Interface (API) and Open Computing Language (OpenCL).	2
5.3	Implementation of simple DSP algorithms - Dot Product	1
5.4	Latest architectural trends in digital signal processing: Introduction to Heterogeneous Multicore DSP Architecture and FPGA SoCs.	1

Simulation Assignments/Course Projects:

1. Design an n-tap FIR filter. Apply pipelining to reduce the effective critical path. Simulate both using CCS and study the effect of pipelining.
2. Design an n-tap FIR filter. Construct a parallel FIR system. Simulate both using CCS and study the effect of parallel processing.
3. Consider a 6-tap FIR filter with data-broadcast structure. Apply folding using a folding factor of 2 on the structure. Implement both the filters and verify the functionality. Analyse the effect of folding.
4. Design a 4-bit bit-serial adder. Apply unfolding by 2 to make it a digit-serial adder. Implement both the filters and verify the functionality. Analyse and study the effect of unfolding.
5. Implement and realise the n-tap FIR filter utilising the multicore architecture of the TMS320C6678 processor. Implement and check the functionality by applying real time signals such as voice or recorded. Study the performance parameters.
6. Implement FFT algorithm using a single core on a TMS320C6678 processor. Extend it for the implementation of a 2-D FFT algorithm on an 8x8 data utilising themulticore architecture of the same processor. Study the performance parameters.
7. Study and implementation of a Real-Time Synthetic Aperture Radar (SAR) Algorithm Using TMS320C6678.
8. Design and implementation of a very large FFT algorithm using TMS320C6678 SoC.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT473

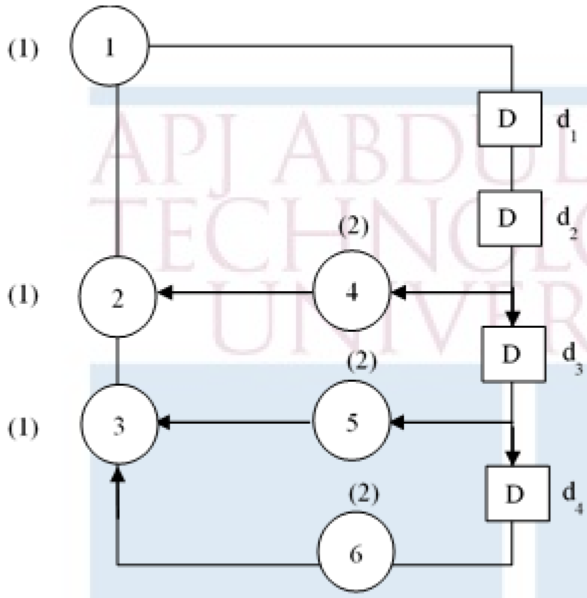
Course Name: DSP ARCHITECTURES

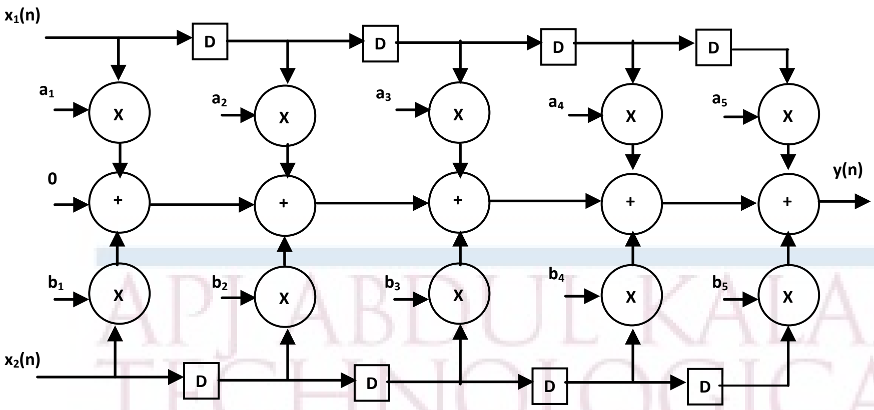
Max. Marks: 100 Duration: 3 Hours

PART A

Answer all Questions. Each Carries 3 mark.

1	Differentiate between Signal Flow Graph (SFG) and Data Flow Graph (DFG) with example.	K2
2	Define the terms Loop Bound and Iteration Bound. Explain the role of Iteration Bound in determining the speed of execution of a hardware.	K2
3	What is pipelining? Explain with an example, how it helps in reducing the critical path delay in implementing the DSP systems.	K2
4	What is Fine-Grain pipelining? Explain	K2
5	In what way the Super Harvard architecture based DSPs differs from the normal microprocessors?	K2
6	Explain with a suitable example, the role of circular buffers in implementing DSP algorithm.	K3
7	Compare and contrast DSP SoCs and FPGAs.	K2
8	Explain the CCS tools available for data visualisation.	K2
9	What is the concept of Heterogeneous Multicore DSP Architecture? Quote an example processor?	K1
10	Quoting a suitable example, explain the architectural advantages of an FPGA SoC.	K2
	PART – B Answer one question from each module; each question carries 14 marks.	
	Module - I	

11		
a.	Explain the Longest Path Matrix (LPM) Algorithm for computing the iteration bound of a DFG.	7
b.	For the DFG shown in figure below, the computation times of the nodes are shown in parentheses. Compute the iteration bound of this DFG using the LPM algorithm.  	7 CO1 K3
	OR	
12		14
a.	What are the advantages of lattice structure compared to other filter structures as far as implementation aspects are concerned.	CO1 K3
b.	For the following transfer function given, Derive the basic lattice filter and draw its structure $H(z)=\dfrac{3.9+2.3z^{-1}+z^{-2}}{1+0.3z^{-1}+0.5z^{-2}}$ $H(z)=\dfrac{-3+5.192\,z^{-1}-3.56\,z^{-2}+2\,z^{-1}}{1+0.28\,z^{-1}+0.056\,z^{-2}+0.4\,z^{-3}}$.	
	Module - II	
13		14
a.	Consider the non-recursive signal processing structure shown below.	
	i. Calculate the minimum sample period required to implement the algorithm using the given structure. Assume that TA and TM are the computation time required for addition and multiplication operations respectively.	CO1 K3
	ii. Find an equivalent implementation of this algorithm to improve the speed of the system using only 4 latches. Calculate the sample speed of the structure.	
	iii. How much improvement in sample speed is possible for the new structure if all the latches in the original structure (8 latches) are used?	
	iv. Is there any method for further improvements without adding any more	

<table>
<tr><td></td><td>registers? Explain.
 </td><td></td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>14</td><td>Consider a direct-form implementation of the FIR filter
y(n) = ax(n) + bx(n-2) +cx(n-3)
Assume that the time required for 1 multiply-add operation is T
i. Pipeline this filter such that the clock period is approximately T
ii. Draw block filter architecture for a block size of three. Pipeline this block filter such that clock period is about T.What is the system sample</td><td>14
CO1
K3</td></tr>
<tr><td></td><td>Module - III</td><td></td></tr>
<tr><td>15
a.
b.</td><td>The TMS320C6713 processor is used for an application where, it has to read the audio data inputted through the codec and has to send the data which is band limited to 1 KHz, to another external device for further processing. If the processor is connected to the audio codec through the McBSPs of the TMS320C6713 processor.
Draw the interconnection diagram showing all the necessary signals, for inputting an analog signal to the processor for the processing and to send the result there after, with the entire data transfer initiated through the McBSPs.
What are the various registers need to be programmed in order to effect the data transfer. Explain the role and functionality of each.</td><td>CO2
K3
6
8</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>16
a.
b.</td><td>Explain the role of a timer in a Digital Signal Processor with suitable examples. With reference to the Timer Control Register (Register fields given), explain the various facilities provided by the Timers in the TMS3206713 DSP processor.
<table>
<tr><td>31</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td></tr>
<tr><td colspan="2">Rsvd</td><td>TSTAT</td><td>INVINP</td><td>CLKSRC</td><td>C/$\overline{P}$</td></tr>
</table>
<table>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>$\overline{HLD}$</td><td>GO</td><td>Rsvd</td><td>PWID</td><td>DATIN</td><td>DATOUT</td><td>INVOUT</td><td>FUNC</td></tr>
</table>
The 6713 processor is used to control a device which is to be triggered every 5msec.</td><td>10
CO2
K3
5</td></tr>
</table>

	If the Timer 0 peripheral of the processor is used for the purpose, what are the values to be loaded into the Timer 0 Period and Timer 0 Count registers to perform the required operation?	
	Module - IV	
17	Draw a neat block schematic of the architecture of TMS320C66x series of processor. Briefly explain the role of each block.	14 CO2 K3
	OR	
18	Give an overview of the memory organisation in TMS320C66xx series of processors. Explain the role of various memory controllers and interfaces in relieving the CPU load..	14 CO3 K2
	Module - V	
19	Explain the role of OpenMP Application Programming Interface and Open Computing Language (OpenCL) in implementing DSP applications that requires multithreading. Explain with reference to a case study project that you have implemented.	14 CO3 K2
	OR	
20	Give an overview of the latest architectural trends for implementing DSP algorithms. How will you compare FPGA SoCs and DSP SoCs?	14 CO3 K3

SEMESTER VII

OPEN ELECTIVE

ECT415	MECHATRONICS	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Preamble: This course introduces students to the rapidly emerging, multi-disciplinary, and exciting field of Mechatronics.

Prerequisite: Nil

Course Outcome: After the successful completion of the course the student will be able to :

CO1	Understand the working principles of various sensors and actuators in Mechatronics systems and be able to choose the suitable one for the real world application
CO2	Formulate and simulate models of mechatronics systems
CO3	Explain the implementation of PLC in mechatronics applications
CO4	Explain the standard fabrication techniques and principle of operation of MEMS devices
CO5	Design and Analysis of commonly encountered mechatronics systems for real time application

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										
CO2	3	3										
CO3	3	3	2									
CO4	3	3										
CO5	3	3										

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the working principles of various sensors and actuators in Mechatronics systems and be able to choose the suitable one for the real world application

1. Illustrate the working of a strain gauged load cell
2. Explain the working of any one non-contact temperature measurement system
3. Explain the principle of operation and suggest two applications of Hall effect sensor in mechatronic systems.
4. With neat sketches explain the working of a double acting hydraulic actuator.
5. Design a hydraulic circuit to operate a winch fitted with a hydraulic motor. The motor should be run clockwise, counter clockwise and stopped. Use a manually operated valve.
6. Explain any two situations when pneumatic actuators are preferred over hydraulic ones.

Course Outcome 2 (CO2): Formulate models of mechatronics systems

1. Derive the mathematical model of a general electrical system and draw its analogy with a mechanical system.
2. Explain the working of a mechanical device using closed loop control system with the help of a suitable example.

Course Outcome 3 (CO3): Explain the implementation of PLC in mechatronics applications

1. Explain ‘latching’ in PLC logic with an example.
2. Illustrate the significance of Internal Relays in PLC program
3. Consider a pneumatic system with single-solenoid controlled valves and involving two cylinders A and B, with limit switches a–, a+, b–, b+ detecting the limits of the piston rod movements. Design a ladder programme with the requirement being when the start switch is triggered, the sequence A+, B+, A–,

10s time delay, B– occurs and stop at that point until the start switch is triggered again.

Course Outcome 4(CO4): Explain the standard fabrication techniques and principle of operation of MEMS devices

1. Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions.
2. Explain the criteria for choice of surface or bulk micromachining techniques in the design of micro systems.
3. Explain with block diagram the steps in LIGA process. State two advantages of LIGA process over other micro machining techniques.

Course Outcome 5 (CO5): Design and Analysis of commonly encountered mechatronics systems for real time applications

1. With the help of a neat sketch explain the different mechatronics modules used in automatic car park barrier system
2. Explain with a neat sketch the mechatronic implementation of a household weighing machine
3. With a neat sketch, explain the physical system and working of a pick and place robot.

SYLLABUS

MODULE I

Introduction to Mechatronics: Structure of Mechatronics system. Comparison between traditional and mechatronics approach. Sensors - Characteristics -Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute. Resolvers and synchros. Piezoelectric sensors. Acoustic Emission sensors. vibration sensors.Force and tactile sensors. Range finders: ultrasonic and light based range finders

MODULE II

Actuators: Hydraulic and Pneumatic actuators - Directional control valves, pressure control valves, process control valves. Rotary actuators. Development of simple hydraulic and pneumatic circuits using standard Symbols. Electrical drives: DC, AC, brushless, servo and stepper motors. Harmonic drive.Magnetostrictive actuators and piezoelectric actuators.

MODULE III

System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools.

Programmable Logic Controllers (PLC) –Basic structure, input/ output processing. Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes.

MODULE IV

Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Micromachining methods for MEMS -Surface and Bulk, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope.

MODULE V

Mechatronics in Robotics- choice of Sensors and Actuators. Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras. Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding.

Case studies of Mechatronics systems: Automatic camera, bar code reader, simple weighing machine, pick and place robot, automatic car park barrier system, automobile engine management system.

Text Books:

1.Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Person Education Limited, New Delhi, 2007

2.Ramachandran K. P., G. K. Vijayaraghavan, M. S. Balasundaram, Mechatronics: IntegratedMechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi, 2008.

3.Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Person Education ,Inc., New Delhi, 2006.

4.Devdas Shetty, Richard A. Kolk, "Mechatronics System Design", Thomson Learning Publishing Company, Vikas publishing house, Second edition, 2001.

Reference Books:

1. David G. Aldatore, Michael B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill Inc., USA, 2003.

2. Gordon M. Mair, Industrial Robotics, Prentice Hall International, UK, 1998.

3. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

4. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, John Wiley & Sons Ltd., England, 2006.

5. Bishop, Robert H. The Mechatronics Handbook-2 Volume Set. CRC press, 2002.

Course Plan Course Contents and Lecture Schedule

Module No	Topic	No. of Lectures
1	Introduction to Mechatronics: Structure of Mechatronics system. Comparison between traditional and mechatronics approach	2
	Sensors - Characteristics -Temperature, flow, pressure sensors.	1
	Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods	1
	Encoders: incremental and absolute. Resolvers and synchros.	1
	Piezoelectric sensors. Acoustic Emission sensors. vibration sensors, Force and tactile sensors	2
	Range finders: ultrasonic and light based range finders	1
2	Actuators: Hydraulic and Pneumatic actuators - Directional control valves	1
	pressure control valves, process control valves,	1
	Rotary actuators.	1
	Development of simple hydraulic and pneumatic circuits using standard Symbols.	1
	Electrical drives: DC, AC, and brushless, servo stepper motors	2
	Harmonic drive.	1
3	System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems.	2
	Typical elements of open and closed loop control systems.	1
	Adaptive controllers for machine tools.	1
	Programmable Logic Controllers (PLC) –Basic structure, input/ output processing.	1
	Programming: Timers, Internal Relays, Counters and Shift registers.	2
	Development of simple ladder programs for specific purposes	1
4	Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography	1
	Micromachining methods for MEMS -Surface and Bulk,	1
	Deep Reactive Ion Etching (DRIE) and LIGA processes.	1
	Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope	2
	Mechatronics in Robotics- choice of Sensors and Actuators.	1
	Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras.	1
	Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding.	2

5	Case studies of Mechatronics systems: Automatic camera, bar code reader, simple weighing machine, picks and place robot,	2
	automatic car park barrier system, automobile engine management system.	1
	Total	**35**

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B TECH DEGREE EXAMINATION
COURSE: ECT415 MECHATRONICS
TIME: 3 HRS MAX. MARKS: 100

PART A

Answer All Questions

1	Differentiate between absolute and incremental encoders	3
2	List six examples of temperature sensors	3
3	Explain how cushioning is achieved in pneumatic actuators with a sketch.	3
4	Mention any two differences between finite position and infinite position valves	3
5	List any 2 controlling factors in wet etching.	3
6	Sketch and label a MEMS based pressure sensor	3
7	What is latching? Draw a simple latched circuit	3
8	Write down the describing equations of basic mechanical building blocks	3
9	Illustrate the histogram processing technique for enhancing the image contrast	3
10	Bring out any 3 difference between CCD and CID camera.	3

PART B

Answer one question from each module. Each question carries 14 marks.

Module I

11(A)	Explain the working of an optical absolute encoder. How the number of tracks and sectors of absolute encoder is related to the resolution of the encoder?	*6*	
11(B)	Explain the structure of a mechatronics system. How is it different form the traditional approach?	*8*	
	OR		
12(A)	Explain the sensor characteristics to be considered when choosing a sensor for a mechatronics application	*8*	
12(B)	Compare the working of resolver and synchro	*6*	
	Module II		
13(A)	Develop a pneumatic circuit with standard symbols, to operate two cylinders in sequence. Explain its working.	*8*	

13(B)	Explain the constructional features and working of brushless DC motor	*6*	
	OR		
14(A)	Illustrate the working of Harmonic Drives with neat sketches	*8*	
14(B)	Design a hydraulic circuit to operate a winch fitted with a hydraulic motor. The motor should be run clockwise, counter clockwise and stopped. Use a manually operated valve.	*6*	
	Module III		
15(A)	Draw and explain the block diagram of a feedback control system.	*4*	
15(B)	Develop a PLC ladder program for the following sequence: Start a motor with push switch, and then after a delay of 90s, start a pump. When the motor is switched off, the pump will get switched off after a delay of 5s. Mention the logic used for each rung in the program to substantiate your answer.	*10*	
	OR		
16(A)	Explain how a PLC can be used to handle analog inputs?	*4*	
16(B)	Explain the model a fluid flow system with basic building blocks, clearly mention all assumptions	*10*	
	Module IV		
17(A)	Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions	*6*	
17(B)	Compare and contrast various micro manufacturing techniques	*8*	
	OR		
18(A)	Describe the various mechanical problems associated with surface micromachining	*6*	
18(B)	Explain the LIGA process associated with MEMS fabrication	*8*	
	Module V		
19(A)	With the help of a neat sketch explain the different mechatronics modules used in automatic car park barrier system	*10*	
19(B)	List any four applications of robotic vision systems	*4*	
	OR		
20(A)	Explain the working of Barcode reader with reference to the coding schemes. Mention the steps to process the digits in a barcode for a particular product. Develop the steps in a program for reading the barcode.	*10*	
20(B)	List the steps in thresholding technique in image processing	*4*	

ECT425	BIOMEDICAL INSTRUMENTATION	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Preamble: This course aims to give a brief introduction to human physiology and various instrumentations system used formeasurement and analysis of physiological parameters.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explainthe human anatomy and physiological signal Measurements.
CO 2	Illustrate various techniques used for measurement of Blood flow, blood pressure, and respiration rate and body temperature.
CO 3	Analyze the recording of ECG, EEG, EMG and ERG signals.
CO 4	Summarizethe concept of assisting and therapeutic devices.
CO 5	Describe the advances in medical imaging techniques.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3										
CO 2	3	3										
CO 3	3	3										
CO 4	3	3										
CO 5	3	3										

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	:	10marks
Continuous Assessment Test(2 numbers)	:	25 marks
Assignment	:	15marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):Introduction to human physiological system

1. Describe in detail the formation of resting potential and action potential in human body.
2. Briefly explain the physiological functions of human circulatory system
3. Briefly explain the physiological functions of human respiratory system

Course Outcome 2 (CO2):Bio potential electrodes and ECG

1. Describe different bio-potential electrode used to measure bioelectric events.
2. Explain in details the electro conduction system of a human heart. Illustrate the same with PQRS waveform of the ECG.

Course Outcome 3 (CO3):Measurement of blood pressure, blood flow and heart sound

1. With help of neat diagram explain how the oscilloetric method helps to measure blood pressure.
2. Write a short note on phonocardiography.

Course Outcome 4 (CO4):Measurement of EEG, EMG and Respiratory Parameters and therapeutic aid

1. Write a short note on tidal volume and vital capacity in breathing mechanism with neat diagram.
2. Explain heart lung machine with the help of neat diagram.
3. Explain spirometer for measurement of respiratory parameters
4. Explain standard 10-20 electrode placement system for EEG measurement.

Course Outcome 5 (CO5):Advances in Radiological Imaging andElectrical safety

1. Draw the block diagram and explain the principle of ultrasound imaging.
2. What are the biological effects of NMR imaging over CT?
3. What is the basic principle of CT? How image reconstruction is done in CT

Syllabus

Module 1

Introduction to human physiological system

Physiological systems of the body (brief discussion on Heart and cardio vascularsystem, Anatomy of nervous system, Physiology of respiratorysystems) problems encountered in biomedical measurements.Sources of bioelectric potentials – resting and action potentials -propagation of action potentials – bio electric potentials example(ECG, EEG, EMG, ERG, EOG, EGG etc.)

Module 2

Bio potential electrodes and ECG

Bio potential electrodes – theory – microelectrodes – skin surfaceelectrodes – needle electrodes – biochemical transducers –transducers for biomedical applications. Electro conduction system of the heart. Electro cardiograph –electrodes and leads – Einthoven triangle, ECG read out devices,ECG machine – block diagram.

Module 3

Measurement of blood pressure, blood flow and heart sound

Measurement of blood pressure – direct and indirect measurement– oscillometric measurement – ultrasonic method, measurement of blood flow and cardiac output, plethysmography –photo electricand impedance plethysmographs.Measurement of heart sounds –phonocardiography

Module 4

Measurement of EEG, EMG and Respiratory Parameters

Electro encephalogram –neuronal communication – EEGmeasurement, recording and analysis. Muscle response– Electromyogram (EMG) – NerveConduction velocity measurements- Electromyogram Measurements. Respiratory parameters – Spiro meter,pneumograph

Therapeutic Aid

Cardiac pacemakers – internal and external pacemakers,defibrillators.Ventilators, heart lung machine, hemodialysis, lithotripsy, infantincubators

Module 5

Advances in Radiological Imaging

X-rays- principles of generation, uses of X-rays- diagnostic stillpicture, fluoroscopy, angiography, endoscopy, and diathermy.Basic principle of computed tomography, magnetic resonanceimaging system and nuclear medicine system – radiation therapy.Ultrasonic imaging system - int roduction and basic principle.

Electrical safety

Electrical safety– physiological effects of electric current –shock hazards from electrical equipment –method of accident prevention, introduction to tele-medicine

Text Book

1. J. G. Webster, Medical Instrumentation, Application and Design, John Wiley and Sons

2. L. Cromwell, F. J. Weibell and L. A. Pfeiffer, Biomedical Instrumentation Measurements, Pearson education, Delhi, 1990.
3. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata Mc Graw Hill
4. J. J. Carr and J. M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education

References:

1. John Enderele , Susan Blanchard, Joseph Bronzino, Introduction to Biomedical Engg,Academic Press
2. Welkovitz, Biomedical Instruments, Theory and Design,Elselvier
3. Jerry L Prince, Jonathan M Links,Medical Imaging Signals & Systems,Pearson Education

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to human physiological system**	
1.1	Physiologicalsystems of the body (brief discussion on Heart and cardio vascularsystem, Anatomy of nervous system, Physiology of respiratorysystems) problems encountered in biomedical measurements.	3
1.2	Sources of bioelectric potentials – resting and action potentials	1
1.3	Propagation of action potentials – bio electric potentials example(ECG, EEG, EMG, ERG, EOG, EGG etc.)	2
2	**Bio potential electrodes and ECG**	
2.1	Bio potential electrodes –basic theory – microelectrodes – skin surfaceelectrodes – needle electrodes	2
2.2	Biochemical transducers –transducers for biomedical applications	1
2.3	Instrumentation for clinical laboratory: Bio Potential amplifiers-instrumentation amplifiers, isolation amplifiers, chopper amplifier	2
2.4	Electro conduction system of the heart, Electro cardiograph –electrodes and leads – Einthoven triangle,	2
2.5	ECG read out devices,ECG machine – block diagram.	1
3	**Measurement of blood pressure, blood flow and heart sound**	
3.1	Measurement of blood pressure – direct and indirect measurement– oscillometric measurement –ultrasonic method	2
3.2	Measurement of blood flow and cardiac output, plethysmography –photo electricand impedance plethysmographs	2
3.3	Measurement of heart sounds –phonocardiography	1
4	**Measurement of EEG,EMG and Respiratory Parameters, Therapeutic Aid**	
4.1	Electro encephalogram –neuronal communication – EEGmeasurement,	2

	recording and analysis	
4.2	Muscle response– Electromyogram (EMG) – NerveConduction velocity measurements- Electromyogram Measurements.	2
4.3	Respiratory parameters – Spiro meter,pneumograph	1
4.4	Cardiac pacemakers – internal and external pacemakers,defibrillators.	1
4.5	Ventilators, heart lung machine, hemodialysis, lithotripsy, infantincubators	3
5	**Advances in Radiological Imaging and Electrical Safety**	
5.1	X-rays- principles of generation, uses of X-rays- diagnostic stillpicture, fluoroscopy, angiography, endoscopy, diathermy	2
5.2	Basic principle of computed tomography, magnetic resonanceimaging system and nuclear medicine system	3
5.3	Ultrasonic imaging system - introduction and basic principle	1
5.4	Electrical safety– physiological effects of electric current –shock hazards from electrical equipment –method of accident prevention, introduction to tele- medicine	2

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B TECH DEGREE EXAMINATION

Course: ECT425 BIOMEDICAL INSTRUMENTATION

Time:3Hrs. **Max. Marks:100**

PART A
Answer All Questions

1 Enumerate different rhythms in EEG with frequency ranges. (3) K_1
2 Write short notes on the formation of bio potential signal (3) K_2
3 What is the difference between microelectrodes and needle electrodes? (3) K_2
4 With the help of a neat diagram of the Einthoven triangle, mention the necessity of the Einthoven triangle. (3) K_2
5 With the help of neat diagram explain ultrasonic method of blood pressure measurement. (3) K_2
6 Explain photoplethysmography. (3) K_2
7 Explain DC defibrillator with the help of neat diagram (3) K_2
8 What is infant incubator? How it works? (3) K_2
9 Mention any three applications of telemetry medicine. (3) K_1
10 Explain different methods of electric accident prevention. (3) K_2

PART B
Answer one question from each module. Each question carries 14 mark.

Module I

11(A) Describe in detail the formation of resting potential and action potential in human body (7) K_2
11(B) Briefly explain the physiological functions of human circulatory system (7) K_2

OR

12(A) Explain the problems encountered in the biomedical measurements (6) K_2
12(B) Briefly explain the physiological functions of human respiratory system. (8) K_2

Module II

13(A)	Describe different bio-potential electrode used to measure bioelectric events.	(6)	K_2
13(B)	Explain chopper amplifier with a neat diagram?	(8)	K_2

OR

14	Explain in details the electro conduction system of a human heart. Illustrate the same with PQRS waveform of the ECG	(14)	K_2

Module III

15(A)	With help of neat diagram explain how the oscillometric method helps to measure Blood Pressure.	(9)	K_2
15(B)	Write a short note on phonocardiography.	(5)	K_2

OR

16(A)	What is blood pressure? How it is measured?	(7)	K_2
16(B)	Explain with the help of neat diagram, impedance plethysmograph for measurement of blood flow	(7)	K_2

Module IV

17(A)	Write a short note on tidal volume and vital capacity in breathing mechanism with neat diagram.	(7)	K_2
17(B)	Explain heart lung machine with the help of neat diagram.	(7)	K_2

OR

18(A)	Explain spirometer for measurement of respiratory parameters	(7)	K_2
18(B)	Explain standard 10-20 electrode placement system for EEG measurement.	(7)	K_2

Module V

19(A)	Draw the block diagram and explain the principle of ultrasound imaging.	(8)	K_2
19(B)	What are the biological effects of NMR imaging over CT?	(6)	K_2

OR

20(A)	What is the basic principle of CT? How image reconstruction is done in CT	(8)	K_2
20(B)	How X-rays are produced? What are its properties?	(6)	K_2

ECT435	ELECTRONIC HARDWARE FOR ENGINEERS	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Preamble: This course will introduce students the exciting field of electronic hardware designing and prototyping. This will help students to innovate faster with electronics technology.

Prerequisite: Nil

Course Outcome: After the successful completion of the course the student will be able to

CO1	Identify various electronic components along with their specifications.
CO2	Design PCB using modern software tools.
CO3	Explain various testing procedures of electronic products.
CO4	Experiment and debug various software and hardware issues of a PC.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1									
CO2	3	2	2		3							
CO3	3	2	2				1					
CO4	3	3	2		1							

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Identify various electronic components along with their specifications.

1. Describe the colour coding of a 4 band resistor and find the colour code for a 470k resistor.
2. Compute the value of capacitors coded as 104 and 47K.

Course Outcome 2 (CO2): Design PCB using modern software tools.

1. Explain PCB design flow chart.
2. Design PCB layout of a regulated full wave rectifier circuit.

Course Outcome 3(CO3): Explain various testing procedures of electronic products.

1. Explain Acceptance testing and Type testing of a product.
2. Explain the testing procedure of a UPS.

Course Outcome 4 (CO4): Experiment and debug various software and hardware issues of a PC.

1. Why is it important to backup files securely? Explain the different types of backup techniques used.

SYLLABUS

MODULE I

Types of Components

Active Components: Diode, Transistor, MOSFET, LED, SCR, Integrated Circuits(ICs)
Passive Components: Resistor, Capacitor, Inductor, Transformer, Speaker/Buzzer.

Component Package Types

Axial lead, Radial Lead, Single Inline Package(SIP), Dual Inline Package (DIP), Transistor Outline (TO), Pin Grid Array (PGA), Metal Electrode Face (MELF), Leadless Chip Carrier (LCC), Small Outline Integrated Circuit (SOIC), Quad Flat Pack(QPF) and Thin QFP(TQFP), Ball Grid Array (BGA), Plastic Leaded Chip Carrier (PLCC).

Introduction & Brief History

What is PCB, Difference between PWB and PCB, Types of PCBs: Single Sided (Single Layer), Multi-Layer (Double Layer), PCB Materials.

MODULE II

Introduction to Electronic Design Automation (EDA)

Brief History of EDA, Latest Trends in Market, How it helps and why it requires, Different EDA tools, Introduction to SPICE and PSPICE Environment, Introduction and Working of PROTEUS

Introduction to PCB Design using OrCAD tool

PCB Designing Flow Chart: Schematic Entry, Net listing, PCB Layout Designing, Prototype Designing, Design Rule Check(DRC), Design For Manufacturing(DFM)

PCB Making: Printing, Etching, Drilling, Assembly of components

Introduction to PCB Design using PROTEUS tool

Assembly of simple circuits

MODULE III

Types of Product Testing

Acceptance Testing, Type Testing , Safety Testing, Safety, safety standards, safety certificates (CE, UL and VDE), Effect of environmental testing(refer to IEC 60068-1 for guidance)

Quality Standards

General awareness of quality standards, quality management systems & documentation, Awareness on ISO 17025, ISO 9001, Calibration and Uncertainty of measurements, Awareness on disposal of Electronic waste

MODULE IV

Testing Procedures: Switch Mode Power Supply - (Applicable Standard: IS 14886) Safety Testing(Earth Leakage current Test, Dielectric Test, Short Circuit Protection), Performance Testing (Line Regulation, Load Regulation for a variation of Load Min to Max load and vice versa)

Inverter, UPS - Inverter (Applicable Standard: IS 13314) Visual Inspection, High Voltage Test, Insulation Resistance Test, No Load Test, Output Test. UPS (Applicable Standard: IEC 62040-3) Steady State Input Voltage Tolerance, Output-Normal Mode – No Load, Full Load, Overload, Short Circuit

Safety Testing of Household Appliances: (Applicable Standard IS 302-1) Definitions and Terminology, Protection against Shock, Power Input and Current, Leakage Current and Electric Strength at Operating Temperature

Testing of Electric Iron/Electric Kettle: (Applicable Standard: IS 302-2) Ground bond resistance, Touch Current, Temperature (Thermostatic Cut off) Power Consumption.

MODULE V

Assembly and Maintenance of PC: Introduction to Computer - Difference between Hardware & Software, Booting concept, Different input and output devices/ cables, connectors, different types of motherboard, controller cards, Ethernet cards, Different types of RAM used in PC's.

Installation: BIOS setting, Formatting of Hard Disk, Installation of Windows, Off-line drive installation / online drive installation / Windows file repairing / BIOS password break / Administrative password break / Data recovery. Application Software Installation, Dual Booting Installation.

Assembly and dismantling: Assembly and dismantling of PCs front panel connection, servicing of computer, Type of Backup, Taking Backup files and fine tuning the system, running diagnostics tool, running of virus protection program.

Text Books:

1. C. Robertson. PCB Designer´s Reference. Prentice Hall, 2003.
2. D. Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall, 2003.
3. Advances in Electronic Testing, edited by D Gizopoulos, 2006

Reference Books:

1. C. Coombs, Printed Circuits Handbook, McGraw-Hill Professional, 6 edition, 2007.
2. Electronic Testing Handbook, McGraw-Hill, Dec 1993
3. PC Repair and Maintenance, A Practical Guide, Joel Rosenthal, Kevin Irwin, 2003
4. A Simple Guide to Computer Maintenance and Troubleshooting, AdaneNegaTarekegn, Alemu KumilachewTegegne, 2015

Course Plan Course Contents and Lecture Schedule

Module No	Topic	No. of Lectures
1	Active Components, Passive Components	3
	Packages: Axial lead, Radial Lead, SIP, DIP, TO,PGA, MELF, LCC, SOIC, QPF and TQFP, BGA, PLCC.	2
	PCB, Difference between PWB and PCB, Types of PCBs	1
2	Brief History of EDA, Latest Trends in Market, How? Why? Different EDA tools	1
	Introduction to SPICE and PSPICE Environment	1
	Introduction and Working of PROTEUS	2
	PCB Designing Flow Chart: Schematic Entry, Net listing, PCB Layout Designing, Prototype Designing, Design Rule Check(DRC), Design For Manufacturing(DFM)	2
	PCB Making: Printing, Etching, Drilling, Assembly of components	1
	Introduction to PCB Design using PROTEUS tool: Assembly of simple circuits	2
3	Acceptance Testing, Type Testing , Safety Testing, Safety, safety standards, safety certificates (CE, UL and VDE), Effect of environmental testing(refer to IEC 60068-1 for guidance)	3
	General awareness of quality standards, quality management systems & documentation, Awareness on ISO 17025, ISO 9001, Calibration and Uncertainty of measurements, Awareness on disposal of Electronic waste	1
4	SMPS Testing: (Applicable Standard: IS 14886) Safety Testing(Earth Leakage current Test, Dielectric Test, Short Circuit Protection), Performance Testing (Line Regulation, Load Regulation for a variation of Load Min to Max load and vice versa)	2
	Inverter (Applicable Standard: IS 13314) Visual Inspection, High Voltage Test, Insulation Resistance Test, No Load Test, Output Test. UPS (Applicable Standard: IEC 62040-3) Steady State Input Voltage Tolerance, Output-Normal Mode – No Load, Full Load, Overload, Short Circuit	2
	(Applicable Standard IS 302-1) Definitions and Terminology, Protection against Shock, Power Input and Current, Leakage Current and Electric Strength at Operating Temperature	1
	(Applicable Standard: IS 302-2) Ground bond resistance, Touch Current, Temperature (Thermostatic Cut off) Power Consumption.	1
	Difference between Hardware & Software, Booting concept	1
	Different input and output devices/ cables, connectors	1

5	Different types of motherboard, controller cards, Ethernet cards, Different types of RAM used in PC's.	1
	BIOS setting, Formatting of Hard Disk	1
	Installation of Windows, Off-line drive installation / online drive installation / Windows file repairing / BIOS password break / Administrative password break / Data recovery	2
	Application Software Installation, Dual Booting Installation.	1
	Assembly and dismantling of PCs front panel connection, servicing of computer	1
	Type of Backup, Taking Backup files and fine tuning the system, running diagnostics tool	1
	Running of virus protection program.	1

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B TECH DEGREE EXAMINATION
COURSE: ECT435 ELECTRONIC HARDWARE FOR ENGINEERS
TIME: 3 HRS MAX. MARKS: 100

PART A

Answer All Questions

1 Differentiate between active and passive components. 3
2 List any six type of electronic component packages. 3
3 State Moore's law and how it is related to electronic design automation. 3
4 What is a Gerber file? How it is used while making a PCB? 3
5 What does CE certification in electronic product mean? 3
6 What does ISO IEC stand for? 3
7 What do you mean by line regulation in a power supply? 3
8 How is leakage current of a device related to temperature? 3
9 Write the operations taking place during the booting of a system 3
10 Does Windows have a data recovery tool? If so, Explain. 3

PART B

Answer one question from each module. Each question carries 14 marks.

Module I

11(A) Compare Dual InlinePackage and Ball Grid Array IC Package. 8
11(B) Compute the value of capacitors coded as 103 and 4K7. 6

OR

12(A) Describe the colour coding of a 4 band resistor and find the colour code for a 2.2k resistor. 7
12(B) Make a note on different types of PCBs. 7

Module II

13(A)	Explain the process of manufacturing PCB from a PCB layout.	6
13(B)	Explain the relevance of Design Rule Check and Design For Manufacturing in PCB development.	8

OR

14(A)	Explain PCB design flow chart.	8
14(B)	Make a note on the tool PROTEUS and explain how it is different from OrCAD.	6

Module III

15(A)	Explain Acceptance testing and Type testing of a product.	8
15(B)	Explain different ways for disposal of Electronic waste.	6

OR

16(A)	What are uncertainties in measurements? How can you quantify it?	8
16(B)	What is IEC 60068-1 ? What properties of the specimen is it concerned about?	6

Module IV

17(A)	Explain the testing procedure of an SMPS.	10
17(B)	Explain the relevance of Insulation resistance test.	4

OR

18(A)	Explain the testing procedure of an Inverter.	10
18(B)	What does IS 302 standard part 1 refer to?	4

Module V

19(A)	Explain the different types of computer RAM with their pros and cons.	7
19(B)	What is the difference between an online drive installation and an offline drive installation in case of windows? Explain the installation process.	7

OR

20(A)	What are the various steps involved in Assembly and dismantling of PCs front panel connection?	8
20(B)	How can a user install two operating systems in a single computer? Explain.	6

ECT445	IOT AND APPLICATIONS	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Preamble: This course aims to develop skills in IoT system development and to apply the same in real life applications.

Prerequisite: ECT342 Embedded systems and ECT401Wireless communication (optional)

Course Outcomes: After the completion of the course,a student will be able to

CO 1 K1	Understand the IoT fundamentals and architecture modeling (K1)
CO 2 K2	Understand the smart things in IoT and functional blocks (K2)
CO3 K2	To understand the communication networks and protocols used in IoT. (K2)
CO 4 K3	To understand the cloud resources, data analysis and applications. (K3)
CO5 K3	To apply the IoT processes in embedded applications. (K3)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2		1			2				2
CO 2	3	3	3		3			2				2
CO 3	3	3	3		3			2	3			2

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	20	10	20
Understand	K2	30	20	40
Apply	K3	0	20	40
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the IoT fundamentals and architecture modeling (K1)

1. What is the definition of IoT and different characteristics of IoT

2. Define the architectural view of IoT and functional blocks

3. What are the different levels of IoT

Course Outcome 2 (CO2): Understand the smart things in IoT and functional blocks (K2)

1. What are the different smart things in IoT

2. How the communication is established among nodes and nodes and cloud.

3. What are the protocols that are used in IoT

Course Outcome 3 (CO3): To understand the communication networks and protocols used in IoT. (K2)

1. Differentiate between IEEE standard protocols

2. Explain the advantages of next generation IP based protocols used in ioT

3. Define different layers used in embedded protocols

Course Outcome 4 (CO4): To understand the cloud resources, data analysis and applications. (K3)

1. Explain how data is stored in IoT environment and processed

2. How to use cloud resources and different options available

3. How end devices can be used to control input and output devices

Course Outcome 5 (CO5): To apply the IoT processes in embedded applications. (K3)

1. What are the security and privacy concerns of IoT

2. Explain the typical applications of IoT.

3. Describe the processes involved in implementing a smart city.

SYLLABUS

Module 1 (7 Hours)
Introduction to IoT technology: Definitions and Characteristics of IoT, IoT Architectural View, Physical Design of IOT, Logical Design of IoT- IoT Functional blocks, IoT communication models, IoT Enabling Technologies, IoT Levels & Deployment Templates.

Module 2 (7 Hours)
IoT and M2M- M2M, Difference between IoT and M2M, SDN and NFV for IoT, Smart Objects: The “Things” in IoT: Sensors, Actuators, and Smart Objects, Sensor Networks- Wireless Sensor Networks (WSNs), Communication Protocols for Wireless Sensor Networks- Connecting Smart Objects- Communication Criteria.

Module 3 (7 Hours)

Unified Data Standards –Protocols –IEEE 802.15.4 -The Physical Layer, The Media-Access Control Layer, Uses of 802.15.4 ,The Future of 802.15.4: 802.15.4e and 802.15.4g–Modbus–ZigBee-Zigbee Architecture- LoRaWAN -Standardization and Alliances, Physical Layer, MAC Layer, Topology, LTE-M, NB-IoT-Network layer –The next generation: IP-based protocols - 6LoWPAN and RPL, Overview of the 6LoWPAN Adaptation Layer .

Module 4 (9 hours)
Data Collection, storage and computing Using a Cloud Platform-Introduction, Cloud Computing Paradigm for Data Collection, Storage and Computing-Cloud Computing Paradigm, Cloud Deployment Models-Everything as a Service and Cloud Service Models-SaaS, PaaS, IaaS, DaaS. Cloud based platforms-XIVELY, NIMBITS.

IoT Physical Devices & Endpoints-IoT Device-Building blocks –Raspberry-Pi -Board-Linux on Raspberry-Pi-Raspberry-Pi Interfaces (serial, SPI, I2C). Raspberry Pi interfacing and programming examples using python (LED, switch, sensor, serial, SPI, I2C devices). Controlling GPIO outputs and displaying sensor readings using web interface/cloud (Python programming is required only for assignments and projects and not for examinations. Other end nodes and platforms can also be used).

Module 5 (6 Hours)

IoT privacy, security and vulnerabilities solutions, vulnerabilities, security requirements, threat analysis, security tomography, layered attacker model, Identity management, access control, secure message communication.

Smart and Connected Cities-An IoT Strategy for Smarter Cities-Vertical IoT Needs for Smarter Cities, Global vs. Siloed Strategies-Smart City IoT Architecture-Street Layer, City Layer, Data Center Layer, Services Layer- Smart City Security Architecture - Smart City Use-Case Examples – Street lighting, smart parking, smart traffic and air pollution monitoring

Maximum 35 /36 Hours

Text Books

1. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on- Approach)”, 1st Edition, VPT, 2014 (Module1,2,4)
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, ―IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017. (Module2,3,5)
3. Rajkamal, “Internet of Things : Architecture and Design Principles”, McGraw Hill (India) Private Limited.
4. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, SimonMonk, O'Reilly (SPD), 2016, ISBN.

Reference Books/Papers

1. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things –Key applications and Protocols”, Wiley, 2012 (Module 3)
2. Al-Fuqaha et al. Internet of things: A survey on enabling technologies, protocols, and applications. IEEE Communications Surveys & Tutorials (2015), pp. 2347- 2376.
3. The Internet of Things (The MIT Press Essential Knowledge series) Paperback – March 20, 2015 by SamuelGreengard
4. The Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, OviduVermesan and Peter Friess, RiverPublishers.
5. Internet of Things - From Research and Innovation to Market Deployment-RIVER PUBLISHERS, PETER FRIESS, OVIDIU VERMESAN (Editors)
6. Internet of Things Security and Data Protection, Sébastien Ziegler,Springer

International Publishing 2019.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Internet of Things- 7Hrs**	
1.1	Introduction, definition and characteristics	1
1.2	IoT architectural view, functional blocks	2
1.3	IoT Communication models, enabling technologies	2
1.4	IoT deployment levels	2
2	**Essential components of IoT- 7Hrs**	
2.1	IoT and M2M	2
2.2	Smart objects	2
2.3	Wireless sensor networks	3
3	**IoT protocols- 7Hrs**	
3.1	IEEE 802.15.4 protocols	2
3.2	Zigbee	1
3.3	6LoWPAN and RPL	2
3.4	LoraWAN, LTE-M and NB-IoT	2
4	**Cloud storage and Programming the end device- 9Hrs**	
4.1	Data storage and computation	3
4.2	Physical devices and end points	2
4.3	Raspberry pi programming	4
5	**Security and Applications-6 Hrs**	
5.1	Security and Privacy	2
5.2	Smart city application	2
5.3	Use case examples	2

Simulation Assignments:

1. At least one assignment should be programming examples (python or any other language) using Raspberry pi (Other options like arduino, node mcu etc. can also be used) Include I/O interfacing, SPI, I2C, serial, sensor interfacing and web interface.
2. Another assignment shall be an IoT system implementation of mini project consisting of a sensor, processing device, communication device and cloud storage (This can be individual or group projects). Mini project is essential for understanding the concepts of IoT.
3. Mini project can be done in the following areas.
    a) Smart city (b) Weather monitoring system (c) air pollution monitoring (d) Smart parking (e) smart traffic (f) any other application/s where sensors/actuators devices are used.
4. Programming and mini project are essential for understanding the concepts of IoT.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, (Model Question Paper)

Course Code: ECT445

Course Name: IoT AND APPLICATIONS

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer for all questions. Each Question Carries 3 marks)

1. List any five characteristics of IoT
2. What are the IoT enabling technologies?
3. What is a wireless sensor network?
4. What are the limitations of smart objects in WSNs??
5. Explain the need for IP optimization in IoTs?
6. What are the transmission modes used in modbus?
7. What are the 4 different cloud deployment models? Explain
8. What is cloud computing? Explain.
9. List the five functional units of security
10. What is message integrity? How it is checked? [10 X 3 = 30 Marks]

PART – B

(Answer one question from each module; each question carries 14 Marks)

Module – I

11. (a) Write a note on physical design of IoT. [06 Marks]
(b) Give a detailed description of the link layer, network layer, transport layer and application layer protocols. [08 Marks]

OR

12. (a) What are the functional blocks of IoT? Explain? [07 Marks]
(b) Discuss different communication models used in IoT. [07 Marks]

Module – II

13. (a) What are the differences between IoT and M2M? [07 Marks]
(b) What are the issues of conventional networking architectures? How is it solved in SDN? [07 Marks]

OR

14. (a) What are smart objects? What are their characteristics and the trends in smart objects? [07 Marks]
(b) What are the characteristics and attributes to be considered for connecting smart objects ? [07 Marks]

Module – III

15. (a) Explain IEEE 802.15.4 physical layer, MAC layer and security implementation with the help of frame formats. [09 Marks]
(b) What are the modifications included in IEEE 802.15.4 e and g versions as compared to IEEE 802.15.4? [05 Marks]

OR

16. (a) With the help of a diagram explain the Zigbee protocol architecture. [07 Marks]
(b) Explain LoraWAN architecture. Give a detailed description of the physical layer and MAC layer of LoraWAN [07 Marks]

Module – IV

17. (a) Write a note on different cloud service models [06 Marks]
(b) What is virtualization in cloud computing? Explain the features, advantages and concerns of cloud computing. [08 Marks]

OR

18. (a) With the help of a diagram explain the basic building blocks of an IoT device [07 Marks]

    (b) Explain cloud based data collection, storage and computing services provided by XIVELY cloud platform. [07 Marks]

Module – V

19. (a) What is security and Privacy? List the 10 vulnerabilities of IoT. [07 Marks]

    (b) Explain the layered attacker model. [07 Marks]

OR

20. (a) With the help of a diagram explain the 4 layer smart city architecture. [07 Marks]

    (b) Write a note on street lighting architecture with the help of a diagram [07 Marks]

ECT455	ENTERTAINMENT ELECTRONICS	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Prerequisite: Nil

Course objectives: The course aims to provide broad knowledge on various industry standards, algorithms and technologies used to carry out digital audio and video broadcasting in infotainment industry.

Course Outcomes: After the completion of the course the student will be able to

CO1 K2	Understand packetized streaming of digital media happens in the field of infotainment industry.
CO2 K2	Realise the critical aspects of DVB and DAB standards used for media broadcasting in infotainment industry.
CO3 K3	Apply video coding/compression algorithms are used to produce high-definition video in MPEG-4 standard.
CO4 K2	Understandmodern display technologies for video reproduction.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										2
CO 2	3	3			2						2	2
CO 3	3	3			3						2	2
CO 4	3	3										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember K1	10	10	20
Understand K2	40	30	60
Apply K3		10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. Mark patterns are as per the syllabus with 100 % for theory.

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain packetized streaming of digital media happens in the field of infotainment industry.

1. Discuss MPEG-2 standards for streaming multimedia data and aspects of synchronization, accessing scrambled programs and program synchronization.

Course Outcome 2 (CO2: Discuss the critical aspects of DVB and DAB standards used for media broadcasting in infotainment industry.

1. Describe the existing standards and features for modulation and demodulation schemes related with DAB, various types of DVB and DRM.

Course Outcome 3 (CO3): Explain how the video coding/compression algorithms are used to produce high-definition video in MPEG-4 standard.

1. Understanding quantization, DCT, differential PCM for MPEG-4 video compression.
2. Developing audio sub-band coding methods based on psychoacoustic model of human ear.

Course Outcome 4 (CO4): Discuss modern display technologies for video reproduction.

1. Explain the basic principles of video reproduction and display technology such as CRT, LCD, plasma and OLED

SYLLABUS

Module	Course contents	Hours
I	**Brief Review of Analog Television:** Scanning, Horizontal and Vertical Synchronization, Color information, Transmission methods. NTSC and PAL standards. **Digital media streaming:** Packetized elementary stream of audio-video data, MPEG data stream, MPEG-2 transport stream packet, Accessing a program, scrambled programs, program synchronization. PSI, Additional (Network information and service description) information in data streams for set-top boxes.	7
II	**Digital Video Broadcasting (DVB):** Satellite TV broadcasting – DVB-S Parameters, DVB-S Modulator, DVB-S set-top box, DVB-S2. Cable TV broadcasting – DVB-C Standard, DVB-C Modulator, DVB-C set-top box. Terrestrial TV broadcasting – DVB-T Standard, DVB-T Modulator, DVB-T Carriers and System Parameters, DVB-T receiver. Broadcasting for Handheld devices – DVB-H Standard DVB tele-text, DVB subtitling system.	7
III	**Digital Audio Broadcasting (DAB):** Comparison of DAB with DVB. Physical layer of DAB. DAB Modulator, DAB Data Structure, DAB single frequency networks, Data broadcastingusing DAB. Digital Radio Mondiale (DRM): Transmitter and receiver, Data rates.	6
IV	**High Definition Video and Audio:** Pixel resolution, Comparison with Standard Definition TV, Review of Discrete Cosine Transforms (DCT), Video Compression - Quantization levels, Horizontal/Vertical blanking interval, Vertical Color resolution, DPCM of moving pictures, DCT, Run-length coding. MPEG-4 Video coding. Psycho-acoustic model, Principle of audio coding, Sub-band coding in MPEG layer 1 and 2, MPEG Layer 3 and Dolby Digital, Multichannel sound.	8
V	**Display Technology:** Block diagram of video reproduction system in a TV, Cathode Ray tubes, Basic principle of Plasma displays, LC displays, Light-emitting diode displays, Field emission displays, Organic light emitting device displays.	7

	Television of future: Holographic TV, Virtual Reality, Augmented Reality.	

Textbooks

1. W. Fischer, Digital Video and Audio Broadcasting Technology: A Practical Engineering Guide (Signals and Communication Technology), Springer, 2020
2. Lars-Ingemar Lundström, Understanding Digital Television An Introduction to DVB Systems with Satellite, Cable, Broadband and Terrestrial TV, Focal Press, Elsevier, 2006.
3. K F Ibrahim, Newnes Guide to Televeision and Video Technology, Newnes, 2007.
4. Jiun-Haw Lee, David N. Liu, Shin-Tson Wu, Introduction to Flat Panel Displays, Wiley, 2008.

References

1. C. Poynton, "Digital Video and HD Algorithms and Interfaces,"Morgan Kaufmann, 2012.
2. Wolfgang Hoeg, Thomas Lauterbach, Digital audio broadcasting: principles and applications of DAB, DAB+ and DMB, Wiley, 2009.
3. John Watkinson, Introduction to Digital Audio, Focal Press, 1994.
4. John Watkinson, Art of Digital Video, Focal Press, 2008.
5. John Watkinson, Introduction to Digital Video, Focal Press, 2001.

Course content and Lecture plan

No	TOPIC	No of Lectures
	MODULE 1	
1.1	Analog Television, Scanning, Horizontal and Vertical Synchronization, Colour information, NTSC and PAL standards.	2
1.2	Analog TV Transmission	1
1.3	Packetized elementary stream. MPEG data stream, MPEG-2 transport stream packet	2
1.4	Accessing a program, scrambled programs, program synchronization. Program Specific Information	1
1.5	Additional (Network information and service description) information in data streams	1
	MODULE II	
2.1	Introduction to DVB, DVB-S Parameters, DVB-S Modulator, DVB-S set-top box, DVB-S2.	2
2.2	DVB-C Standard, DVB-C Modulator, DVB-C set-top box.	1
2.3	DVB-T Standard, DVB-T Modulator, DVB-T Carriers and System Parameters, DVB-T receiver.	2

2.4	Broadcasting for Handheld devices – DVB-H Standard	1
2.5	DVB teletext, DVB subtitling system.	1
	MODULE III	
3.1	Introduction to DAB, Comparison of DAB with DVB.	1
3.2	Physical layer of DAB. DAB Modulator, DAB Data Structure, DAB single frequency networks, Data broadcastingusing DAB.	3
3.3	Digital Radio Mondiale (DRM): Transmitter and receiver, Data rates.	2
	MODULE IV	
4.1	HDTV versus SDTV,Pixel resolution,	1
4.2	Review of Discrete Cosine Transforms (DCT)	1
4.3	Video Compression - Quantization levels, Horizontal/Vertical blanking interval, Vertical Colour resolution, DPCM of moving pictures, DCT, Run-length and Huffman coding. MPEG-4.	3
4.4	Psychoacoustic model, Principle of audio coding	1
4.5	Subband coding in MPEG layer 1 and 2	1
4.6	MPEG Layer 3 and Dolby Digital, Multichannel sound	1
	MODULE V	
5.1	Block diagram of video reproduction system in a TV	1
5.2	Cathode Ray tubes	1
5.3	Basic principle of Plasma displays, LC displays, Light-emitting diode displays, Field emission displays, Organic light emitting device displays.	3
5.4	Holographic TV, Virtual Reality, Augmented Reality.	2

Simulation Assignments (optional)

1 Realise live streaming of audio and video data using Python/MATLAB-Simulink or other platforms.
2 Realise a basic video compression scheme from basic principles studied from this course using Python/MATLAB. Obtain the performance parameters before and after comparison.
3 Simulate a DAB transmitter and receiver system using MATLAB/Simulink and study its Performance under Gaussian noise.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

VII SEMESTER B. TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT455

Course Name: ENTERTAINMENT ELECTRONICS

Max. Marks: 100 Duration: 3 Hours

	PART A **Answer all questions, each carries3marks**	
1.	Compare interlaced scanning and progressive scanning.	3
2	What is the maximum video signal frequency in PAL TV system? How is it obtained?	3
3	Mention the differences between DVB-C and DVB-S modulators.	3
4	A DVB-C coaxial system uses 64QAM modulation with symbol rate 69 Mega symbols/s. Roll-off factor used is 0.15. Compute the gross data rate.	3
5	Write short notes on coded OFDM.	3
6	What is the function of the Ensemble Transport Interface(ETI) in DAB system? Explain.	3
7	With a suitable example, illustrate run length encoding.	3
8	Define discrete cosine transform. How is it important in signal compression?	3
9	List the essential features of LCD screen compared to CRT/plasma displays.	3
10	Differentiate between virtual reality and augmented reality.	3
		10x3=30
	PART B **Answer any one full question from each module carries14marks.**	
	MODULE 1	
11a	Sketch the frequency spectrum of typical PAL TV system. Show the bandwidth, vision carrier, sound carrier and guard band frequencies.	7
11b	Explain the packetized elementary streams in MPEG	7
	OR	
12a	What is the need of vertical sync pulses and equalising pulses in PAL	7

	TV system? Explain with necessary diagrams.	
12b	Explain how program synchronisation is achieved in MPEG-2.	7
	MODULE II	
13a	With a block diagram explain DVB-C modulator.	7
13b	With a block diagram explain the basic units in digital receiver/decoder set-top-box in digital TV.	7
	OR	
14a	How DVB-T modulator can be implemented using IFFT blocks? Explain.	7
14b	Explain the requirements of a standard on digital video broadcasting for hand held mobile terminals.	7
	MODULE III	
15a	Explain the details of physical layer in DAB.	7
15b	Compare DAB and DVB.	
	OR	
16a	With a block diagram explain DAB modulator and transmitter.	7
16b	Describe the essential features of Digital Radio Mondiale.	7
	MODULE IV	
17a	Explain subband coding technique in layers I,II of MPEG1, MPEG 2.	7
17b	With relevant details illustrate how the principle differential pulse code modulation can be applied in MPEG 1 and MPEG 2video compression methods.	7
	OR	
18a	Explain a technical model for human ear, which will help in audio coding. How this principle can be applied for developing an audio coding scheme for compression.	7
18b	Explain any one type of transform coding principle for video compression.	7
	MODULE V	
19a	With a diagram explain the principle of working of a two layer organic LED device.	7
19b	Explain the advantages and disadvantages of plasma displays.	7
	OR	
20a	With a neat diagram explain the working of any one type of cathode ray tube.	7
20b	Explain the applications of virtual reality technology.	7

SEMESTER VII

MINOR

ECD481	**MINIPROJECT**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		PWS	**0**	**0**	**3**	**2**

Preamble: The course aims

- To estimate the ability of the students in transforming the theoretical knowledge studied in to a working model of an electronic system
- For enabling the students to gain experience in organisation and implementation of small projects.
- Design and development of Small electronic project based on hardware or a combination of hardware and software for electronics systems.

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex electronic system with practical applications, this should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

Course Outcomes

CO1	Be able to practice acquired knowledge within the selected area of technology for project development.
CO2	Identify, discuss and justify the technical aspects and design aspects of the project with a systematic approach.
CO3	Reproduce, improve and refine technical aspects for engineering projects.
CO4	Work as a team in development of technical projects.
CO5	Communicate and report effectively project related activities and findings.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	2		3						2
CO 2	3	3	3	2		3					3	2
CO 3	3	3	3	2		3					3	2
CO 4								3		3	3	2
CO 5								3	3	3		2

Evaluation

The internal evaluation will be made based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, Academic coordinator for that program, project guide/coordinator.

The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	1 hour

Split-up of CIE

Component	Marks
Attendance	10
Marks awarded based on guide's evaluation	15
Project Report	10
Evaluation by Committee	40

Split-up of ESE

Component	Marks
Level of completion	10
Demonstration of functionality	25
Project Report	10
Viva-voce	20
Presentation	10

SEMESTER VII

HONOURS

ECT495	RF MEMS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course introduces students to the rapidly emerging, area of MEMS with special emphasis on its applications in RF and wireless engineering

Prerequisite: Nil

Course Outcome: After the successful completion of the course the student will be able to

CO1	Understand the various fabrication techniques and actuation mechanisms used in RF -MEMS design and apply them in practical situations
CO2	Explain the principle of operation of MEMS switches
CO3	Understand the construction and principle of operation of micromachined inductors and capacitors
CO4	Understand the construction and principle of operation of micromachined RF filters and phase shifters
CO5	Analyse the performance improvement of antenna due to micromachining techniques.
CO6	Identify the constraints in integration and packaging of RF MEMS devices

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										
CO2	3	3										
CO3	3	3										
CO4	3	3										
CO5	3	3										
CO6	3	3					2					

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the various fabrication techniques and actuation mechanisms used in RF -MEMS design and apply them in practical situations

1. Explain why Silicon evolved as the ideal substrate material for MEMS fabrication.
2. Explain any two thin film deposition processes as applied to MEMS fabrication.
3. Discuss the various fabrication challenges associated with surface micromachining.
4. List five applications of RF MEMS in our daily lives.
5. With a neat sketch explain the principle of operation of a MEMS piezoelectric actuator.

Course Outcome 2 (CO2): Explain the principle of operation of MEMS switches

1. Explain the various parameters to be considered in the design of RF switches
2. With neat sketches explain the construction and working of a shunt type RF MEMS switch

Course Outcome 3(CO3): Understand the construction and principle of operation of micromachined inductors and capacitors

1. With neat sketches explain one application each of gap-tuning and area tuning capacitors
2. Explain how inductance of micro machined inductors can be varied

Course Outcome 4 (CO4): Understand the construction and principle of operation of micromachined RF filters and phase shifters

1. Sketch and explain the principle of operation of a surface acoustic wave filter
2. Sketch and explain the principle of operation of any two types of micromachined Phase Shifters

Course Outcome 5 (CO5): Analyse the performance improvement of antenna due to micromachining techniques

1. Analytically justify the need for micro machined antennas. How can its performance be improved?
2. Explain the basic characteristics and design of microstrip antenna

Course Outcome 6 (CO6): Identify the constraints in integration and packaging of RF MEMS devices

1. List the types of MEMS packages
2. Explain the reliability issues associated with RF MEMS packaging

SYLLABUS

MODULE I

Introduction: RF MEMS for wireless applications, MEMS technology and fabrication, mechanical modeling of MEMS devices, MEMS materials and fabrication techniques-surface micromachining, Bulk micromachining, LIGA, Actuation Mechanisms in MEMS, Piezoelectric, Electrostatic, Thermal,Magnetic.

MODULE II

MEMS Switches: Introduction to MEMS switches; Capacitive shunt and series switches: Physical description, circuit model and electromagnetic modeling; Techniques of MEMS switch fabrication and packaging; Design of MEMS switches

MODULE III

Inductors and Capacitors: Micromachined passive elements; Micromachined inductors: Effect of inductor layout, reduction of stray capacitance of planar inductors, folded inductors, variable inductors and polymer-based inductors; MEMS Capacitors: Gap-tuning and area-tuning capacitors, dielectric tunable capacitors.

MODULE IV

RF Filters and Phase Shifters: Principle of operation of - micromachined filters, surface acoustic wave filters, micromachined filters for millimeter wave frequencies; Various types of MEMS phase shifters; Ferroelectric phase shifters

MODULE V

Micromachined antennas: Micromachining techniques to improve antenna performance, reconfigurable antennas.

Integration and Packaging: Role of MEMS packages, types of MEMS packages, module packaging, packaging materials and reliability issues.

Text Books:

1.Vijay Varadan, K. J. Vinoy, K. A. Jose, "RF MEMS and Their Applications", Wiley, 2003.

2. Hector J. De Los Santos,."RF MEMS Circuit Design for Wireless Applications", Artech House, 2002

References

1.Gabriel M. Rebeiz, "RF MEMS: Theory, Design, and Technology", Wiley, 2003

2.Eun Sok kim "Fundamentals of Micro electro mechanical Systems (MEMS)" McGraw Hill

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to RF MEMS:** RF MEMS for wireless applications, ,	1
	MEMS technology and fabrication	1
	mechanical modeling of MEMS devices,	2
	MEMS materials	2
	MEMS fabrication techniques – Surface - Bulk Micromachining and LIGA	2
	Actuation Mechanisms in MEMS, Piezoelectric, Electrostatic, Thermal,Magnetic.	2
2	Introduction to MEMS switches	2
	Capacitive shunt and series switches: Physical description	2
	circuit model and electromagnetic modeling;	2
	Techniques of MEMS switch fabrication and packaging	2
	Design of MEMS switches	2
3	Inductors and Capacitors**:** Micromachined passive elements;	3
	Micromachined inductors: Effect of inductor layout reduction of stray capacitance of planar inductors	2
	folded inductors, variable inductors and polymer-based inductors	2
	MEMS Capacitors: Gap-tuning and area-tuning capacitors, dielectric tunable capacitors	2
4	RF Filters and Phase Shifters:Principle of operation - micromachined filters,	2
	surface acoustic wave filters,	2
	micromachined filters for millimeter wave frequencies	2
	Various types of MEMS phase shifters; Ferroelectric phase shifters	2

5	Micromachined antennas: Micromachining techniques to improve antenna performance	2
	reconfigurable antennas.	2
	Integration and Packaging: Role of MEMS packages, types of MEMS packages	2
	module packaging, packaging materials and reliability issues.	2

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B TECH DEGREE EXAMINATION
COURSE: ECT495 RF MEMS

Time: 3 Hrs **Max. Marks: 100**

PART A

Answer All Questions

1	List three applications of MEMS technology in RF communication devices	3
2	Explain why electrostatic actuation technique is preferred over magnetic actuation in MEMS devices.	3
3	List the advantages of cantilever switches	3
4	Mention the differences between series and shunt RF MEMS switches	3
5	Explain one key parameter used in the design of MEMS inductors	3
6	Which of the two MEMS capacitors - Area tuning and Gap tuning is preferred and why?	3
7	Explain the significance of Q factor in the design of MEMS filters	3
8	Explain one practical application of Phase shifters	3
9	What are the parameters to be optimised in the design of micro strip antennas	3
10	State three reliability issues in RF Microsystems packaging	3

PART B

Answer one question from each module. Each question carries 14 marks.

Module I

11(A) Design a capacitor-based MEMS device for actuating the air-bag system in a passenger car. Show relevant diagrams. Compare it with a piezo electric based MEMS. *7*

11(B) With neat sketches explain the LIGA process. Also mention two applications of the same. *7*

OR

12(A) With neat sketches explain the steps in fabrication of two structures using bulk and surface micromachining. *8*

12(B) An ink jet printer needs a fast and efficient mechanism for ink dispensing. *6*

Design a MEMS based system for this application. Give required sketches and equations.

Module II

13(A) Explain the various parameters to be considered in the design of RF switches. *7*

13(B) With relevant equations explain how the pull-in voltage of cantilever beam type switches can be reduced. What are the integration and biasing issues for RF switches *7*

OR

14(A) With neat sketches explain the construction and working of a shunt type RF MEMS switch. Explain the RF MEMS design flow with a neat sketch. *10*

14(B) List the approaches used for low actuation voltage switching. *4*

Module III

15(A) With neat sketches describe the fabrication process of any micro machined inductor *7*

15(B) Explain how the capacitance can be varied for micro machined capacitors. *7*

OR

16(A) With neat sketches explain one application each of gap-tuning and area tuning capacitors. *6*

16(B) With the help of relevant equations show how inductance is varied in micro machined inductors. *8*

Module IV

17(A) Explain the realization of micro machined filters using resonators. *7*

17(B) Explain the principle of operation of any two types of phase shifters *7*

OR

18(A) With neat sketches explain the working of micromechanical filters using comb drives. *10*

18(B) Detailing the basic principles, mention two applications of MEMS phase shifters *4*

Module V

19(A) Explain the significance of reconfigurable antennas in satellite communication *7*

19(B) Discuss the reliability issues of MEMS packaging materials. *7*

OR

20(A) Explain the need for micro machined antennas with analytical justification. How can its performance be improved? *6*

20(B) Explain different types of MEMS packages *8*

ECT497	DESIGN AND ANALYSIS OF ANTENNAS	CATEGORY	L	T	P	CREDIT
		VAC	4	0	0	4

Preamble: This course aims to impart knowledge on the basic parameters, matching techniques, design and working of various broad band antennas, practical antennas, antenna arrays and its radiation patterns. It also introduces standard software to design antennas with a set of given specifications.

Prerequisite: ECT 302 ELECTROMAGNETICS, ECT 401 MICROWAVE AND ANTENNAS

Course Outcomes: After the completion of the course the student will be able to:

CO1-K2	Understand the concept of radiation mechanism, antenna parameters and antenna matching techniques.
CO2-K2	Illustrate the far filed pattern of different types of antennas.
CO3-K3	Analyze different types of broad band antennas and its radiation patterns.
CO4-K3	Design of various practical antennas, antenna arrays and field patterns.
CO5-K3	Familiarize Antenna Design Software and design microstrip patch antenna.

Mapping of course outcomes with program outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2		1								2
CO2	3	2	2	1	2							2
CO3	3	2	3	2	3							2
CO4	3	2	3	2	3							2
CO5	3	2	3	2	3							2

Assessment Pattern:

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember			
Understand K2	20	20	40
Apply K3	30	30	60
Analyse			
Evaluate			
Create			

Mark distribution:

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 Hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

Maximum Marks: 100 **Time: 3 hours**

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 subdivisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the steps involved in the design of a T-match circuit.
2. With the help of neat sketches explain the working of a Rhombic Antenna and its features.
3. Explain omega match.
4. Calculate the Directivity of an antenna with field pattern given by,

$$E = E_{\vartheta} = \frac{\mu}{4\pi r}\,\mathrm{e}^{\text{-jkr}}\cos^2\phi\sin^2\theta, 0 \le \theta \le \pi, 0 \le \phi \le 2\pi$$

5. Derive the vector potential for an electric current source J.
6. Explain the optimum design of rhombic antenna.
7. Derive expressions for the Far Field components and Radiation Resistance and Directivity of a half wave dipole antenna.

Course Outcome 2 (CO2):

1. Explain the axial mode and normal mode of operation of a helical antenna.
2. Derive the expressions for the fields radiated by a circular loop antenna.
3. Explain field equivalence principle and give the step to form an equivalent and aperture problem.
4. Explain solution of Hallen’s Integral equation using delta gap model.

Course Outcome 3 (CO3):

1. Discuss about any two feeding techniques for Microstrip Antenna.
2. List the important features of a Yagi-Uda Antenna.
3. Design an aperture antenna, with uniform illumination, so that the directivity is maximized at an angle $30^0$from the normal to the aperture. Determine the optimum dimension and its associated directivity when the aperture is (i) square (ii) circular.
4. Design a Microstrip patch antenna for 2.4 GHz. The patch substrate has a dielectric of 2.2 and with height 2.2 mm.

Course Outcome 4 (CO4):

1. Explain the working of Lens Antenna. What do man by zoning in Lens Antenna?
2. Design a broad side Dolph-Tscebycheff array of 10 elements with spacing *d*between the elements and with a major to minor lobe ratio of 26 dB. Find the excitation coefficients and form the array factor.
3. Derive general expression for array factor of non-isotropic antennas.
4. Derive expression for array factor of N isotropic sources for end-fire array and also the expression for major lobe, minor lobes and Nulls of the array.
5. Calculate the half-power beam width and directivity for the Dolph-Tchebyscheff array of lobe ratio 26 dB for a spacing of $\lambda/2$ between the elements.
6. Design an 8 element broadside array of isotropic sources having $\lambda/2$ spacing between the elements .The pattern is to be optimized with a side lobe -25dB down the minor lobe maxima.

Course Outcome 5 (CO5):

1. Design a rectangular patch antenna operates at 5.5GHz.Use FR4/Duroid RT5870 as the substrate of patch antenna. Determine the thickness from data sheet. Write a procedure in order to design desired antenna by giving all equations , dimensions and simulation results (using MATLAB/HFSS/CST Microwave Studio or any Open software)
2. By using the rectangular patch antenna which is designed in Question no 1 as unit element, designing 1x4 array antennas at 5.5GHz on FR4/Duroid RT 5870 substrate. Determine the optimum distance between the unit element using HFSS and also give simulation results (radiation pattern, VSWR plot etc.).

Syllabus

Module	Course contents	Hours
I	Review of Antenna Parameters: -Polarization, Input impedance, Gain. Relation between radiation fields and magnetic vector potential – Helmholtz equation and Lorentz conditions. Antenna matching –T match, Baluns, Gamma and Omega match.Review of dipole antennas (short dipole and arbitrary length), Monopole antennas, Vand rhombic antennas. Folded dipole and it's properties.	9
II	Analysis of Circular Loop and Biconical Antenna. Helical Antennas (normal mode and axial mode) – relation for far fields, radiation resistance and gain.Current induced in a dipole antenna – Pocklington and Hallen's integral equations. Solution of Hallen's integral equation for current induced in a dipole antenna for delta gap model.	9
III	Near fields of linear antennas, self and mutual impedance, arrays of parallel dipoles, Yagi-Uda antennas.Aperture antenna – Field equivalence principle. Radiation from open-ended wave-guides, horn antennas, horn radiation fields, horn directivity, optimum horn design, Rectangular micro-strip antennas –field analysis and design.Designing an antenna with a set of given specifications using standard software (MATLAB/HFSS/CST Microwave Studio or any Open software)	10
IV	Parabolic reflector antennas, gain and beam width of reflector antennas, aperture-field and current distribution methods, radiation patterns of reflector antennas, dual-reflector antennas, lens antennas -hyperbolic lens and zoned lens. Frequency independent antennas – Rumsey Principle – Spiral Antennas. Design of log periodic dipole arrays.	8
V	Antenna arrays – General expression for array factor. Grating lobes. One dimensional arrays- Broad side, end fire and Chebyshev arrays. Concept of beam steering. Design of array using Schelkunnof's zero placement method and Fourier series method. Woodward-Lawson frequency-sampling design, Narrow beam design and Butler matrix beam former. Adaptive Beam forming. 2D arrays – Rectangular and Circular array.	9

Text Books:

1. Sopholes J. Orfanidis – Electromagnetic waves and antennas. Available at: http://eceweb1.rutgers.edu/~orfanidi/ewa/
2. Consrantive A Balanis -Antenna Theory - Analysis and Design – 2/e John Wiley & Sons.
3. John D. Krans, Ronald J. Marhefka : Antennas for all Applications , 3/e, TMH
4. Thomas A Milligan – Modern Antenna Design, 2/e John Wiley & Sons.

References:

1. Collin R.E, Antennas & Radio Wave Propagation, McGraw Hill. 1985.
2. Jordan E.C. & K. G. Balmain, Electromagnetic Waves & Radiating Systems, 2/e, PHI.
3. Raju G.S.N., Antenna and Wave Propagation, Pearson, 2013.
4. Sisir K.Das & Annapurna Das, Antenna and Wave Propagation, McGraw Hill,2012

Course Contents and Lecture Schedule.

No	Topic	No.of. Lectures
	Module I	
1.1	Basic antenna parameters (all parameters and related simple problems), Relation between parameters (derivation required)	**1**
1.2	Relation between radiation fields and magnetic vector potential – Helmholtz equation and Lorentz conditions.	**2**
1.3	Antenna matching –T match, Baluns, Gamma and Omega match.	**2**
1.4	Review of dipole antennas (short dipole and arbitrary length),	**2**
1.5	Monopole antennas, Vand rhombic antennas. Folded dipole and it's properties.	**2**
	Module II	
2.1	Analysis of Circular Loop and Biconical Antenna.	**2**
2.2	Helical Antennas (normal mode and axial mode) – relation for far fields, radiation resistance and gain.	**2**
2.3	Current induced in a dipole antenna – Pocklington and Hallen's integral equations.	**3**
2.4	Solution of Hallen's integral equation for current induced in a dipole antenna for delta gap model.	**2**
	Module III	
3.1	Near fields of linear antennas, self and mutual impedance, arrays of parallel dipoles, Yagi-Uda antennas.	**2**
3.2	Aperture antenna – Field equivalence principle.	**2**
3.3	Radiation from open-ended wave-guides, horn antennas, horn radiation fields, horn directivity, optimum horn design,	**2**
3.4	Rectangular micro-strip antennas – Field analysis and design.	**2**
3.5	Designing an antenna with a set of given specifications using standard software(MATLAB/HFSS/CST Microwave Studio or any Open software).	**2**
	Module IV	
4.1	Parabolic reflector antennas, gain and beam width of reflector antennas, aperture-field and current distribution methods, radiation patterns of reflector antennas,	**2**
4.2	Dual-reflector antennas, lens antennas -hyperbolic lens and zoned lens.	**2**
4.3	Frequency independent antennas – Rumsey Principle – Spiral Antennas.	**2**
4.4	Design of log periodic dipole arrays.	**2**
	Module V	
5.1	Antenna arrays – General expression for array factor. Grating lobes.	**1**
5.2	One dimensional arrays- Broad side, end fire and Chebyshev arrays. Concept of beam steering.	**2**

5.3	Design of array using Schelkunnof's zero placement method and Fourier series method.	**2**
5.4	Woodward-Lawson frequency-sampling design, Narrow beam design and Butler matrix beam former.	**2**
5.5	Adaptive Beam forming. 2D arrays – Rectangular and Circular array.	**2**

Simulation Assignments (ECT 477)

The following simulation assignments can be done with MATLAB/HFSS/CST Microwave Studio or any Open software.

- Design a rectangular microstrip antenna (using MATLAB) for 1.8 GHz with RT-Duroid 5880 FR4 substrate having permittivity 4.4, loss tangent=0.001 and h=1.6mm and also plot 3D, 2D radiation patterns and VSWR.
- The dimensions of a rectangular microstrip antenna are: L=3.733cm and W=3.973 cm. The substrate height h=1.6mm and dielectric constant = 4.4.If operating frequency is 1.8 GHz.Write a MATLAB program to calculate

    (a) The input impedance
    (b) The position of the inset feed point for matching to 50 ohm feeder line.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B. TECH DEGREE EXAMINATION

Course Code: ECT497

Course Name: DESIGN AND ANALYSIS OF ANTENNAS

Max. Marks: 100 Duration: 3 Hours

PART A

(*Answer All Questions*)

1	Using Lorentz condition show that $\nabla^2 A + k^2 A = -\mu J$	(3)
2	Explain design procedure of Gamma match.	(3)
3	Derive expression for input impedance of a folded dipole antenna.	(3)
4	Derive radiated fields for a circular loop of constant current.	(3)
5	Explain the delta gap model in dipole antennas.	(3)
6	Derive the expression for far field pattern of an open ended wave guide.	(3)
7	Discuss about the Frequency Sampling Technique for Array Design.	(3)
8	Explain the working of Spiral Antenna. Derive appropriate expressions.	(3)
9	Design an Antenna Array using Schelkunnoff's Zero Placement technique.	(3)
10	Explain Butler Matrix Beam Forming.	(3)

PART B

(*Answer one question from each module. Each question carries 14 marks*)

MODULE I

11 a)	Derive the relation between magnetic vector potential and radiation fields in antennas, stating clearly Helmholtz equation and Lorentz conditions.	(9)
b)	An antenna with overall length $l = 5\lambda$ the observations are made at $r = 60\lambda$. Find the errors in phase and amplitude using far field approximation.	(5)
	OR	
12a)	Derive expressions for the Far Field components and Radiation Resistance and Directivity of a short dipole antenna.	(6)
b)	Derive the self and mutual impedance of two parallel Centers driven coupled dipole antennas.	(8)

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MODULE II

13 a) Design an axial mode helical antenna for directivity 28 dBi for operating at 600 MHz. Calculate the radiation resistance, HPBW, BWFN and bandwidth of the designed antenna. (5)

b) Derive Pocklington's and Hallen's Integral Equation. Explain their significance. (9)

OR

14 a) Explain the Field Equivalence Principle in detail. (5)

b) Derive the expressions for power density, radiation resistance, and directivity of Circular loop antenna. (9)

MODULE III

15 a) Design a rectangular Microstrip antenna resonating at 2 GHz. The antenna uses a substrate with a dielectric of 10.2 and the height of the substrate is 0.3 cm. (8)

b) Derive expressions for the Directivity of a Horn Antenna. (6)

OR

16a) Design a Yagi-Uda array with a directivity of 9.2 dB at $f_0 = 50MHz$. The desired diameter of the parasitic elements is 2.54 cm and of the metal supporting boom 5.1 cm. Find the element spacing, lengths and total array length. (7)

b) State Huygens' Principle and discuss field equivalence in aperture antennas. (7)

MODULE IV

17a) Design a LPDA with τ = 0.85, σ = 0.03 for the frequency range 15-45 MHz. (7)

b) Explain the working of a parabolic dish antenna. Write down the expression for gain, HPBW and BWFN. (7)

OR

18 a) Derive Rumsey Principle for frequency independent antennas. (7)

b) Why equiangular spiral antenna and log periodic antennas are called frequency independent antennas. Explain their working. (7)

MODULE V

19 a) Design an antenna array using Schelkunoff's zero placement method. (7)

b) Design a 5 element Dolph-Tscebycheff array with peak side lobe level 22 dB. (7)

OR

20 a) Design an antenna array using Woodward-Lawson Frequency Sampling technique. (8)

b) Derive the array factor of 90^0 corner reflector. (6)

ECT499	MULTIRATE SIGNAL PROCESSING AND WAVELETS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: The aim of this course is to introduce the idea of wavelets, and the related notions of time frequency analysis, of time-scale analysis, and to describe the manner in which technical developments related to wavelets have led to numerous applications. The concepts of multirate filter banks is also introduced. The relation between wavelets and multirate systems is brought out to illustrate how wavelets may actually be realized in practice.

Prerequisite: ECT 303 Digital Signal Processing

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the concepts, properties and interconnection of Multirate systems, Wavelets and Filterbanks and apply them in the analysis of signal processing systems.
CO 2	Construct wavelets and multirate systems using the time domain and the frequency domain approaches.
CO 3	Apply the wavelet transform, wavelet packet transform and its variants as a tool in 1-D and 2-D signal analysis and processing.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3	3	3								2
CO 2	3	3	3	3								2
CO 3	3	3	3	3	3			1	2	2	1	2

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	10	20
Apply	K3	10	20	50
Analyse	K4	10	10	20
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the concepts, properties and interconnection of Multirate systems, Wavelets and Filter banks and apply them in the analysis of signal processing systems.

1. Explain the basic building blocks of a multirate/ multi resolution analysis system.
2. Analyse the frequency domain behavior of the rate conversion operations to build analysis and synthesis filters of a filter bank.
3. Analyse the time-frequency behaviour of signals through various analysis tools such as Fourier Transform, Short Time Fourier Transform(STFT) and wavelet transform and compare their properties.
4. What are the properties of a wavelet basis functions and what are the advantages of representing signals using them.

Course Outcome 2 (CO2): Construct wavelets and multirate systems using the time domain and the frequency domain approaches

1. Construct different families of wavelets using the filter bank approach.
2. Construct different families of wavelets using frequency domain approach.
3. Establish the relationship between filterbanks and wavelets to construct efficient wavelet based analysis-synthesis systems.

4. Design appropriate analysis and synthesis filters using the z-domain analysis that satisfy the properties of a wavelet system.

Course Outcome 3 (CO3): Apply the wavelet transform, wavelet packet transform and its variants as a tool in 1-D and 2-D signal analysis and processing.

1. Explain the wavelet packet transform and its implantation using filterbanks.
2. Explain the construction of the filter bank for the analysis of 2-D signals.
3. How will you choose wavelets for various applications? What properties of wavelets are suited for different applications? Analyse and study with respect to the application point of view

SYLLABUS

Module 1: Basics of Multirate processing and Filter banks

Introduction to multiresolution and multirate signal processing with some example applications, Multirate System Fundamentals: Basic multirate operations – Decimation and Interpolation, Transform domain analysis of Decimators and Interpolators, Decimation and Interpolation filters, Fractional sampling rate alteration Interconnection of decimators and interpolators, The Noble Identities.

Introduction to digital filter banks, The DFT filter bank, Two Channel Quadrature Mirror Filterbank (QMF), Two channel Conjugate Quadrature Filter Bank (CQF). Perfect Reconstruction.

Module 2: Introduction to Wavelet Transform

The Uncertainty Principle - Time-bandwidth product uncertainty, The time frequency plane and its tilings, Short Time Fourier Transform, The Gabor Transform and its generalization, Wavelet Transform in general and origin of Wavelets. The Continuous Wavelet Transform (CWT), Condition of admissibility and its implications.

Introduction to Discrete Wavelet Transform (DWT), DWT from CWT, Logarithmic Scale Discretization and Dyadic Discretization, Families of wavelets: Orthogonal and biorthogonal wavelets, Vanishing moments and regularity.

Module 3: The Multiresolution Analysis (MRA), Wavelets and Filter Banks

The Multiresolution Analysis: The Dyadic Haar Multiresolution Analysis - The Haar Scaling Functions and Function spaces, Nested spaces, The Haar Wavelet function, Orthogonality of the Haar Scaling and Wavelet functions. Relating Scaling and Wavelet functions of Haar and Filters, The Haar Filter Bank, Z-domain analysis of Haar filter bank.

The Daubechies' family of MRA, Daubechies' Filter banks, Relating QCF filter banks and Daubechies' wavelets.

Module 4: Biorthogonal Wavelets

Introduction to biorthogonal vector space, Biorthogonal Wavelet Systems, Signal representation using Biorthogonal Wavelet System, Construction of Biorthogonal wavelets Design of Wavelet systems using frequency domain approach – Frequency domain characterisation of filter coefficients, Design of Daubechies Wavelets using frequency domain approach, JPEG 2000 5/3 filter bank and Spline MRA.

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Module 5: Wavelet packets and 2-D DWT

The wavelet packet transform, Best wavelet packet tree, Noble identities and the Haar wave Packet Transform. Introduction to 2-D DWT, Wavelet transform of an image, The Embedded Zero-tree Wavelet (EZW) Coding. Applications of wavelets in audio & image compression and denoising.

Text Books

1. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson Education, 2006.
2. K. P. Soman, K. I. Ramachandran, "Insight Into Wavelets - From Theory to Practice", Prentice Hall of India, 3rd Edition, Eastern Economy Edition, Prentice Hall of India Private Limited, 2010. Video lectures and Transcripts: Adv. Digital Signal Processing: Multirate and Wavelet NPTEL Lecture series - https://nptel.ac.in/courses/117/101/117101001/

Reference Books

1. Gilbert Strang and Truong Q. Nguyen, Wavelets and Filter banks, 2nd Edition, Wellesley- CambridgePress,1998
2. Raghuveer M. Rao, Ajit S. Bopardikar, "Wavelet Transforms: Introduction to Theory and Applications, Prentice Hall, 1998.
3. N.J. Fliege, Multirate Digital Signal Processing, John Wiley, 1999.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Basics of Multirate processing and Filter banks**	
1.1	Introduction to multiresolution and multirate signal processing with some example applications.	1
1.2	Multirate System Fundamentals: Basic multirate operations – Decimation and Interpolation, Transform domain analysis of Decimators and Interpolators, Decimation and Interpolation filters.	2
1.3	Fractional sampling rate alteration	1
1.4	Interconnection of decimators and interpolators, The Noble Identities.	1
1.5	Introduction to digital filter banks, The DFT filter bank.	2
1.6	Two Channel Quadrature Mirror Filterbank (QMF)	1
1.7	Two Channel Conjugate Quadrature Filter Bank (CQF). Perfect Reconstruction.	2
2	**Introduction to Wavelet Transform**	

2.1	The Uncertainty Principle - Time-bandwidth product uncertainty, The time frequency plane and its tilings.	2
2.2	Short time Fourier Transform, The Gabor Transform and its generalization, Wavelet Transform in general and origin of Wavelets.	2
2.3	The Continuous Wavelet Transform (CWT), Condition of admissibility and its implications.	2
2.4	Introduction to Discrete Wavelet Transform (DWT), DWT from CWT, Logarithmic Scale Discretization and Dyadic Discretization	1
2.5	Families of wavelets: Orthogonal and biorthogonal wavelets, Vanishing moments and regularity.	2
3	**The Multiresolution Analysis (MRA), Wavelets and Filter Banks**	
3.1	The Multiresolution Analysis: The Dyadic Haar Multiresolution Analysis - The Haar Scaling Functions and Function spaces, Nested spaces, The Haar Wavelet function, Orthogonality of the Haar Scaling and Wavelet functions.	3
3.2	Relating Scaling and Wavelet functions of Haar and Filters, The Haar Filter Bank, Z-domain analysis of Haar filter bank.	3
3.3	The Daubechies' family of MRA, Daubechies' Filter banks, Relating QCF filter banks and Daubechies' wavelets.	3
4	**Biorthogonal Wavelets**	
4.1	Introduction to biorthogonal vector space, Biorthogonal Wavelet Systems.	2
4.2	Signal representation using Biorthogonal Wavelet System, Construction of Biorthogonal wavelets	2
4.3	Design of Wavelet systems using frequency domain approach – Frequency domain characterisation of filter coefficients, Design of Daubechies Wavelets using frequency domain approach.	3
4.4	JPEG 2000 5/3 filter bank and Spline MRA.	1
5	**Wavelet packets and 2-D DWT**	
5.1	The wavelet packet transform, Best Wavelet packet tree, Noble identities and the Haar wave Packet Transform.	3
5.2	Introduction to 2-D DWT, Wavelet transform of an image	3
5.3	The Embedded Zero-tree Wavelet (EZW) Coding.	1
5.4	Applications of wavelets in audio & image compression and denoising	2

Course Projects:

1. Study the spectral characteristics of Down sampler (Decimator) and Up sampler (Interpolator).
2. Implement a 2- channel QMF/QCF filterbank and observe and syudy the ouput at every stage of the filter bank.
3. Study the effect of sample rate conversion (Down sampling and Up sampling) on audio data or on your own recorded speech.
4. Generate and plot the scaling and wavelet functions of Daubechies' wavelets using recursion/iterative method.
5. Study the equivalence of Haar multi resolution analysis and Haar filter bank for a piecewise linear function.
6. Implement a biorthogonal 5/3 filter bank used in JPEG2000 standard.
7. Read an image and apply 2-D wavelet transform on it. Observe and study the contribution of various subbands by reconstructing the image using selective subbands.
8. Study and implementation of Wavelet Packet Transform and best wavelet packet tree.
9. Read an image and apply 2-D wavelet transform on it. Apply thresholding on the wavelet coefficients of different subband based on energy of the coefficient and reconstruct the signal. Compute the compression obtained and the quality of the reconstructed image (PSNR) by varying the thresholds.
10. Apply Wavelet transform on noisy data and implement various wavelet based denoising methods

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION,

(Model Question Paper)

Course Code: ECT499

Course Name: MULTIRATE SIGNAL PROCESSING AND WAVELETS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	Illustrate the frequency domain behavior of a decimator.	K2
2	State and prove the noble identities for the multirate systems.	K1
3	Explain dyadic discretization of constructing DWT from CWT	K2
4	Explain Gabor transform. What is its drawback?	K2
5	Explain the concept of nested spaces in multirate Analysis.	K3
6	Establish the relationship between QCF Filterbank and Daubechies wavelet.	K3
7	Explain the concept of biorthogonal vector space	K2
8	When will you go for biorthoganal wavelet trasforms rather than orthogonal wavelet transform. Specify any one application where biorthogonal wavelet transform is used.	K2
9	What are the advantages of Wavelet Packet Transform over Wavelet Transform?	K2
10	Give a block schematic of 2-D wavelet decomposition and explain the construction of image subbands.	K2
	PART – B Answer one question from each module; each question carries 14 marks.	
	Module - I	

11 a. b.	Show that the decimator and interpolator are linear time varying systems For the system shown in Figure below, find the expression for y(n) in terms of x(n). x(n) ↑3 ↓2 ↓3 ↑2 y(n)	7 7 CO1 K3

	OR	
12 a.	Draw the block diagram of a 2-channel Quadrature Mirror Filterbank (QMF) and derive the expression for the output using z-domain analysis. What is the condition for alias cancellation? How will you construct an alias free QMF?	14 CO1 K2
	Module - II	
13 a.	Derive Heisenberg's uncertainty principle relating the time and frequency resolutions. Prove that if the window function is Gaussian, equality holds.	7 CO1 K2
b.	Briefly explain the difference between Fourier Transform, Short Time Fourier Transform (STFT) & Wavelet Transform.	7 CO1 K3
	OR	
14 a. b.	State and prove the admissibility conditions of a wavelet. Check whether the following function is an admissible wavelet? $e^{-t2}\ \text{Cos}\left(\pi \frac{2}{\ln 2} t\right)$	7 7 CO2 K4
	Module - III	
15 a.	Find two level Haar Wavelet transform using the analysis filters $\{h(-k)\} = \left\{\frac{1}{2}, \frac{1}{2}\right\}$ & $\{g(-k)\} = \left\{\frac{1}{2}, \frac{-1}{2}\right\}$ for the following sequence. [1, 0, -3, 2, 1, 0, 1, -2] Remove from the Wavelet transform, the coefficients between –1 & 1 and then reconstruct the function and compute Mean Squared Error.	14 CO2 K3

	OR	
16	Let φ (t) and ψ(t) be the Haar scaling and wavelet functions. Let Vj and Wj be the spaces spanned by $\varphi_{j,k}(t) = 2^{j/2}\varphi(2^j t - k)$ and $\psi_{j,k}(t) = 2^{j/2}\psi(2^j t - k)$, respectively. Let f(t) be defined on $0 \le t < 1$ and given by $f(t) = \begin{cases} -1 & 0 \le t < 1/4 \\ 4 & 1/4 \le t < 1/2 \\ 2 & 1/2 \le t < 3/4 \\ -3 & 3/4 \le t < 1 \end{cases}$ 1. Express f in terms of the basis for V2. 2. Decompose f into its component parts in W1, W0, and V0. In other words, find the Haar wavelet decomposition for f. 3. Sketch each of the four decompositions..	14 CO2 K3
	Module - IV	
17	Prove that in a Bi-orthogonal Wavelet System $\sum_k h(k) = \sum_k \tilde{h}(k) = 2$ $\sum_k \tilde{h}(k)\, h(k - 2l) = \delta_{l,0}$.	14 CO1 K3
	OR	
18	Construct db2 wavelet using time domain approach.	14 CO2 K2
	Module - V	
19	Discuss the application of wavelet analysis in Audio Coding and Signal Denoising. Compare wavelet based denoising technique with FFT based denoising method	14 CO3 K2
	OR	

20 a.	Explain the Embedded Zero-tree Wavelet (EZW) algorithm used in image compression.	7 CO3 K2
b.	For the seven-level decomposition shown below, $\begin{array}{cccc} 21 & 6 & 15 & 12 \\ -6 & 3 & 6 & 3 \\ 3 & -3 & 0 & -3 \\ 3 & 0 & 0 & 0 \end{array}$ Find the bit stream or labels generated by the Embedded Zerotree Wavelet (EZW) coder, after three steps of multiple pass procedure. Also, determine the list of significant coefficients.	7 CO3 K3

SEMESTER VIII

ECT402	WIRELESS COMMUNICATION	CATEGORY	L	T	P	CREDIT
		PCC	2	1	0	3

Preamble: This course aims to introduce students to basic theory and principles of wireless communication systems in general, and cellular systems in particular. It also introduces basics of radio wave propagation.

Prerequisite: ECT 305 Analog and Digital Communication

Course Outcomes: After the completion of the course the student will be able to

CO1 **K2**	Summarize the basics of cellular system and cellular design fundamentals.
CO2 **K2**	Describe the wireless channel models and discuss capacity of wireless channels.
CO3 **K4**	Analyze the performance of the modulation techniques for flat-fading channels and multicarrier modulation.
CO4 **K3**	Illustrate how receiver performance can be enhanced by various diversity techniques.
CO5 **K3**	Identify advantages of various equalization techniques and multiple-access techniques in wireless communication.
CO6 **K3**	Calculate system parameters such antenna height, range, maximum usable frequency in different modes of radio wave propagation.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	2		1			2				2
CO2	3	3	3		3							2
CO3	3	3	3		3							
CO4	3	3	3		3							
CO5	3	3	3		3							
CO6	3	3	3									2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember			
Understand K2	15	15	30
Apply K3	20	20	40
Analyse K4	15	15	30
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1) : Summarize the basics of cellular system and cellular design fundamentals. (K2).

1. List certain challenges in the design of a cellular wireless communication system.
2. A total of 33MHz of bandwidth is allocated to an FDD cellular system which uses two 25kHz simplex channels to provide full-duplex voice & control channels. Compute the number of channels available per cell if the system uses 7-cell reuse.
3. Describe methods to improve coverage and capacity of a cellular system.

Course Outcome 2 (CO2): Describe the wireless channel models and discuss capacity of wireless channels. (K2)

1. Compare and contrast flat-fading and frequency-selective fading channels.
2. How are Doppler spread and coherence time related? What is their significance?
3. Consider a Rayleigh fading channel with average received power of 25dBm. Compute the probability that the received power is below 10dBm.
4. Differentiate between ergodic capacity and capacity with outage.

Course Outcome 3 (CO3): Analyze the performance of the modulation techniques for flat-fading channels and multicarrier modulation. (K4)

1. Under Rayleigh flat-fading, derive an expression for the required average SNR to ensure that outage probability does not below P_{out} .
2. How can subcarrier fading be mitigated?
3. Why is cyclic prefix required in OFDM?

Course Outcome 4 (CO4): Illustrate how receiver performance can be enhanced by various diversity techniques. (K3)

1. Explain receiver diversity technique of maximal ratio combining technique.
2. Describe Almouti scheme for 2x2 MIMO.
3. Find the outage probability of BPSK modulation at $P_b = 10^{-3}$ for a Rayleigh fading channel with SC diversity for M = 1 (no diversity) M = 2. Assume equal branch SNRs of 15 dB.

Course Outcome 5 (CO5): Identify advantages of various equalization techniques and multiple-access techniques in wireless communication. (K3)

1. Describe the steps for LMS algorithm.
2. Compare multiple-access schemes TDMA, FDMA and CDMA.
3. Consider a channel with impulse response h(t) = exp(-t/T) u(t). Find two-tap Zero-forcing equalizer for this channel?

Course Outcome 6 (CO6): Calculate system parameters such antenna height, range, maximum usable frequency in different modes of radio wave propagation. (K3)

1. Derive expression for critical frequency, maximum usable frequency and skip distance (assuming flat earth's surface) for sky wave propagation.
2. A communication system is to be established at a frequency of 50MHz with a transmitter power 1.2kW. The field strength of the directive antenna is 3 times that of a half wave antenna, ht = 50m , hr = 5m. A field strength of 80μV/m is required to give satisfactory reception. Find the range of the system.

SYLLABUS

Module 1: Introduction to Wireless Communication Systems (8 Hours)

1.1 Introduction to Wireless Communication Systems (4): Generations: 2G, 3G, 4G, 5G. Wireless LAN, Bluetooth and Personal Area networks, Broadband Wireless Access -- WiMAX Technology. Wireless Spectrum allocation, Standards.

1.2 Cellular System Design Fundamentals (4): Frequency Reuse, channel assignment strategies, Handoff strategies, Interference and system capacity, trunking and grade off service, improving coverage and capacity – cell splitting, sectoring, microcells.

Module 2: Wireless Channels (7 Hours)

2.1 Path loss and shadowing (1): Free space path loss, Two-Ray model, Shadowing,

2.2 Statistical Multipath Channel Models (4): Time-varying channel impulse response, Narrowband fading, Wideband fading models, Delay spread and Coherence bandwidth, Doppler spread and Coherence time, Flat fading versus frequency selective fading, Slow fading versus fast fading, Discrete-time model.

2.3 Capacity of Wireless Channels (2): Review of Capacity in AWGN, Capacity of flat fading channel – Ergodic capacity, Capacity with Outage, Capacity with CSI-R. (Derivations of capacity formulae are not required; Only expressions, computations and significance required.)

Module 3: Modulation techniques (7 Hours)

2.1 **Digital Signaling for Flat fading Channels (4):** Analysis of Average Error Probability and Outage probability of BPSK in flat-fading channels.

2.2 **Multi-carrier Modulation (3)**: Data transmission using multicarrier modulation for frequency-selective fading channels. Overlapping subchannels, Mitigation of Subcarrier Fading, Discrete Implementation of multicarrier – OFDM. Cyclic prefix, Peak-to-average-power-ratio.

Module 4: Diversity, Equalization, and Multiple Access (8 Hours)

4.1 Diversity (3 hours): Receiver diversity – selection combining, maximal ratio combining. Transmitter diversity – Alamouti scheme for 2x2 MIMO.

4.2 Equalization (3): Equalization – Linear and non-linear equalization, Zero forcing, MMSE equalizers. LMS algorithm. Adaptive Equalization.

4.3 Multiuser Systems (2): Uplink and Downlink, Multiple Access, Frequency-Division Multiple Access (FDMA), Time-Division Multiple Access (TDMA), Code-Division Multiple Access (CDMA), Orthogonal Frequency-Division Multiple Access (OFDMA).

Module 5 Radio Wave Propagation (7 Hours)

Ground wave propagation, Plane earth reflection, Space wave and surface wave, Spherical earth propagation, Tropospheric waves, Ionospheric propagation, Effects of earth's magnetic field, Critical frequency, Maximum usable Frequency, Virtual height.

Text Books

1. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005
2. Theodore S. Rappaport, Wireless communication: Principles and Practice, 2/e, Pearson Education, 1990
3. Aditya Jagannatham, Principles of Modern Wireless Communication Systems, Mc Graw Hill, 2017.
4. Robert Collin, Antennas and Radiowave Propagation, McGraw Hill, 2016.

Reference Books

1. David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005
2. Jochen Schiller, Mobile Communications, Pearson, 2008
3. Andreas F Molish , Wireless Communications, 2nd Edition , Wiley India Publications, 2013
4. W. C. Y. Lee, Mobile Cellular Telecommunication, McGraw Hill,
5. Gordon L. Stuber, Principles of Mobile Communication , Springer,2017
6. Rahim Thafazoli, Technologies for The Wireless Future , Volume 2 , Wiley and Sons , 2004
7. Edward C Jordan and Keith G Balmain, Electromagnetic Wave and Radiating System, Pearson.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to wireless communication systems (8 Hours)**	
1.1	Generations: 2G, 3G, 4G, 5G.	2
1.2	Wireless LAN, Bluetooth and Personal Area networks, Broadband Wireless Access -- WiMAX Technology.	1
1.3	Wireless Spectrum allocation, Standards	1
1.4	Cellular concept, Frequency Reuse, channel assignment strategies,	2

	Handoff strategies	
1.5	Interference and system capacity, trunking and grade off service.	1
1.6	improving coverage and capacity – cell splitting, sectoring, microcells.	1
2	**Wireless Channels (7 Hours)**	
2.1	Free space path loss, Two-Ray model, Shadowing	1
2.3	Time-varying channel impulse response, Narrowband fading	2
2.4	Wideband fading models – Delay spread and Coherence bandwidth, Doppler spread and Coherence time	1
2.5	Flat fading versus frequency selective fading, Slow fading versus fast fading, Discrete-time model.	1
2.6	Review of Capacity in AWGN, Capacity of flat fading channel – Ergodic capacity, Capacity with Outage, Capacity with CSI-R.	2
3	**Modulation Techniques (7 Hours)**	
3.1	Average Probability of error and outage probability	1
3.2	Performance evaluation of BPSK in flat fading channels	2
3.4	Multi carrier modulation in frequency-selective channel	1
3.5	OFDM – DFT/IDFT, Cyclic Prefix	2
3.6	PAPR	1
4	**Diversity, Equalization and Multiple Access (8 Hours)**	
4.1	Receiver Diversity – Selection combining, Maximal ratio combining	2
4.2	Transmit Divesity – Alamouti for 2x2 MIMO	1
4.3	Equalization – linear and nonlinear, ZF and MMSE, LMS, Adaptive	3
4.4	Multiple access – FDMA, TDMA, CDMA, OFDMA	2
5	**Radio Wave Propagation (7 Hours)**	
5.1	Ground wave propagation, Plane earth reflection, Space wave and surface wave	2
5.2	Spherical earth propagation, Tropospheric waves, Ionospheric propagation	2
5.3	Effects of earth’s magnetic field, Critical frequency, Maximum usable Frequency, Virtual height.	3
	Total Hours	**37**

Simulation Assignments:

1. Simulate flat fading and frequency-selective fading wireless channel models using Python/MATLAB
2. Evaluate BPSK, QPSK, QAM in wirelss fading channels using Python/MATLab.
3. Evaluate zero-forcing and MMSE equalization techniques using Python/MATLAB.
4. Simulation of standard path loss models using Python/MATLab.
5. Simulation of Alamouti scheme using Python/MATLab
6. Students can undertake course projects based on following topics: (a) Channel Modelling of wireless channels (b) Comparison of modulation schemes for wireless system (c) Multi carrier modulation schemes (d) Comparison of equalization techniques (e) Implementation of MIMO schemes.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B. TECH. DEGREE EXAMINATION

Course Code: ECT402

Course Name: WIRELESS COMMNICATION

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer ALL Questions. Each Question Carries 3 Marks.)

1. Give important features of 5G system.
2. Discuss different handoff strategies.
3. Explain the notion of delay spread and coherence bandwidth.
4. Give the expression for capacity of flat fading AWGN channel with CSIR. Describe how it is obtained assuming AWGN capacity.
5. Define outage probability.
6. What is the purpose of using cyclic prefix in an OFDM system?
7. Consider a channel with impluse response h(t) = exp(-t/T) u(t). Find tap coefficients of a two-tap zero-forcing equalizer for this channel.
8. Why do we say that maximal ratio combining achieves full diversity?
9. Distinguish between critical frequency and maximum usable frequency.
10. Define virtual height in antennas. [10 X 3= 30]

PART – B

(Answer one question from each module; each question carries 14 marks)

Module I

11. (a) How are co-channel signal-to-interference ratio, cluster size and system capacity are related to one another in a cellular system ? Explain with necessary equations. [07 Marks]

    (b) Explain the architecture of wireless LAN (WLAN). [07 Marks]

OR

12. (a) List three differences between 2G and 3G systems. [03 Marks]

    (b) A total of 33MHz of bandwidth is allocated to an FDD cellular system which uses two 25kHz simplex channels to provide full-duplex voice & control channels. Compute the number of channels available per cell if the system uses 7-cell reuse. [03 Marks]

    (c) What is cell splitting? How does it improve system performance? [08 Marks]

Module II

13. (a) Explain the effect of multipath propagation using 2-ray model. [07 Marks]

    (b) Assuming narrow band fading model, derive statistical characterization of in-phase and quadrature components of a received signal when an unmodulated carrier is transmitted. [07 Marks]

OR

14. (a) Derive time-varying impulse response of multipath wireless channel. [07 Marks]

    (b) Consider a flat-fading channel with iid channel gains g[i] which can take on values g1=0.05 with probablity p1=0.1, g2=0.5 with probability p2=0.5, and g3=1 with probability p3=0.4. The transmit power is 10mW, noise spectral density N0 = 10^{-9} W/Hz, and channel bandwidth is 30kHz. Assume instantaneous CSI-R, but transmitter does not have CSI. Compute the capacity of the channel. [07 Marks]

Module III

15. (a) Derive expression for average probability of error in BPSK under Rayleigh flat-fading when symbol duration is roughly equal to channel coherence time. [07 Marks]

    (b) What is Peak-to-Average Power-Ratio (PAPR) in OFDM system? How can it be reduced ? [07 Marks]

OR

16. (a) Determine the average SNR per bit of BPSK modulation in Rayleigh slow-fading channel such that 95% of the times, average probability of bit error is less than 10^{-4} . [05 Marks]

    (b) Explain multi-carrier modulation in OFDM. [09 Marks]

Module IV

17. (a) Explain Least-Mean-Square algorithm for equalization. [09 Marks]

(b) Compute the average probability of bit error of BPSK under maximal-ratio-combining two-branch diversity with iid Rayleigh fading. Average SNR on each branch is 10dB. [05 Marks]

OR

18. (a) Describe Alamouti scheme for 2x2 MIMO. [07 Marks]

(b) Describe how multiple-access works on uplink and downlink in CDMA.[07 Marks]

Module V

19. (a) Derive an expression for the LOS distance in km when the antenna heights above ground are ht and hr respectively for the transmitter and receiver antennas. [07 Marks]

(b) A receiving antenna is located at 80km from the transmitting antenna. The height of the transmitting antenna is 100m. What is the required height of the receiving antenna? [07 Marks]

OR

20. (a) An HF radio communication is to be established between two points on the earth's surface. The points are at a distance of 2600km. The height of the ionosphere layer is 200km and critical frequency is 4MHz. Find maximum usable frequency. [07 Marks]

(b) Derive expression for critical frequency, maximum usable frequency and skip distance (assuming flat earth's surface) for sky wave propagation. [07 Marks]

ECT404	COMPREHENSIVE COURSE VIVA	CATEGORY	L	T	P	CREDIT
		PCC	1	0	0	1

Preamble: The objective of this Course viva is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to become competent in placement tests and other competitive examinations.

Guidelines

1. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.
2. The viva voce will be conducted by the same three member committee assigned for final project phase II evaluation. It comprises of Project coordinator, expert from Industry/research Institute and a senior faculty from a sister department.
3. The pass minimum for this course is 25.
4. The mark will be treated as internal and should be uploaded along with internal marks of other courses.
5. Comprehensive Viva should be conducted along with final project evaluation by the three member committee.

Mark Distribution

Total marks: 50, only CIE, minimum required to pass : 25 Marks

ECD416	PROJECT PHASE II	CATEGORY	L	T	P	CREDIT
		PWS	0	0	12	4

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

- To apply engineering knowledge in practical problem solving.
- To foster innovation in design of products, processes or systems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs]: After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

Abstract POs defined by National Board of Accreditation			
PO #	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO0	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE II

Phase 2 Targets

- In depth study of the topic assigned in the light of the report prepared under Phase - I;
- Review and finalization of the approach to the problem relating to the assigned topic.
- Preparing a detailed action plan for conducting the investigation, including teamwork.
- Detailed Analysis/ Modeling / Simulation/ Design/ Problem Solving/Experiment as needed.
- Final development of product/ process, testing, results, conclusions and future directions.
- Preparing a paper for Conference Presentation/ Publication in Journals, if possible.
- Presenting projects in Project Expos conducted by the University at the cluster level and/ or state level as well as others conducted in India and abroad.
- Filing Intellectual Property Rights (IPR) if applicable.
- Preparing a report in the standard format for being evaluated by the Department Assessment Board.
- Final project presentation and viva voce by the assessment board including the external expert.

Evaluation Guidelines & Rubrics

Total: 150 marks (Minimum required to pass: 75 marks).

- Project progress evaluation by guide: 30 Marks.
- Two interim evaluations by the Evaluation Committee: 50 Marks (25 marks for each evaluation).
- Final evaluation by the Final Evaluation committee: 40 Marks
- Quality of the report evaluated by the evaluation committee: 30 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor. The final evaluation committee comprises of Project coordinator, expert from Industry/research/academic Institute and a senior faculty from a sister department).

Evaluation by the Guide

The guide/supervisor must monitor the progress being carried out by the project groups on regular basis. In case it is found that progress is unsatisfactory it should be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (5)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (9)

Completion of the project: The students should demonstrate the project to their respective guide. The guide shall verify the results and see that the objectives are met. (5)

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 1

No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-a	Novelty of idea, and Implementation scope [CO5] [Group Evaluation]	**5**	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea can be implemented. There is still lack of originality in the work done so far by the team. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team . There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable / publishable work.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-b	Effectiveness of task distribution among team members. [CO3] [Group Evaluation]	**5**	No task distribution of any kind. Members are still having no clue on what to do.	Task allocation done, but not effectively, some members do not have any idea of the tasks assigned. Some of the tasks were identified but not followed individually well.	Good evidence of task allocation being done, supported by project journal entries, identification of tasks through discussion etc. However, the task distribution seems to be skewed, and depends a few members heavily than others. Mostly the tasks are being followed by the individual members.	Excellent display of task identification and distribution backed by documentary evidence of team brainstorming, and project journal entries. All members are allocated tasks according to their capabilities, and as much as possible in an equal manner. The individual members are following the tasks in an excellent manner.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-c	Adherence to project schedule. [CO4] [Group Evaluation]	**5**	Little or no evidence of continued planning or scheduling of the project. The students did not stick to the plan what they were going to build nor plan on what materials / resources to use in the project. The students do not have any idea on the budget required even after the end of phase - I. No project journal kept or the journal.	There is some improvement in the primary plan prepared during phase I. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no useful details on the project.	Good evidence of planning done and being followed up to a good extent after phase I. Materials were listed and thought out, but the plan wasn't followed completely. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is neither complete nor updated regularly.	Excellent evidence of enterprising and extensive project planning and follow-up since phase I. Continued use of project management/version control tool to track the project. Material procurement if applicable is progressing well. Tasks are updated and incorporated in the schedule. A well-kept project journal showed evidence for all the above, in addition to the interaction with the project guide.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-d	Interim Results. [CO6] [Group assessment]	**5**	There are no interim results to show.	The team showed some interim results, but they are not complete / consistent to the current stage, Some corrections are needed.	The interim results showed were good and mostly consistent/correct with respect to the current stage. There is room for improvement.	There were significant interim results presented which clearly shows the progress.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-e	Presentation [Individual assessment]	**5**	Very poor presentation and there is no interim results. The student has no idea about the project proposal.	Presentation is average, and the student has only a feeble idea about the team work.	Good presentation. Student has good idea about the team's project. The overall presentation quality is good.	Exceptionally good presentation. Student has excellent grasp of the project. The quality of presentation is outstanding.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 1 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation – 2

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-f	Application of engineering knowledge [CO1] [Individual Assessment]	**10**	The student does not show any evidence of applying engineering knowledge on the design and the methodology adopted. The student's contribution in application of engineering knowledge in the project is poor.	The student appears to apply some basic knowledge, but not able to show the design procedure and the methodologies adopted in a comprehensive manner.	The student is able to show some evidence of application of engineering knowledge in the design and development of the project to good extent.	Excellent knowledge in design procedure and its adaptation. The student is able to apply knowledge from engineering domains to the problem and develop solutions.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-g	Involvement of individual members [CO3] [Individual Assessment]	**5**	No evidence of any Individual participation in the project work.	There is evidence for some amount of individual contribution, but is limited to some of the superficial tasks.	The individual contribution is evident. The student has good amount of involvement in core activities of the project.	Evidence available for the student acting as the core technical lead and has excellent contribution to the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-h	Results and inferences upon execution [CO5] [Group Assessment]	**5**	None of the expected outcomes are achieved yet. The team is unable to derive any inferences on the failures/ issues observed. Any kind of observations or studies are not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Documentation and presentation. .[CO6] [Individual assessment]	**5**	The individual student has no idea on the presentation of his/her part. The presentation is of poor quality.	Presentation's overall quality needs to be improved.	The individual's presentation performance is satisfactory.	The individual's presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 2 Total Marks: 25						

EVALUATION RUBRICS for PROJECT Phase II: Final Evaluation

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-j	Engineering knowledge. [CO1] [Group Assessment]	10	The team does not show any evidence of applying engineering knowledge on the design and the methodology adopted.	The team is able to show some of the design procedure and the methodologies adopted, but not in a comprehensive manner.	The team is able to show evidence of application of engineering knowledge in the design and development of the project to good extent. There is scope for improvement.	Excellent knowledge in design procedure and its adaptation. The team is able to apply knowledge from engineering domains to the problem and develop an excellent solution.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-k	Relevance of the project with respect to societal and/or industrial needs. [Group Assessment] [CO2]	5	The project as a whole do not have any societal / industrial relevance at all.	The project has some relevance with respect to social and/or industrial application. The team has however made not much effort to explore further and make it better.	The project is relevant to the society and/or industry. The team is mostly successful in translating the problem into an engineering specification and managed to solve much of it.	The project is exceptionally relevant to society and/or industry. The team has made outstanding contribution while solving the problem in a professional and/ or ethical manner.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Innovation / novelty / Creativity [CO5] [Group Assessment]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea appears to be practical. There is still lack of originality in the work done. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/ or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team. There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity. Could be translated into a product / process if more work is done.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable publishable work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-m	Quality of results / conclusions / solutions. [CO1] [Group Assessment]	10	None of the expected outcomes are achieved. The team is unable to derive any inferences on the failures/issues observed. Any kind of observations or studies is not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

2-n	Presentation - Part I Preparation of slides. [CO6] [Group Assessment].	5	The presentation slides are shallow and in a clumsy format. It does not follow proper organization.	Presentation slides follow professional style formats to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly, or acknowledged. Presentation slides needs to be more professional.	Presentation slides follow a good style format and there are only a few issues. Organization of the slides is good. Most of references are cited properly. The flow is good and team presentation is neatly organized. Some of the results are not clearly shown. There is room for improvement.	The presentation slides are exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed. Results/ inferences clearly highlighted and readable.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
	Presentation - Part II: Individual Communication [CO6] [Individual Assessment].	5	The student is not communicating properly. Poor response to questions.	The student is able to explain some of the content. The student requires a lot of prompts to get to the idea. There are language issues.	Good presentation/ communication by the student. The student is able to explain most of the content very well. There are however, a few areas where the student shows lack of preparation. Language is better.	Clear and concise communication exhibited by the student. The presentation is outstanding. Very confident and tackles all the questions without hesitation. Exceptional traits of communicator.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Final Evaluation, Marks: 40						

EVALUATION RUBRICS for PROJECT Phase II: Report Evaluation

Sl. No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-o	Report [CO6]	30	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly unacknowledged content. Lack of effort in preparation is evident. References are not cited. Unprofessional and inconsistent formatting.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report. There is lack of formatting consistency.	Project report shows evidence of systematic documentation. Report is mostly following the standard style format and there are only a few issues. Organization of the report is good. Mostly consistently formatted. Most of references/sources are cited/ acknowledged properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows professional styles. Consistent formatting and exceptional readability.
			(0 - 11 Marks)	(12 - 18 Marks)	(19 - 28 Marks)	(29 - 30 Marks)
Phase - II Project Report Marks: 30						

SEMESTER VIII

PROGRAM ELECTIVE III

ECT414	BIOMEDICAL ENGINEERING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course will introduce aspects of biomedical engineering as applied to biologicalsystems described using engineering principles and the use of modern diagnostic and therapeutic equipment.

Prerequisite:NIL

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand basic bioelectric potentials and its implications in diagnostics
CO2	Understand the principles used for diagnosis of abnormalities in the cardiovascular system
CO3	Explain the techniques used for diagnosis and therapy in the neuromuscular system
CO4	Understand the principle and working of different types of bio medical equipment/device
CO5	Classify various diagnostic medical imaging techniques.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										
CO3	3	3										
CO4	3	3										
CO5	3	3										

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End semester examination
	I	II	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyze			
Evaluate			
Create			

Mark distribution

Total marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain10 questions with 2 questions from each module, having 3 marks for each question. Studentsshould answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand basic bioelectric potentials and their implications in diagnostics

1. Explain the different types of bio electric potential with diagrams?
2. How does depolarisation and repolarisation occur in a cell?
3. Explain different types of bio-potential electrodes?

Course Outcome 2 (CO2): Explain the principles used for diagnosis of abnormalities in the cardiovascular system

1. Explain ECG machine with a block diagram
2. A patient was subjected to non-invasive method of blood pressure measurement. Which is the method used? What is the principle behind the method and how is it done?

Course Outcome 3 (CO3): Explain the techniques used for diagnosis and therapy in the neuromuscular system

1. Explain with adiagramthe 10-20 system of electrode placement to perform EEG analysis.
2. Explain instrumentation system for acquiring EMG?
3. Explain how functional activity can be elicited from the paralyzed limb of a spinal cord injured patient using electrical stimulation.

Course Outcome 4 (CO4): Understand the principle and working of different types of bio medical equipment/device

1. Explain ventilator parameters?
2. What is a cardiac defibrillator? With a neat diagram explain DC defibrillator.
3. With a neat block diagram explain single channel ECG telemetry transmitter

Course Outcome 5 (CO5): Understand various diagnostic medical imaging techniques

1. Explain the principle of basic pulse echo system with necessary diagrams.
2. Compare NMR imaging and CT imaging.

Syllabus

Module 1

Introduction to bio-medical engineering, overview of anatomy and physiological systems of the body.Sources of bio-electric potential: Resting and action potential, propagation of action potentials. Bioelectric potentials examples (ECG, EEG, EMG, ERG, EOG, EGG concept only.)
Electrode theory: Nernst relation, Electrode skin interface, Bio potential electrodes: Microelectrodes, skin surface electrodes, needle electrodes
Instrumentation for clinical laboratory: Bio potential amplifiers-instrumentation amplifiers, carrier amplifiers, isolation amplifiers, chopper amplifiers

Module 2

Heart and cardiovascular system (brief discussion), electro conduction system of the heart. Electrocardiography, ECG machine block diagram, ECG lead configurations, ECG recording system, Einthoven triangle, analysis of ECG signals.
Measurement of blood pressure: Direct, indirect and relative methods of blood pressure measurement, auscultatory method, oscillometric and ultrasonic noninvasive pressure measurements.
Measurement of blood flow: Electromagnetic blood flowmeters and ultrasonic blood flow meters

Module 3

The human nervous system. Neuron, action potential of brain, brain waves, types of electrodes, placement of electrodes, evoked potential, EEG recording, analysis of EEG.
Electrical activity of muscles- EMG. Signal Acquisition and analysis. Applications of EMG - myoelectric control system.Electrical stimulation of the muscle and nerve, Functional Electrical Stimulation- Principle and applications.
Physiology of respiratory system (overview), Respiratory parameters, spirometer, body plethysmographs, gas exchange and distribution.

Module 4

Instruments for clinical laboratory: Oxymeters, pH meter, blood cell counter, flame photometer, spectrophotometer

Therapeutic Equipments: Principle, block schematic diagram, working and applications of : pacemakers, cardiac defibrillators, heart–lung machine, dialyzers, surgical diathermy equipment, ventilators

Biomedical Telemetry system: Components of biotelemetry system, application of telemetry in medicine, single channel telemetry system for ECG and temperature measurement.

Module 5

Medical Imaging systems (Basic Principle only): X-ray imaging - Properties and production of X-rays, X-ray machine, applications of X-rays in medicine.

Computed Tomograpy: Principle, image reconstruction, scanning system and applications

Ultrasonic imaging systems: Basic pulse echo system, propagation of ultrasonic through tissues and reflections, display types, A-Scan, B-Scan, M-Scan, applications, real-time ultrasonic imaging systems and probes.

Magnetic Resonance Imaging – Basic NMR components, Biological effects and advantages of NMR imaging

Patient Safety: Electric shock hazards, leakage current,safety codes for electro medical equipments

Text Books

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata Mc Graw Hill
2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, PHI, 2nd Edition, 2004

References:

1. John G Webster, “Medical Instrumentation application and design”, John Wiley 3rd e/d
2. J. J. Carr, “Introduction to Biomedical Equipment Technology”, Pearson Education 4th e/d.
3. Richard Aston, “Principle of Biomedical Instrumentation and Measurement”. Merrill Education/Prentice Hall.
4. Barbara Christe, Introduction to Biomedical Instrumentation, Cambridge University Press, 2008

Course Contents and Lecture Schedule

MODULE NO	TOPIC	NO. OF LECTURES
I	Introduction to bio-medical instrumentation system, overview of anatomy and physiological systems of the body.	2
	Sources of bio-electric potential: Resting and action potential, propagation of action potentials, Bioelectric potentials examples (ECG, EEG, EMG, ERG, EOG, EGG concept only.)	2
	Electrode theory: Nernst relation, Electrode skin interface,	1
	Bio potential electrodes: Microelectrodes, skin surface electrodes, needle electrodes	1
	Instrumentation for clinical laboratory: Bio potential amplifiers-instrumentation amplifiers, carrier amplifiers, isolation amplifiers, chopper amplifiers	2
II	Heart and cardiovascular system (brief discussion), electro conduction system of the heart.Electrocardiography	1
	ECG machine block diagram, ECG lead configurations, ECG recording system, Einthoven triangle, analysis of ECG signals.	2
	Measurement of blood pressure: Direct, indirect and relative methods of blood pressure measurement, auscultatory method oscillometric and ultrasonic noninvasive pressure measurements.	2
	Measurement of blood flow: Electromagnetic blood flow meters and ultrasonic blood flow meters	1
III	The human nervous system. Neuron, action potential of brain, brain waves, types of electrodes, placement of electrodes, evoked potential, EEG recording, analysis of EEG.	2
	Electrical activity of muscles- EMG. Signal Acquisition and analysis. Applications of EMG - myoelectric control system.	2
	Electrical stimulation of the muscle and nerve, Functional Electrical Stimulation- Principle and applications.	1
	Physiology of respiratory system (overview), Respiratory parameters, spirometer, body plethysmographs, gas exchange and distribution.	2
IV	Instruments for clinical laboratory: Oxymeters, pH meter, blood cell counter, flame photometer, spectrophotometer	2
	Therapeutic Equipments: Principle, block schematic diagram, working and applications of : pacemakers, cardiac defibrillators	2
	heart–lung machine, dialyzers, surgical diathermy equipment, ventilators	2

	Biomedical Telemetry system: Components of biotelemetry system, application of telemetry in medicine	1
V	Medical Imaging systems (Basic Principle only): X-ray imaging - Properties and production of X-rays, X-ray machine, applications of X-rays in medicine.	2
	Computed Tomograpy: Principle, image reconstruction, scanning system and applications	1
	Ultrasonic imaging systems: Basic pulse echo system, propagation of ultrasonic through tissues and reflections, display types, A-Scan, B-Scan, M-Scan, applications, real-time ultrasonic imaging systems and probes.	2
	Magnetic Resonance Imaging – Basic NMR components, Biological effects and advantages of NMR imaging	1
	Patient Safety: Electric shock hazards, leakage current,safety codes for electro medical equipments	1

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B.TECH DEGREE EXAMINATION
(Electronics & Communication Engineering)
BIOMEDICAL ENGINEERING

Max Marks : 100 **Duration : 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1	What is a microelectrode? List any two	3
2	List three typical features of a biopotential amplifier	3
3	Draw and explain the Einthoven triangle	3
4	List the various blood pressure measurement techniques	3
5	Explain action potential and Resting Potential of brain?	3
6	What is meant by nerve conduction velocity. What is its significance?	3
7	List three ventilator parameters and explain any one.	3
8	What is ventricular defibrillation.	3
9	What are the electric shock hazards?	3
10	Compare NMR imaging and CT imaging.	3

PART B

(Answer one full question from each module)

MODULE 1

11a)	Explain about electrode-electrolyte interface and the electrical activity associated with one contraction in a muscle.	8
b)	Explain isolation amplifier with a neat diagram?	6
	OR	
12a)	How does depolarisation and repolarisation occur in a cell?	7

b) Explain chopper amplifier with a neat diagram? State applications 7

MODULE 2

13a) With necessary illustration, explain any two basic ECG lead configurations. 7

b) Explain ultrasonic blood flow meter with neat diagram? What are the advantages over other flow meters? 7

OR

14a) Explain electro conduction system of the heart with illustration 7

b) Compare direct and indirect blood pressure measurement. What is Korotkoff sound in blood pressure measurement? 7

MODULE 3

15a) With necessary block schematic explain the principle of operation of a myoelectric controlled prosthetic device. 7

b) With necessary illustration, explain the placement of electrodes for recording EEG signal. 7

OR

16a) Explain different respiratory parameters. Explain the working of a spirometer. 7

b) List six applications of Functional electrical stimulation and explain one application in detail. 7

MODULE 4

17a) What is a pacemaker? What is its significance? Explain the working with illustration of an atrio-synchronous pacemaker. 7

b) What is diathermy? With a neat block schematic diagram, explain the working and applications of surgical diathermy equipments. 7

OR

18a) What is dialysis? Explain any one type of dialyzer with necessary illustration 7

b) With the help of neat block diagram, explain the components of biotelemetry system 7

MODULE 5

19a)	With a neat block diagram, explain the technique of producing CT images.	7
b)	Explain the principle and any one application of M-mode display in ultrasound systems.	7

OR

20a)	Explain the components of an NMR imaging system with neat block diagram	8
b)	Explain how electric shock is hazardous to human body. What changes it will bring in the body, when the current increases.	6

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ECT424	SATELLITE COMMUNICATION	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to impart the basic knowledge of satellite communication and its applications.

Prerequisite: ECT 305Analog &Digital communication

Course Outcomes: After the completion of the course the student will be able to

CO1	Define satellite communications& possible satellite orbits.
CO2	Describe satellite communication subsystems& launching mechanisms of satellites.
CO3	Calculate link budgets.Provide an in-depth treatment of satellite communication systems operation and planning
CO4	Analyze the various methods of satellite access.
CO5	Discuss various applications of satellite communications

Mapping of course outcomes with program outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3										
CO2	3	3										
CO3	3	3	3									
CO4	3	3			2							
CO5	3	3										

AssessmentPattern

Bloom'sCategory	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	15	15	20
Understand	15	15	20
Apply	10	10	30
Analyse	10	10	30
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Course Seminar &Assignment :15 marks

It is mandatory that a course seminar shall be undertaken by each student for this subject. The courseseminar of 5 to 10 minute durationshall be presented by taking any topic related with satellite communication approved by the faculty. Studentshall be awarded 5 marks for presentation of topic and a brief report. Thereport has tobesubmittedforacademicauditing. In addition two assignments may be given for 5 marks each which can be a class or home assignment.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum of 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Define satellite communications& possible satellite orbits.

1. Explain the different types of satellite orbits?
2. Describe various orbital elements
3. Describe the effect of orbits on satellite performance?

Course Outcome 2 (CO2): Describe satellite communication subsystems& launching mechanisms of satellites.

1. Describe the major subsystems of a communication satellite .
2. Describe the significance of antenna subsystem why uplink and downlink frequency different in satellite communication are different.

Course Outcome 3 (CO3): Calculate link budgets. Provide an in-depth treatment of satellite communication systems operation and planning

1. Calculation of total link loss for various sky condition
2. Calculation of Effective Isotropic Radiated Power required for various Sky Conditions.

Course Outcome 4 (CO4): Analyze the various methods of satellite access

1. Describe various multiple Access Technique.
2. Compare the uplink power requirement for FDMA and TDMA

Course Outcome 5 (CO5): Discuss various applications of satellite communications

1. Explain the Basic Principle of navigation Satellite.
2. Explain Satellite Radio Broadcasting.

SYLLABUS

Module 1: Satellite Orbits:

Introduction to Satellite Communication,Historical background, Basic concepts of Satellite Communications,Kepler'slaws of planetary motion, types of satellite orbits,orbit determination.Definitions of terms for Earth-Orbiting Satellites, Orbital Elements,Apogee and Perigee Heights,satellite stabilization,orbital effects onsatellites performance. Antenna Look Angles, The Polar Mount Antenna, Limits of Visibility, launch systems for geostationary satellites.

Module 2: Satellite System:

The Space Segment

Introduction, The Power Supply, Attitude&Orbit Control, Satellite stabilization, Station Keeping, Thermal Control, TT&C Subsystem, Transponders, Antenna Subsystem

The Earth Segment

Types of earth station, architecture & design considerations .Transmit-Receive Earth Station ,

Wideband receiver, the input demultiplexer, the power amplifier, Satellite tracking.

Module3: The Satellite Link design :

Introduction,Transmission Theory,System Noise Temperature and G/T Ratio, Design of Downlinks

Ku-Band GEO Satellite Systems, Uplink Design , Design for Specified CNR: Combining CNR and C/I Values in Satellite Links ,System Design for Specific Performance. Regional &global satellite systems INSAT, INTELSAT& INMARSAT.

Module 4: Modulation & Multiple Access

Introduction,Digital Modulation techniques preferred in satellites, Multiple Access ,Frequency Division Multiple Access (FDMA) ,

Time Division Multiple Access (TDMA), Transmitter Power in TDMA Networks, Demand Assignment Multiple Access (DAMA), Random Access (RA) , Packet Radio Systems and Protocols, Code Division Multiple Access (CDMA)

Module 5: Satellite Application:

Introduction, Frequency bands, , Comparison between Satellite & terrestrial networks, Satellite Telephony,SatelliteTelevision,DTH,Satellite Radio broadcasting,Remote Sensing Satellite;Classification, orbits,payloads,Weather ForecastingSatellites:Orbits, payloads.

Navigation Satellite:Basic principles of satellite navigation, GPS Position Location Principle functional segments of GPS, Indian Contribution to positioning systems. NGSO satellite systems.

Text Books

1. Dennis Roddy, Satellite Communications, 4th Edition, McGraw- Hill International edition, 2006
2. Timothy Pratt,Jeremy E,Allnutt, Satellite Communications, Wiley, 3rd Edition, October 2019

Reference Books

1. Gerard Maral,Michel Bousquet,Zhili Sun, Satellite Communications Systems: Systems, Techniques and Technology,Wiley,6thedition,April 2020
2. Anil K. Maini, Varsha Agrawal, Satellite Communications, Wiley India Pvt. Ltd.,

2015
3. TRI.T. HA, Digital Satellite Communications, McGraw-Hill,second edition

Course Content & Lecture Schedule

Sr. No.	Content	Total Hrs
Module 1	Satellite Orbits	
	Introduction to Satellite Communication, Historical background, Basic concepts of Satellite Communication	1
	Kepler's laws of planetary motion, types of satellite orbits, orbit determination	2
	Definitions of terms for Earth-Orbiting Satellites, Orbital Elements, Apogee and Perigee Heights,	1
	Satellite stabilization, orbital effects on satellites performance.	1
	Antenna Look Angles, The Polar Mount Antenna, Limits of Visibility	1
	Launch systems for geostationary satellites.	1
Module 2	Satellite System	
	The Space Segment Introduction, The Power Supply, Attitude &Orbit Control, Satellite stabilization, Station Keeping, Thermal Control,	2
	TT&C Subsystem, Transponders,	1
	Antenna Subsystem, Antenna types & designequation(derivation not required)	1
	The Earth Segment Types of earth station, architecture & design considerations Transmit-Receive Earth Station ,	2
	Wide band receiver, The input demultiplexer, The power amplifier, Satellite tracking.	1
Module 3	The Satellite Link design	
	Introduction, Transmission Theory , System Noise Temperature and G/T Ratio , Design of Downlinks Ku-Band GEO Satellite Systems	2
	Uplink Design , Design for Specified CNR: Combining CNR and C/I Values in Satellite Links ,System Design for Specific Performance	2
	Regional &global satellite systems INSAT,INTELSAT& INMARSAT.	2
	Modulation & MultipleAccess	
	Introduction, Digital Modulation techniques preferred in satellite communication.	2

Module4	Multiple Access ,Frequency Division Multiple Access (FDMA) ,Time Division Multiple Access (TDMA), Transmitter Power in TDMA Networks, Demand Assignment Multiple Access (DAMA),	2
	Random Access (RA) , Packet Radio Systems and Protocols, Code Division Multiple Access (CDMA)	3
Module 5	Satellite Application:	
	Introduction, Frequency bands, , Comparison between Satellite & terrestrial networks,	1
	Satellite Telephony, Satellite Television, DTH, Satellite Radio broadcasting,	2
	Remote Sensing Satellite; Classification, orbits, payloads, Weather Forecasting Satellites: Orbits, payloads.	2
	Navigation Satellite: Basic principles of satellite navigation, GPS Position Location Principle functional segments of GPS. Indian Contribution to positioning systems, NGSO satellite systems.	3
	Total	**35**

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
Eighth Semester B Tech Degree Examination Branch: Electronics and Communication
Course: ECT424 SATELLITE COMMUNICATION

PART A
(Answer All Questions. Each question carries 3 marks)

1. How do geostationary and geosynchronous orbit differ?
2. What are the limits of visibility of a satellite?
3. How thermal control achieved in space craft? Why is it necessary?
4. What is the need of tracking a spacecraft & how is it practiced?
5. Briefly describe the causes of interference and noise in a satellite link?
6. Why uplink and downlink frequency different in satellite communication?
7. State the advantages of demand assignment over preassigned access techniques?
8. Why synchronization is a must for TDMA?
9. Compare satellite & terrestrial networks?
10. State the orbital requirements & payload of a remote sensing satellite?Give one example of remote sensing satellite.

PART B
(Answer one question from each module. Each question carries 14 mark.)

Module 1
11(a) State Kepler's laws of planetary motion.Using these laws determine the height of geostationary orbit (8)

11(b) Discuss the various satellite orbits and their applications. (6)

OR

12(a) Explain the need for stabilization of a space craft & methods to achieve it. (7)

(b) Briefly describe the launching methods & Launch vehicles used for putting a spacecraft into geostationary orbit. (7)

Module 2
13. Discuss the major subsystems of a communication satellite. (14)

OR

14. With a block schematic describe a transmit receive earth station (14)

Module 3
15. Derive the uplink and downlink design of a geostationary Ku band satellite (14)

OR

16(a). Discuss the regional communication satellite of India (7)

16(b). How global coverage is possible using INTELSAT. What is the use of INMARSAT (7)

Module 4

17. Discuss the digital modulation techniques used in satellite communication. (14)

OR

18(a). Discuss the Random-access techniques and the associated protocols. (7)
18 (b). Compare FDMA,TDMA,CDMA. (7)

Module 5

19(a) Discuss direct broadcast satellite & satellite radio enumerating their advantages (7)
19(b) Discuss the weather forecasting satellites explaining the orbits chosen and the payload, and applications (7)

OR

20(a) Explain the functional system of a GPS. How position determined in GPS system and methods to reduce error (8)
20(b) Explain NGSO satellite constellations. (6)

ECT434	SECURE COMMUNICATION	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to provide an insight into the theory and technology behind secure communication.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO 1 K2	Explain network security services and mechanisms and the types of attacks they are designed for
CO 2 K3	Model the symmetric encryption process and different encryption techniques
CO 3 K3	Apply the concepts of group, ring, field,modular arithmetic, Euclidean algorithm,Finite fields and polynomial arithmetic
CO4 K2	Illustrate the principles of modern symmetric ciphers like the Data Encryption Standard and Advanced Encryption Standard
CO5 K2	Outline the concepts of public key cryptography, RSA algorithm, key distribution and management for public key systems
CO6 K2	Explain the requirements for authentication and the types of functions used to produce an authenticator

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2
CO 4	3	3										2
CO 5	3	3										2
CO 6	3	3										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember K1	10	10	10
Understand	20	20	20

K2			
Apply K3	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain network security services and mechanisms and the types of attacks they are designed for

1. Describe the OSI security architecture

2. Differentiate between active and passive security threats

3. Define the categories of security services and security threats

Course Outcome 2 (CO2): Explain the general model for the symmetric encryption process and some of the encryption techniques in use

1. Describe the five ingredients in a symmetric cipher model

2. Encrypt and decryptplaintext using Hill cipher.

3. Describe one time pad.

Course Outcome 3 (CO3): Apply the concepts of group, ring, field, modular arithmetic, Euclidean algorithm, Finite fields and polynomial arithmetic

1. Define a group, ring and field

2. Determine the gcd of 2 given numbers.

3. Find the multiplicative inverse using extended Euclidean algorithm

Course Outcome 4 (CO4): Illustrate the principles of modern symmetric ciphers like the Data Encryption Standard and Advanced Encryption Standard

1. Explain avalanche effect

2. Describe the DES encryption algorithm

3. Describe ShiftRows transformation in AES

Course Outcome 5 (CO5): Describe the concepts of public key cryptography, RSA algorithm, key distribution and management for public key systems

1. Describe the key elements of a public key cryptosystem

2. Encrypt and decrypt using RSA algorithm

3. List the different schemes for distribution of public keys

Course Outcome 6 (CO6): Describe the requirements for authentication and the types of functions that may be used to produce an authenticator

1. What types of attacks are addressed by message authentication?
2. Explain the basic uses of message encryption
3. Explain the basic uses of Message Authentication Code

SYLLABUS

Module 1: Introduction and Classic Encryption Techniques

OSI security architecture, Security attacks – Passive attacks, Active attacks, Security services- Authentication, Access Control, Data Confidentiality, Data integrity, Nonrepudiation, Availability service. Model for network security. Symmetric cipher model, Cryptography, Cryptoanalysis, Substitution techniques- Hill Cipher, One time pad, Transposition Techniques

Module 2: Finite Fields

Groups,Rings and Fields, Modular arithmetic, Euclidian algorithm, Finite Fields of the form GF(p), Polynomial arithmetic

Module 3: Block Ciphers. Data Encryption Standard, AES Cipher

Block Cipher Principles – Stream Ciphers and Block Ciphers, Feistel Cipher, Feistel Decryption algorithm, The Data encryption standard, DES Decryption - Avalanche effect, The AES Cipher, substitute bytes transformation, Shift row transformation, Mix Column transformation

Module 4: Public Key Cryptography, RSA and Key Management

Principles of public key cryptosystems-Public key cryptosystems, Application for Public key cryptosystem requirements, Fermat's theorem, Euler's Totient Function, Euler's theorem, RSA algorithm, Key management, Distribution of public keys, Publicly available directory, Public key authority, public key certificates, Distribution of secret keys using public key cryptography

Module 5: Message Authentication and Hash Function

Authentication requirements, Authentication functions- Message Encryption, Public Key Encryption, Message Authentication Code, Hash function

Text Books

1. William Stallings, Cryptography and Network security: principles and practice", 4th Edition, Prentice Hall of India, New Delhi, 2006

Reference Books:

1. Behrouz A. Forouzan, Cryptography and Network security Tata McGraw-Hill, 2008
2. David S. Dummit& Richard M Foote, Abstract Algebra, 2nd Edition, Wiley India Pvt. Ltd.,2008.
3. Douglas A. Stinson, Cryptography, Theory and Practice, 2/e, Chapman & Hall, CRC PressCompany, Washington, 2005.
4. Lawrence C. Washington, Elliptic Curves: Theory and Cryptography, Chapman & Hall, CRCPress Company, Washington, 2008.
5. N. Koeblitz: A course in Number theory and Cryptography, 2008
6. Thomas Koshy: Elementary Number Theory with Applications, 2/e, Academic Press, 2007
7. Tyagi and Yadav, Cryptography and network security, Dhanpatrai, 2012

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction**	
1.1	OSI system architecture, Security attacks – Passive attacks, Active attacks	1
1.2	Security services- Authentication, Access Control, Data Confidentiality, Data integrity, Nonrepudiation, Availability service. Security Mechanisms	2
1.3	A model for network security	1
1.4	Symmetric cipher model, Cryptography, Cryptoanalysis,	1
1.5	Substitution techniques- Hill Cipher, One time pad	2
1.6	Transposition Techniques	1
		8
2	**Finite Fields**	
2.1	Groups, Rings and Fields	1
2.2	Modular arithmetic	2
2.3	Euclidian algorithm	1
2.4	Finite Fields of the form GF(p)	2
2.5	Polynomial arithmetic	2
		8
3	**Block Ciphers. Data Encryption Standard, AES Cipher**	
3.1	Block Cipher Principles – Stream Ciphers and Block Ciphers, Feistel Cipher, Feistel Decryption algorithm	2
3.2	The Data encryption standard, DES Decryption – The Avalanche effect	3
3.3	The AES Cipher, substitute bytes transformation, Shift row transformation, Mix Column transformation	4
		9
4	**Public Key Cryptography, RSA and Key Management**	
4.1	Principles of public key cryptosystems-Public key cryptosystems, Application for Public key cryptosystem requirements	2
4.2	Fermat's theorem, Euler's Totient Function, Euler's theorem, RSA algorithm- Description of the algorithm	3
4.3	Key management, Distribution of public keys, Publicly available directory, Public key authority, public key certificates, Distribution of secret keys using public key cryptography	2
		7
5	**Module 5: Message Authentication and Hash Function**	
5.1	Authentication requirements, Authentication functions- Message Encryption, Public Key Encryption, Message Authentication Code, Hash function	3
		3

Simulation Assignments: (Using Matlab/Python or any suitable software)

1. Write a program that can encrypt and decrypt using a 2x2 Hill cipher
2. Write a program that can encrypt and decrypt a railfence cipher
3. Write a program to find the multiplicative inverse using extended Euclidean algorithm
4. Write a program for calculating Euler's Totient Function

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: ECT434

Course Name: SECURE COMMUNICATION

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	Illustrate the categories of active attacks	K2
2	Express Hill Cipher system in general terms. Describe the strength of the Hill Cipher.	K2
3	Determine whether the set of residue class modulo 3 forms a group with respect to addition.	K3
4	Determine the multiplicative inverse of each non zero element in Z_5	K3
5	Differentiate between diffusion and confusion	K2
6	Differentiate between block cipher and stream cipher	K2
7	State and prove Fermats theorem	K2
8	Explain the requirements for public key cryptography	K2
9	Define the types of attacks which can be addressed by message authentication	K2
10	Define the 3 classes of functions which can be used to produce an authenticator.	K2
	PART – B Answer one question from each module; each question carries 14 marks.	
	Module - I	
11 a.	Describe specific and pervasive security mechanisms	7 CO1

		K2
b.	Decrypt the following message that was encrypted by using a railfence cipher with 4 rails. TTTPT QDSYP RSHII XEDOH EIUNS ESLDY TEMES SERSE NELSC NEAUC FLERE GAMAE BHDIH SCUCD NG	7 CO2 K3
	OR	
12 a	Describe a symmetric cipher model	7 CO1 K2
b.	Encrypt the message: "payransom" using Hill Cipher with the key $\begin{pmatrix} 5 & 1 \\ 2 & 7 \end{pmatrix}$.	7 CO2 K3
	Module - II	
13 a.	Define a field.	7 CO3 K2
b.	Find the gcd (24140, 16762)	7 CO3 K3
	OR	
14 a.	Using the extended Euclidean algorithm, find the multiplicative inverse of 1234 mod 4321	7 CO3 K3
b.	Calculate using coefficients in Z_{10} (a) $(7x+2) - (x^2+5)$ (b) $(6x^2+x+3) \times (5x^2+2)$	7 CO3 K3
	Module - III	
15 a.	Describe the internal structure of a single round of DES Encryption algorithm	8 CO4 K2
b.	In an AES system, given the plaintext {000102030405060708090A0B0C0D0E0F} and the key {01010101010101010101010101010101}, (a) Show the original contents of **State**, displayed as a 4x4 matrix (b) Show the value of **State** after initial Add Round Key Describe the characteristics of the AES Cipher	6 CO4 K3
	OR	

16	What are the parameters and design choices that determine the actual algorithm of a FeistalCipher.Describe Feistel Encryption and Decryption.	14 CO4 K2
	Module - IV	
17 a. b.	State and prove Euler's theorem Using Fermat's Theorem, find(i) 3^{201} mod 11 (ii) a number *a* between 0 and 72 with *a* congruent to 9794 modulo 73	6 CO5 K2 8 CO5 K3
	OR	
18 a. b.	Describe the essential elements of a public key cryptosystem scheme Perform encryption and decryption using RSA algorithm for p = 3, q =11, e = 7, M = 5.	7 CO5 K2 7 CO5 K3
	Module - V	
19	Describe a hash function. Illustrate the different ways in which hash function can be used to provide message authentication. Describe the confidentiality and authentication implications of the different approaches.	14 CO6 K2
	OR	
20(a) (b)	Illustrate the basic uses of message encryption Explain authentication using message authentication code	7 CO6 K2 7 CO6 K2

ECT444	PATTERN RECOGNITION	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to impart the fundamentals of statistical pattern recognition and neural network techniques.

Prerequisite: MAT 101 Linear Algebra and Calculus, MAT 204 Probability, Random Process, and Numerical Methods, ECT 463 Machine Learning

Course Outcomes: After the completion of the course the student will be able to

CO1 K2	Understand the basics of statistical pattern recognition
CO2 K3	Apply statistical methods in linear classification
CO3 K3	Apply linear algebra and statistical methods in parameter and non-parameter estimation
CO4 K3	Apply statistical methods in non-linear classification and neural networks
CO5 K2	Understand the basics of deep learning networks, convolutional neural networks

Mapping of course outcomes with program outcomes

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO11	PO12
CO 1	3											
CO 2	3	3	3	3	3							
CO 3	3	3	3	3	3							
CO 4	3											
CO 5	3			3	3							

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember				
Understand	K2	20	20	40
Apply	K3	30	30	60
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the basics of statistical pattern recognition (K2)

1. Describe the classification of pattern recognition systems
2. Describe statistical pattern recognition

Course Outcome 2 (CO2): Apply statistical methods in linear classification (K3)

1. Describe linear classifiers
2. Obtain linear classifiers using statistical methods

Course Outcome 3 (CO3): Apply linear algebra and statistical methods in parameter and non-parameter estimation (K3)

1. Explain different parameter estimation methods
2. Describe different non-parameter estimation methods

Course Outcome 4 (CO4): Apply statistical methods in non-linear classification and neural networks (K3)

1. Explain non-linear classifiers, neural networks and various associated terms
2. Using optimization techniques obtain the backpropagation algorithm

Course Outcome 5 (CO5): Understand the basics of deep learning networks, convolutional neural networks, and recurrent neural networks(K2)

1. Describe deep learning networks

2. Explain convolutional neural networks and its layers.

SYLLABUS

Module I

Basics of pattern recognition system, various applications, classification of pattern recognition systems, design of Pattern recognition system. Statistical pattern recognition: review of probability theory, Gaussian distribution, Bayes decision theory, optimal solutions for minimum error and minimum risk criteria.

Module II

Linear Classifiers, linearly separable classes, normal density, discriminant functions, decision surfaces, linear discriminants, binary class, multiple classes, cost functions, perceptron algorithm, SVM, Fisher's linear discriminant.

Module III

Parameter estimation methods: Maximum-Likelihood estimation, Bayesian parameter estimation, mixture models, mixtures of Gaussians, Expectation-maximization method.
Non-Parameter methods: Non-parametric techniques for density estimation - Parzen-window method, K-nearest neighbour density estimation, nearest neighbor rule.

Module IV

Nonlinear classifiers, the XOR problem, two-layer multilayer perceptrons, multilayer perceptrons, neural networks, feed-forward networks, hidden units, activation function, weight vector, bias, cost functions, forward and backward propagation, learning by gradient descent, backpropagation algorithm.

Module V

Introduction to deep learning networks, deep feedforward networks,ReLU, bias-variance tradeoff, regularization, dropout, vanishing/exploding gradients, weight initialization for deep networks, basics of convolutional neural networks, layers of convolutional neural networks.

Text Books:

1. Bishop, C. M. “Pattern Recognition and Machine Learning” Springer, New York, 2006.
2. Duda, R.O., Hart, P.E., and Stork, D.G. “Pattern Classification”. Wiley, New York, 2001.

References:

1. Hastie, T., Tibshirani, R. and Friedman, J. “The Elements of Statistical Learning”. Springer. 2001.
2. Theodoridis, S. and Koutroumbas, K. “Pattern Recognition”. Academic Press, San Diego, 2003.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville. “Deep Learning” MIT Press, 2016
4. Morton Nadier and Eric Smith P., Pattern Recognition Engineering , John Wiley & Sons, New York, 1993.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module I**	
1.1	Basics of pattern recognition system, various applications,	1
1.2	types of pattern recognition systems, design of Pattern recognition system.	1
1.3	Statistical pattern recognition: review of probability theory	2
1.4	Bayes decision theory, optimal solutions for minimum error and minimum risk criteria.	2
2	**Module II**	
2.1	Linear Classifiers, linearly separable classes, normal density,	2
2.2	discriminant functions, decision surfaces,	1
2.3	linear discriminants, binary class, multiple classes, cost functions,	2
2.4	perceptron algorithm, SVM ,Fisher’s linear discriminant.	2
3	**Module III**	
3.1	Parameter estimation methods: Maximum-Likelihood estimation,	2
3.2	Bayesian parameter estimation,	1
3.3	mixture models, mixtures of Gaussians, Expectation-maximization method.	2
3.4	Non-parametric techniques for density estimation - Parzen-window method,	2
3.5	K-nearest neighbour density estimation, nearest neighbor rule.	1

4	**Module IV**	
4.1	Nonlinear classifiers, the XOR problem, two-layer multilayer perceptrons,	2
4.2	multilayer perceptrons, neural networks, feed-forward networks,	1
4.3	hidden units, activation function, weight vector, bias, cost functions,	1
4.4	forward and backward propagation, learning by gradient descent, backpropagation algorithm.	3
5	**Module V**	
5.1	Introduction to deep learning networks, deep feedforward networks,	2
5.2	ReLU, bias-variance tradeoff, regularization, dropout,	2
5.3	vanishing/exploding gradients,weight initialization for deep networks,	1
5.4	basics of convolutional neural networks, layers of convolutional neural networks	2

Simulation Assignments (using Python or Matlab)

- Linear classifiers
- Maximum likelihood estimation,
- Bayesian estimation
- Expectation-maximization method.
- Multilayer perceptrons
- backpropagation
- Deep learning examples
- Basic CNN

Model Question Paper

APJ ABDULKALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER

ECT444 PATTERN RECOGNITION

Time: 3 hours **Max.Marks:100**

PART A

Answer ***all*** questions. Each question carries ***3 marks***.

1. Explain different types of pattern recognition systems with examples.
2. Explain Bayes classification rule
3. Explain the significance of minimizing risk
4. Describe discriminant functions and decision surfaces
5. Explain Fisher's linear discriminant.
6. Differentiate ML and MAP parameter estimation.
7. Explain the significance of Gaussian mixture models
8. Explain activation functions.
9. Explain vanishing and exploding gradients.
10. How weight initialization is done for deep networks.

PART B

Answer ***anyone*** question from each module. Each question carries ***14 marks.***

MODULE I

11. (a) Describe the design principles of pattern recognition system with an example(6 marks)
(b) Explain Bayes decision rule. Explain how it can be used for two class classification. (8 marks)

OR

12. (a) Show that the Bayesian classifier is optimal with respect to minimizing the classification error probability? (8 marks)
(b) Give any three applications of pattern recognition systems (6 marks)

MODULE II

13. (a)Give a description of minimum distance classifiers (8 marks)
(b) Explain Fisher's linear discriminant. (6 marks)

OR

14. (a) Obtain the decision surface for an equi-probable two class system, where the probability density functions of n-dimensional feature vectors in both classes are normally distributed. (8 marks)
(b) Give step by step description of perceptron algorithm (6 marks)

MODULE III

15. (a) Assuming a Gaussian distribution of the features, Explain the general principle of the maximum likelihood estimation for the following cases
1. Unknown mean and known covariance matrix
2. Unknown mean and unknown covariance matrix (8 marks)
(b) Compare parametric and non parametric methods for probability density function estimation. (6 marks)

OR

16. (a) Give step by step description of expectation maximization algorithm. (8 marks)
(b) How mixture models are created using Gaussian densities? (6 marks)

MODULE IV

17. (a) Explain the working principle of back propagation neural networks with neat architecture diagram (8 marks)
(b) List different types of activation functions used in perceptron models. (6 marks)

OR

18. (a) How does a multi-layer perceptron solve the nonlinear XOR problem? (8 marks)
(b) Explain weight vector, bias, cost functions (6 marks)

MODULE V

19. (a) Explain convolutional layer, pooling layers and activation functions in convolutional neural networks. (6 marks)
(b) Give the structure of deep neural networks with description of all layers (8 marks)

20. (a) Describe convolutional neural networks with detailed description of each layers (8 marks)
(b) Explain i) ReLU, ii) regularization, iii) dropout (6 marks)

ECT454	RF CIRCUIT DESIGN	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course deals with the analysis, design and simulation of Radio Frequency (RF) Circuits and Components for wireless communication systems. The course provides fundamentals of transmission lines, high frequency circuit behavior, impedance matching networks, filters, active RF components, amplifiers, and mixers. The course will enable the students to use CAD tools for simulating and designing RF circuits.

Prerequisite: ECT 302 Electromagnetics, ECT 202 Analog Circuits and ECT 205 Network Theory

Course Outcome: After the completion of the course the student will be able to

CO 1 K2	Explain the basic idea about RF networks and working of RF filter circuits
CO 2 K2	Describe the behaviour of RF components and application of Network analyser in parameter measurement
CO 3 K3	Apply the principle of RF networks in the designing of RF amplifiers, RF Oscillators and Mixers

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2		2							2
CO 2	3	3	2		3							2
CO 3	3	3	3		3				2			2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember K1	10	10	20
Understand K2	20	20	40
Apply K3	20	20	40
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1) : Explain the basic idea about RF networks and working of RF filter circuits (K2)

1. Explain the high frequency behavior of inductors
2. What do mean by characteristic impedance of a transmission line ? Give expressions
3. Give the scattering matrix for a two-port network and define each element of the matrix.
4. Explain the steps involved in the design of a filter using insertion loss technique

Course Outcome 2 (CO2): Describe the behaviour of RF components and application of Network analyser in parameter measurement (K2)

1. Describe the different physical geometry structures for high frequency BJT fabrication.
2. Explain how impedance matching is done using Quarter-wave tranformers
3. Describe the steps involved in simulating an RF circuit using any EM Simulation software
4. Explain the working of a Vector Network Analyzer

Course Outcome 3 (CO3): Apply the principle of RF networks in the designing of RF amplifiers, RF Oscillators and Mixers(K3)

1. Explain the importance of stability circles in designing Microwave Amplifiers.
2. Design a single stage transistor for maximum gain
3. Describe the working principle of a negative resistance oscillator
4. Explain the working of a Dielectric resonator oscillator.

SYLLABUS

Module 1 : Introduction to RF System (07 Hours)

1.1 **RF circuit introduction** - Importance of radio frequency design, RF behavior of resistors , inductors and capacitors.(02)

1.2 **Transmission Lines**-Equivalent Circuit representation-General Transmission Line Equation- Terminated transmission lines- Input impedance, Standing waves, VSWR, Return loss, Insertion loss, Characteristic impedance, Phase velocity.
Planar Transmission Lines – Microstrip lines and Striplines – Constructional Features (05)

Module 2 :RF Network Analysis (08 Hours)

2.1 **Single and Multi-port Networks**– Definitions-Impedance matrix, Scattering matrix, Transmission (ABCD) matrix(02)

2.2 **Impedance Matching Networks-**Design of Matching Circuits using Lumped Elements, Single Stub tuning, Quarter-Wave Transformers, Multi-Section Transformer – Binomial Transformer(04)

2.3 **RF Filter Design**- Filter Design using insertion loss technique – (02)

Module 3 :RF Components (07 Hours)

3.1 **Active RF components**- Bipolar junction Transistor – Construction-Functionality-Power Frequency Limitations of High Frequency transistors.GaAs devices - Familiarization of RF Field Effect Transistors and High Electron Mobility Transistors–Constructional details (04)

3.2 **RF circuit measurements and characterization**- Using Vector Network analyzer - S parameter, Reflection Coefficient and Insertion lossMeasurement (02)

3.3 **Modeling and Simulation of RF circuits using** – Open source or Commercial EM Simulation Softwares(01)

Module 4:Radio Frequency Amplifiers (07 Hours)

4.1 **Amplifier design using S-parameters** - Characteristics of Amplifier Power Relations, Stability Considerations – Stability Circles, Tests for Unconditional Stability -(04)

4.2 **High frequency amplifier design** – Single stage amplifier Design – Design for maximum gain, Low noise amplifier design (03)

Module 5: Radio Frequency Oscillators and Mixers (07 Hours)

5.1 **Basic oscillator model** -Feedback oscillator design—Negative Resistance Oscillator-Dielectric Resonator Oscillator - YIG Tuned Oscillator (04)

5.2 Mixer - Basic characteristics – Single-Ended Mixer Design,Single-balanced and double-balanced mixers (03)

Text Books

1. Ludwig, Reinhold. *RF Circuit Design: Theory & Applications, 2/e*. Pearson Education India, 2000.
2. Pozar, David M. *Microwave and RF design of wireless systems*. John Wiley & Sons, 2000

Reference Books

1. Radmanesh, Matthew M. *Advanced RF & microwave circuit design: the ultimate guide to superior design*. AuthorHouse, 2008.
2. Carr, Joseph J. *Secrets of RF circuit design*. McGraw-Hill Education, 2001.
3. Misra, Devendra K. *Radio-frequency and microwave communication circuits: analysis and design*. John Wiley & Sons, 2012.
4. Mathew M. Radmanesh, "Radio Frequency & Microwave Electronics", 2nd Edition, Pearson Education Asia, 2002.
5. Rohde, Ulrich L., and David P. Newkirk. *RF/microwave circuit design for wireless applications*. John Wiley & Sons, 2000.
6. Davis, W. Alan, and Krishna Kumar Agarwal. *Radio frequency circuit design*. John Wiley, 2001.
7. Christopher, Bowick, Ajluni Cheryl, and Blyler John. *RF Circuit Design*. Newnes, 2007.
8. Abrie, Pieter LD. *Design of RF and microwave amplifiers and oscillators*. Artech House, 1999.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to RF System07**	
1.1	Introduction to RF circuits- Importance of radio frequency design, RF behaviour of resistors , Inductors and capacitors	2
1.2	Transmission Lines- Equivalent Circuit representation- General Transmission Line Equation	1
1.2	Terminated transmission lines –Input Impedance	1
1.2	Standing waves, VSWR, Return loss, Insertion loss, Characteristic impedance,	1
1.2	Planar Transmission Lines – Microstrip lines and Striplines – Constructional Features	2

2	**RF Network Analysis**	**08**
2.1	Single and Multi-port Networks- Impedance matrix, Scattering matrix, Transmission (ABCD) matrix	2
2.2	Impedance matching Network- Design of Matching Circuits using Lumped Elements, Single Stub Matching	2
2.2	Quarter-Wave Transformers, Multi-Section Transformer – Binomial Transformer	2
2.3	RF Filter Design - Filter Design using insertion loss technique	2
3	**RF Components**	**07**
3.1	Active RF components - Bipolar junction Transistor – Construction - Functionality-Power Frequency Limitations of High Frequency transistor	2
3.1	GaAs devices - Familiarization of RF Field Effect Transistors and High Electron Mobility Transistors – Constructional details	2
3.2	RF circuit measurements and characterization - Using Vector Network analyzer - S parameter, Reflection Coefficient and Insertion loss Measurement	2
3.3	Modelling and Simulation of RF circuits using – Opensource/Commercial EM simulation software’s	1
4	**RF Amplifiers**	**07**
4.1	Amplifier design using S-parameters- Characteristics of Amplifier Power Relations	2
4.1	Stability Considerations – Stability Circles, Tests for Unconditional Stability	2
4.2	High frequency amplifier design– Single stage amplifier Design – Design for maximum gain,	2
4.2	Low noise amplifier design	1
5	**RF Oscillators and Mixers**	**07**
5.1	Basic oscillator model-Feedback oscillator design—Negative Resistance Oscillator	2
5.1	Dielectric Resonator Oscillator- YIG Tuned Oscillator	2
5.2	Mixer **-** Basic characteristics – Single-Ended Mixer Design	2
5.2	Single-balanced and double- balanced mixers	1

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: ECT454

Course Name: RF CIRCUIT DESIGN

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer ALL Questions. Each Question Carries 3 Marks.)

1. Explain how the capacitor behave at high frequencies
2. Derive the expression for the input reflection coeff(Γ_{in}), source reflection coeff(Γ_s), and output reflection coeff (Γ_{out}), of a loaded transmission line.
3. What is scattering matrix? Give the scattering parameters of a two port network.
4. How the impedance matching is performed with quarter wave transformer?
5. Describe the features of HEMT.
6. Explain how S-parameter measurement is done using vector network analyser
7. Explain how will you check whether a transistor is unconditionally stable or not
8. How the input VSWR and Output VSWR affects the design of amplifiers?
9. Explain the principle of negative resistance oscillators.
10. What is Inter Modulation Distortion (IMD)? [10 X 3= 30]

PART – B

(Answer one question from each module; each question carries 14 marks)

Module – I

11. (a) Explain the terms i)VSWR ii)Return loss iii) Characteristic impedance . [07 Marks]
 (a) How the inductor coils behave at high frequencies ? [07Marks]

OR

12. (a)How the resistors behave at high frequency? Give the electric equivalent circuit representation of a high frequency resistor. [07 Marks]
 (b). What is lossless transmission line? Derive expression for Characteristic impedance of a lossless transmission line [07 Marks]

Module – II

13. (a) Explain the steps involved in the design of filter using the Insertion Loss Technique ? [08 Marks]
 (b) What is transmission parameter matrix? Derive the same for a T network. [06 Marks]

OR

14. (a) With the help of neat sketches explain how single stub tuning is done. [07 Marks]

(b) Design a binomial transformer for to match 50 Ω to a 75 Ω line and calculate the bandwidth for $\Gamma_m = 0.03$. [07 Marks]

Module – III

15. (a) With the help of a neat block diagram explain the working of Vector network analyzer. [07 Marks]

(b) What is power frequency limitation of high frequency power transistors? Explain. [07 Marks]

OR

16. (a) Explain the steps involved in designing a circuit using any EM simulation software [08 Marks]

(b) Draw the cross sectional view of HEMT device and explain the working of the same device. [06 Marks]

Module – IV

17. (a) Derive the expression for the Unilateral Power gain G_{TU} of an amplifier. [07 Marks]

(b) Explain how a low noise amplifier is designed [07 Marks]

OR

18. (a)What is the radius and center of an output stability circle of a RF amplifier? [07 Marks]

(b) How will you design a single stage amplifier for maximum gain ? [07 Marks]

Module V

19. (a) Explain the working principle of a negative resistance oscillator [07 Marks]

(b) With the help of neat sketches explain the working of YIG tuned Oscillator. [07 Marks]

OR

20. (a) Derive the S matrix for the dielectric resonator oscillator . [07 Marks]

(b)Draw the neat circuit diagram for a double balanced diode mixer circuit and explain the working of the same. [07 Marks]

ECT464	MIXED SIGNAL CIRCUIT DESIGN	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to analyse various CMOS analog and digital mixed signal circuits.

Prerequisite: ECT 202 ANALOG CIRCUITS, ECT 203 LOGIC CIRCUIT DESIGN

Course Outcomes: After the completion of the course the student will be able to

CO1/K3	Implement various analog and digital CMOS subcircuits
CO2/K4	Analyse various CMOS amplifiers
CO3/K4	Analyse Data Converters

Mapping of course outcomes with program outcomes

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember K1	10	10	10
Understand K2	20	20	20
Apply K3	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1: Implement various analog and digital CMOS subcircuits

1. Analyse MOS with different load conditions.
2. Design of current mirror circuits

Course Outcome 2 Analyse various CMOS amplifiers

1. Analyse CMOS CS Amplifiers for various load conditions.
2. Explain various circuit technique for improving gain of Opamp
3. Design of Two stage opamp for different load condition

Course Outcome 3 Analyse Data Converters

1. Explain various non idealities in DAC and ADC.
2. Design of ADC's for given specification (eg: 6 Bit 100 MHz Folding ADC).

SYLLABUS

Module 1:CMOS Amplifiers

Active load: MOS resistor, MOS current source, diode connected MOS.

CMOS Amplifiers: Common source amplifier with resistive and active loads, Common source amplifier with source degeneration, Common gate and Common drain amplifier (only voltage gain and input and output impedances of the circuits).

Module 2:CMOS Differential Amplifiers

MOS Current Mirror: Simple, Cascode and Wilson current mirror circuits.

CMOS Differential Amplifier: Differential Amplifier with resistive, current source, with current mirror and cascode loads(only voltage gain and input and output impedance of the circuits).

Module 3:CMOS Operational Amplifier

Opamp Performance parameters, Single stage and two stage op-amps with different types of load. Gain Boosting in Opamp

Module 4:References and Switched Capacitor Circuits

References: Supply Independent Biasing, Temperature independent references– band gap reference.

Switched Capacitor Circuits: Switched capacitor resistor, Switched CapacitorIntegrator,1st order filter.

Module 5: Data Converters

DAC: Non-idealities in DAC, Types: Resistive, Charge redistribution, Voltage Scaling, Cyclic and Pipelined.

ADC: Non-idealities in ADC, Sample and Hold circuit, quantization errors, Types of ADC : Flash, two step, pipelined, successive approximation, Folding.

Text Books:

1.Behzad Razavi, "Design of Analog CMOS Integrated Circuits", McGraw-Hill, 2/e, 2002

2.Meyer Gray , Hurst, Lewis, "Analysis and Design of Analog Integrated Circuits", 5th Edition ,Wiley 2009

Reference Books:

1. Phillip E. Allen, Douglas R. Holbery, CMOS Analog Circuit Design, Oxford, 2004.
2. Razavi B., Fundamentals of Microelectronics, Wiley student Edition2014.
3. Baker, Li, Boyce, CMOS: Circuits Design, Layout and Simulation, PHI, 2000

Course Contents and Lecture Schedule

No.	Topic	Hrs.
1	**CMOS Amplifiers**	
1.1	MOS basics.	1
1.2	MOS resistor, MOS current source, diode connected MOS.	2
1.3	Common source amplifier with resistive and active loads, Common source amplifier with source degeneration.	3
1.4	Common gate amplifier.	1
1.5	Common drain amplifier.	1
2	**CMOS Differential Amplifiers**	
2.1	Simple current mirror, Cascode and Wilson current mirrors.	1
2.2	Differential Amplifier with resistive load.	1
2.3	Differential Amplifier with current source and current mirror loads.	2
2.4	Differential Amplifier with cascode load.	2
3	**CMOS Operational Amplifier**	
3.1	Opamp Performance Parameters	1
3.2	Single stage op-amp with resistive and active loads.	2
3.3	Two stage op-amp with resistive and active loads.	2
3.4	Gain Boosting in Opamp	1
4	**References and Switched Capacitor Circuits**	
4.1	SupplyIndependentBiasing.	1
4.2	Temperatureindependent reference- Negative and Positive T C Voltage	1
4.3	Bandgapreference.	1
4.4	Switched capacitor resistor, Switched Capacitor Integrator	2
4.5	1st order filter.	1
5	**Module 5: Data Converters**	
5.1	DAC non-idealities, Resistive DAC, Charge redistribution DAC.	1

5.2	Voltage Scaling DAC, Cyclic and Pipelined DAC.	2
5.3	ADC non-idealities,	1
5.4	Sample and Hold circuit.	1
5.5	Quantization errors.	1
5.6	ADC Types:Flash, two step, pipelined, successive approximation, folding ADC	3
	Total Hours	**35**

Simulation Assignments:
Atleast one assignment should be simulation of the circuits. The simulations can be done in QUCS, KiCad or PSPICE.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B.TECH DEGREE EXAMINATION
Course Code: ECT464
Course Name: MIXED SIGNAL CIRCUIT DESIGN
Max. Marks: 100 Duration: 3 Hours

PART A
Answer ALL Questions. Each Carries 3 mark.

1	Write down the expression for drain current of an NMOS transistor in active and saturation regions.	K1
2	Draw the small signal model of low frequency MOSFET.	K1
3	State the significance of diode connected transistor in current mirror circuits.	K2
4	Differentiate between cascade and cascode configurations.	K2
5	What is the significance of tail current source in a differential amplifier?	K2
6	What is the purpose of stage 1 and sage 2 amplifiers in a 2-stage op-amp?	K2
7	What are the important parameters that are to be considered while designing reference circuits?	K1
8	Derive the equivalent resistance of a series switched capacitor resistor.	K3
9	Mention any two non-idealities of a DAC.	K2
10	What is quantization error in an ADC?	K2
	PART – B Answer one question from each module; each question carries 14 marks.	
	Module - I	
11a.	Draw the circuit diagram and derive the equivalent resistance of a MOS resistor.	4 CO1 K3
b.	Derive the voltage gain and output impedance of common source amplifier.	10 CO2 K3
	OR	
12a.	Draw the circuit diagram and derive the equivalent resistance of a MOS current	4

	source.	CO1 K3
b.	Derive the voltage gain and output impedance of common gate amplifier.	10 CO2 K3
	Module - II	
13a.	Derive the output impedance of simple current mirror	6 CO1 K3
b.	Derive the voltage gain and output impedance of Differential Amplifier with current source load.	8 CO2 K3
	OR	
14	Derive the voltage gain and output impedance of Differential Amplifier with current mirror load.	14 CO2 K3
	Module - III	
15	Draw the circuit diagram and derive the voltage gain and output impedance of a simple op-amp with cascade load.	14 CO2 K3
	OR	
16	Draw the circuit diagram and derive the voltage gain and output impedance of a 2-stage op-amp with NMOS inputs.	14 CO2 K3
	Module - IV	
17a.	Draw the circuit diagram and explain the working of supplyindependentbiasing circuit	5 CO3 K3
b.	Draw the circuit diagram and derive the transfer function of parasitic sensitive switched capacitor integrator.	9 CO3 K3
	OR	
18	Draw the circuit diagram and derive the transfer function of general1st order switched capacitor filter. Also mention the circuits for high pass and low pass filters.	14 CO3 K3
	Module - V	
19a.	Derive the expression for SNR of a DAC	5 CO3 K3
b.	Draw the circuit diagram and explain the working of pipeline DAC	9 CO3 K3
	OR	

20a.	Explain INL and DNL errors in data converters.	5 CO3 K3
b.	Draw the circuit diagram and explain the working of successive approximation ADC	9 CO3 K3

ECT474	ENTREPRENEURSHIP	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: The objective of this course is to understand the knowledge of entrepreneurship and apply in the organization.

Prerequisite: Students should have a basic knowledge in management

Course Outcomes: After the completion of the course the student will be able to

CO 1	Discuss the fundamental concepts of entrepreneurship
CO 2	Understand entrepreneurial motivation and motivation theories
CO 3	Analyze types of enterprises and ownership structure
CO 4	Applyproject evaluation methods
CO5	Evaluate enterprise financial strength

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1										1	1	
CO 2								2		1		
CO 3										1		
CO 4	2		1		2					1	3	
CO 5	2		1		2					1	3	

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	10
Understand	20	10	10
Apply	20	10	40
Analyse		10	20
Evaluate		10	20
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the Concept of entrepreneur.

2. Explain the characteristics and qualities of entrepreneurs.

Course Outcome 2 (CO2):

1. Describe a few ways to promote innovations in an organization.

2. Discuss the motivational theories.

Course Outcome 3(CO3):

1. Explain the various types of ownerships available to entrepreneurs.

2 Describe features of limited companies.

Course Outcome 4 (CO4):

1. Explain the factors influencing project plan.

2. Write a note on IRR.

Course Outcome 5 (CO5):

1. List the sources of finance.

2. Define break-even analysis.

Syllabus

Module I

Entrepreneurship: definition, requirements to be an entrepreneur, entrepreneur and intrapreneur, entrepreneur and manager, growth of entrepreneurship in India, women entrepreneurship, rural and urban entrepreneurship.

Entrepreneurial Motivation: motivating factors, motivation theories-Maslow's need hierarchy theory, McClelland's acquired need theory, government's policy actions towards entrepreneurial motivation, entrepreneurship development programmes.

Module II

Types of Enterprises and Ownership Structure: small scale, medium scale and large scale enterprises, role of small enterprises in economic development; proprietorship, partnership, limited companies and co-operatives: their formation, capital structure and source of finance.

Module III

Institutional Support and Policies: institutional support towards the development of entrepreneurship in India, technical consultancy organizations,Government programs, policies, incentive and institutional networking for enterprise setting,women entrepreneurship development in India, promotional schemes.

Module IV

Projects: identification and selection of projects, project report, contents and formulation, elements of project formulation, project design and network analysis, concept of project evaluation, methods of project evaluation: internal rate of return method and net present value method.

Module V

Management of Enterprises: objectives and functions of management, scientific management, general and strategic management; introduction to human resource management: planning, job analysis, training, recruitment and selection, marketing and organizational dimension of enterprises; enterprise financing, raising and managing capital, shares, debentures, bonds, cost of capital; break- even analysis, balance sheet analysis.

Textbook

1. Ram Chandran, Entrepreneurial Development,Tata McGraw Hill, New Delhi, 2008
2. Saini, J. S.Entrepreneurial Development Programmes and Practices, Deep & Deep Publications,2012

References

1. Khanka,SS.Entrepreneurial Development, S Chand & Company Ltd. New Delhi,2007
2. Badhai, B Entrepreneurship for Engineers, Dhanpat Rai & co, 2006
3. Desai,Vasant, Project Management and Entrepreneurship',HimalayanPublishing ,Mumbai, 2017
4. Gupta, Srinivasan, 'Entrepreneurial Development', S Chand & Sons, New Delhi,2020
5. Kuratko and Rao, Entrepreneurship,Cengage Learning,2012

Course Contents and Lecture Schedule

No	TOPIC	No. of Lectures
1	Introduction to Entrepreneurship	
1.1	Entrepreneurship: definition, requirements to be an entrepreneur, entrepreneur and intrapreneur,	1
1.2	Entrepreneur and manager, growth of entrepreneurship in India, women entrepreneurship	1
1.3	Rural and urban entrepreneurship.	1
1.4	Entrepreneurial motivation: motivating factors, motivation theories, Maslow's Need Hierarchy Theory.	2
1.5	McClelland's acquired need theory, government's policy actions towards entrepreneurial motivation.	1
1.6	Entrepreneurship development programmes.	1
2	Types of enterprises and ownership structure	
2.1	Small scale, medium scale and large scale enterprises.	2
2.2	Role of small enterprises in economic development.	1
2.3	Proprietorship, partnership	1
2.4	Limited companies	1
2.5	Co-operatives: their formation, capital structure and source of finance	2
3	Institutional support and policies	
3.1	Institutional support towards the development of entrepreneurship in India	1
3.2	Technical consultancy organizations	1
3.3	Government programs, policies, incentive and institutional networking	2

	for enterprise setting.	
3.4	Women entrepreneurship development in India	1
3.5	Promotional schemes.	1
4	Projects	
4.1	Identification and selection of projects	1
4.2	Project report, contents and formulation.	1
4.3	Elements of project formulation,	1
4.4	Project design and network analysis.	1
4.5	Concept of project evaluation, methods of project evaluation	1
4.6	Internal rate of return method	1
4.7	Net present value method.	1
5	Management of Enterprises	
5.1	Objectives and functions of management, scientific management, general and strategic management.	1
5.2	Introduction to human resource management, planning, job analysis.	1
5.3	Training, recruitment and selection	1
5.4	Marketing and organizational dimension of enterprises.	1
5.5	Enterprise financing, raising and managing capital, shares, debentures bonds, cost of capital	2
5.6	Break- even analysis	1
5.7	Balance sheet analysis.	1

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B.TECH DEGREE EXAMINATION
COURSE CODE: ECT474
COURSE NAME: ENTREPRENEUSHIP
Max. Marks: 100 Duration: 3 Hours

PART A

(Answer **all** questions. Each question carries **3** marks)

1“Entrepreneurs are made or born.” Give your views.

2 Explain the role of entrepreneurial development programme (EDP)

3 Explain the organizational structure of SMEs.

4 Explain the various types of ownerships available to entrepreneurs.

5 Write a note on Women entrepreneurs.

6 Discuss the incentives availablefor enterprise setting.

7 List the Explain the factors influencing project plan.

8 Discuss the aspects and methods of project appraisal.

9 List the job analysis methods.

10 Explain raising and managing capital.

(10x3=30 marks)

PART B

(Answer **one** question from each module. Each question carries **14** marks)

Module I

11 Explain the characteristics and qualities of entrepreneurs.

12 Discuss the Maslow's need hierarchy theory.

Module II

13Explain the role and importance of Small and Medium Enterprises.

14Explain the various types of ownerships available to entrepreneurs. Discuss each form in brief.

Module III

15 Explain the role of central Government and state Government in promoting entrepreneurship.

16 What is the status of women entrepreneurs in contemporary business? Illustrate with examples.

Module IV

17 Explain IRR.

18 Explain net present value method.

Module V

19 What is working capital? Why is it important for any enterprise? Explain.

20 Discuss break- even analysis.

(5x14=70 marks)

SEMESTER VIII

PROGRAM ELECTIVE IV

ECT416	**MODERN COMMUNICATION SYSTEMS**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		PEC	**2**	**1**	**0**	**3**

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Preamble: This course aims to impart knowledge on the basics of modern communication systems and the breakthrough wireless technologies.

Prerequisite: MAT 204 Probability, Random Process and Numerical Methods, ECT 305 Analog and Digital Communication, ECT 306 Information Theory and Coding

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain OFDM, OFDMA and SC-FDMA techniques used in cellular communication
CO2	Discuss the different wireless communication standards for short range communication
CO3	Explain the IoT architecture and various connectivity technologies used in IoT Systems
CO4	Understand the various communication standards for connected autonomous vehicles
CO5	Explain the significance and architecture of software defined radio and cognitive radio

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO1	3	3	3		2							
CO2	3	3	3			3						1
CO3	3	3	3			3						
CO4	3	3	3			3						1
CO5	3	3	3		2							

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. Mark patterns are as per the syllabus with 70 % for theory and 30% for logical/numerical problems, derivation and proof.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is shadowing and how it can be modelled in mobile communication?
2. Explain PAPR in OFDM systems.

Course Outcome 2 (CO2):

1. Compare the physical-layer characteristics of various IEEE 802.11 standards.
2. Explain the characteristics of millimeter wave.

Course Outcome 3 (CO3):

1. Differentiate between WiFi and Bluetooth standards in IoT systems.
2. Explain the salient features of 6LoWPAN.

Course Outcome 4 (CO4):

1. Mention the advantages of 4G/5G LTE standard in vehicular communication.
2. Explain the DSRC standard for vehicular communication.

Course Outcome 5 (CO5):

1. Explain the issues with zero IF receiver architecture for SDR.
2. Discuss the functions of software adaptable network (SAN) in cognitive network.

SYLLABUS

Module	Course contents
I	**Module 1: Cellular Communication System** Need for Multi carrier system, Basics of Orthogonal Frequency Division Multiplexing (OFDM), Multiple access for OFDM systems, Orthogonal Frequency Division Multiple Access (OFDMA), Single carrier Frequency Division Multiple Access (SC-FDMA). Cellular concept, path loss and shadowing, Doppler shift, Multipath effect, Significance of diversity in wireless communication systems.
II	**Module 2: Short Range Communication System** Introduction to current wireless technologies, background and current scenario, future wireless network requirements, IEEE 802.11 (Wi-Fi) standards and applications (IEEE 802.11a/b/g/n/ac/ax), HiperLAN technology, WPAN (IEEE 802.15.1, IEEE 802.15.3 & IEEE 802.15.4) and WMAN (IEEE 802.16a - WiMAX), Space time wireless standards, IEEE 802.16 (Wi-Max standard), 3GPP-LTE standard, Millimeter wave characteristics, Channel performance at 60 GHz, Development of millimeter wave standards, Indoor and outdoor applications for millimeter wave communications. 6G Networks – Use Cases and Technologies.
III	**Module 3: IoT System** Introduction of IoT, characteristics, physical and logical design of IoT, IoT Enabling Technologies – Wireless Sensor networks, Cloud computing. Introduction to IoT, Evolution of IoT, IoT Networking Components. IoT Connectivity Technologies – Zigbee, Wireless HART, RFID, NFC, LoRa, WiFi, Bluetooth. IoT Communication Technologies – Infrastructure Protocols – IPv6, 6LoWPAN, Data Protocols – MQTT, MQTT-SN, CoAP. IoT Case Studies and Future Trends – Agricultural IoT, Vehicular IoT, Healthcare IoT.
IV	**Module 4: Intelligent Transport System** Introduction to Intelligent Vehicular Communication – Evolution, Vehicular Networks and ITS, Vehicular Communication Standards/ Technologies – DSRC, IEEE 802.11p WAVE, IEEE 1609, IEEE 802.15.7 - Visible Light Communication (VLC), 4G/5G-Device to Device (D2D), 6G Cellular Networks and Connected Autonomous Vehicles, Operational Scenario – Collision Avoidance.
V	**Module 5: Software Defined Radio System** Software radio concepts, Operating frequency bands, Transmitter and Receiver specifications of SDR, Architecture of SDR, Introduction of cognitive radio,

	significance of cognitive radio and spectrum subleasing, spectrum sharing in cognitive radio, implementation of cognitive radio.

Text Books

1. Aditya K. Jagannatham, "Principles of Modern Wireless Communication Systems", Tata McGraw Hill, 2016.
2. T.L. Singal, "Wireless Communications", Tata McGraw Hill Education Private Limited, Second Edition, 2011.
3. K. C. Huang, Z. Wang, "Millimeter Wave Communication systems", John Wiley &Sons.
4. Sudip Misra, Anandarup Mukherjee & Arijit Roy. "Introduction to IoT". Cambridge University Press. 2021.
5. George J. Dimitrakopoulos. "Current Technologies in Vehicular Communication", Springer International Publishing, 2017.
6. He, J., Yang, K. and Chen, H.H, "6G Cellular Networks and Connected Autonomous Vehicles", IEEE Network, vol. 35, no. 4, pp. 255 -261, 2020.
7. Walter Tuttlebee, "SDR Enabling Technologies", John Wiley.
8. Huseyin Arslan, "Cognitive Radio, SDR and Adaptive Wireless System", Springer, 2007.

Reference Books

1. Dipankar Raychaudhuri, Mario Gerla, "Emerging Wireless Technologies and the Future Mobile Internet", Cambridge University Press, 2011.
2. ArshdeepBahga, A., & Vijay Madisetti V. "Internet of Things: A hands-on approach". Vpt., 2014.
3. Paul, A., Chilamkurti, N., Daniel, A. and Rho, S. "Intelligent vehicular networks and communications: fundamentals, architectures and solutions". Elsevier, 2016.
4. Peter B. Kenington, 'RF and baseband techniques for software defined radio", Artech House Mobile Communication, 2005.

Course content and Lecture plan

No	TOPIC	No of Lectures
MODULE 1		
1.1	Need for Multi carrier system	1
1.2	Basics of Orthogonal Frequency Division Multiplexing (OFDM), Multiple access for OFDM systems	2
1.3	Orthogonal Frequency Division Multiple Access (OFDMA)	1
1.4	Single carrier Frequency Division Multiple Access (SC- FDMA)	1
1.5	Cellular concept, path loss and shadowing, doppler shift,	2

	Multipath effect	
1.6	Significance of diversity in wireless communication systems	1
MODULE II		
2.1	Introduction to current wireless technologies, background and current scenario, future wireless network requirements	1
2.2	IEEE 802.11 (Wi-Fi) standards and applications (IEEE 802.11a/b/g/n/ac/ax)	1
2.3	HiperLAN technology	1
2.4	WPAN (IEEE 802.15.1, IEEE 802.15.3 & IEEE 802.15.4)	2
2.5	WMAN (IEEE 802.16a - WiMAX), 3GPP-LTE standard	1
2.6	Millimeter wave characteristics, Channel performance at 60 GHz, Development of millimeter wave standards	2
2.7	Indoor and outdoor applications for millimeter wave communications, 6G Networks – Use Cases and Technologies.	1
MODULE III		
3.1	Introduction to IoT, Evolution of IoT, IoT Networking Components	1
3.2	IoT Connectivity Technologies – Zigbee, Wireless HART, RFID, NFC, LoRa, WiFi, Bluetooth	2
3.3	IoT Communication Technologies – Infrastructure Protocols – IPv6, 6LoWPAN	2
3.4	Data Protocols – MQTT, MQTT-SN, CoAP	1
3.5	IoT Case Studies and Future Trends – Agricultural IoT, Vehicular IoT, Healthcare IoT	1
MODULE IV		
4.1	Introduction to Intelligent Vehicular Communication – Evolution, Vehicular Networks and ITS	1
4.2	Vehicular Communication Standards/ Technologies – DSRC, IEEE 802.11p WAVE, IEEE 1609, IEEE 802.15.7 - Visible Light Communication (VLC)	2
4.3	4G/5G-Device to Device (D2D), 6G Cellular Networks and Connected Autonomous Vehicles	2
4.4	Operational Scenario – Collision Avoidance	1
MODULE V		
5.1	Software radio concepts, Operating frequency bands, Transmitter and Receiver specifications of SDR	1
5.2	Architecture of SDR	1
5.3	Introduction of cognitive radio, significance of cognitive radio and spectrum subleasing, spectrum sharing in cognitive radio	2
5.4	Implementation of cognitive radio	1

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B. TECH DEGREE EXAMINATION

Course Code: ECT416

Course Name: MODERN COMMUNICATION SYSTEMS

Max. Marks: 100 Duration: 3 Hours

	PART A **Answer all questions, each carries 3 marks**	
1.	Explain inter-carrier interference in OFDM systems.	3
2	Determine the maximum speed of a vehicle in a mobile communication system experiencing a maximum Doppler frequency shift of 70 Hz and a frequency of transmission 900 MHz.	3
3	Write the physical layer specifications of IEEE 802.16 WMAN technology.	3
4	What are the main challenges in utilizing a 60 GHz channel for millimeter wave communication?	3
5	Describe the various IoT networking components?	3
6	What is LoRaWAN? How is it different from LoRa?	3
7	What are the advantages of VLC standard over other communication standards in vehicular communication?	3
8	Mention the main limitations of IEEE 802.11p standard compared to cellular communication in connected autonomous vehicles.	3
9	List the main SDR transmitter specifications?	3
10	Describe spectrum subleasing and sharing in cognitive radio.	3
	PART B **Answer any one full question from each module carries 14 marks.**	
	MODULE 1	
11	a. What is the need for adding cyclic prefix to the OFDM sequence.	4
	b. Draw and explain the SC-FDMA transmitter and receiver schematic.	10
	OR	

12	a. Briefly explain free space propagation model in wireless communication.	8
	b. A mobile subscriber travels at a uniform speed of 60 km/h. Compute the time between fades if the mobile uses (i) a cellphone operating at 900 MHz (ii) a PCS phone operating at 1900 MHz Comment on the results obtained.	6
	MODULE II	
13	a. Write any three indoor and outdoor applications of millimeter wave communication.	6
	b. Compare the three different IEEE 802.15 WPAN standards.	8
	OR	
14	a. Briefly explain the different elements to be considered while considering an existing backhaul network to support a millimeter wave network.	8
	b. Discuss the advantages and disadvantages of WLAN technology.	6
	MODULE III	
15	a. Explain the principle of operation of MQTT data protocol employed in IoT networks.	6
	b. Briefly describe the architecture of healthcare IoT system.	8
	OR	
16	a. Briefly explain Zigbee protocol stack used in IoT Systems.	8
	b. Discuss the salient features of the CoAP protocol.	6
	MODULE IV	
17	a. Explain the key components of connected autonomous vehicles in 6G communications with the help of a diagram.	6
	b. Describe how collision avoidance can be achieved through vehicular communication.	8
	OR	
18	a. With the help of a diagram, explain the architecture of ITS system utilizing VLC standard for V2X communication.	9
	b. Briefly explain IEEE 1609 standard used in vehicular communication.	5
	MODULE V	
19	a. Briefly explain the low IF receiver architecture for SDR.	9
	b. Define cognitive radio and explain its significance.	5
	OR	

20	a. Describe software defined radio with the help of functional block diagram.	7
	b. Discuss about the implementation of cognitive network.	7

Simulation Assignments

The following simulation assignments can be done with Python/ MATLAB/ SCILAB/ LabVIEW.

1. **Peak to Average Power Ratio (PAPR) of OFDM and SC-FDMA system**
    - Realize the block diagram of OFDMA transmitter system shown in Fig 7.8 in page 240 in *Principles of Modern Wireless Communication Systems*.
    - Create a random bit vector of arbitrary length. Realize the OFDM transmitter by mapping the message bits into a sequence of QPSK symbols and convert it into N parallel streams.
    - Realize the multicarrier modulation by computing IFFT.
    - Implement parallel to serial converter and add cyclic prefix to generate the OFDM signal.
    - Compute the PAPR of OFDM signal and plot its complementary CDF (CCDF).
    - Realize the block diagram of SC-FDMA transmitter system shown in Fig 7.18 in page 260 in *Principles of Modern Wireless Communication Systems*.
    - To generate SC-FDMA signal, repeat the steps followed in OFDM transmitter with the addition of 2 blocks FFT computation and subcarrier mapping before IFFT computation.
    - Compute the PAPR of SC-FDMA signal and plot its CCDF.
    - Compare both CCDF graphs and observe the reduction in PAPR for SC-FDMA system.

2. **Computation of Free space path loss and received power**
    - Input a suitable signal frequency, f and distance between the transmitter and receiver, d.
    - Compute the free space propagation path loss, Lp using Eq. 3.13 and 3.14 in page 71 in *Wireless Communications,* assuming transmitter and receiver antenna gain as unity.
    - Study the effect of antenna gain on path loss by computing path loss, with non-unity transmitter, Gt and receiver antenna gain, Gr.
    - Find the received power, Pr for a particular transmitter power, Pt, Gt , Gr and Lp using Eq. 3.12 in page 71 in *Wireless Communications.*
    - Repeat the above step for different values of Pt, Gt, Gr and Lp. Observe the variation in received power

3. **SDR Receiver**
    - Study the various dynamic range issues of SDR receiver, based on the receiver design considerations given in Section 2.2.1 in page 29 – 31 in *SDR Enabling Technologies*.
    - Compute third order intercept (TOI) using Eq. 1 in page 36 in *SDR Enabling Technologies,* by giving suitable input parameters.

- Compute overall noise figure of cascade of amplifiers and its worst-case TOI using Eq. 2 and 3 in page 36 in *SDR Enabling Technologies*.
- Study the dynamic range of SDR receiver by calculating spurious free dynamic range (SFDR) using Eq. 5 in page 40 in *SDR Enabling Technologies*.

ECT426	REAL TIME OPERATING SYSTEMS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Prerequisite: ECT 206 computer Architecture and Microcontrollers

Course objectives: The objectives of this course are to:

1. Identify the basics of general operating systems.
2. Understand the structure and the scheduling operations performed by the operating systems.
3. Introduce Real Time Operating Systems, its basic structure, building blocks and various operations.
4. Summarize the different scheduling algorithms used in RTOS.
5. Identify the different applications of real time operating systems

Course Outcomes: After the completion of the course the student will be able to

CO1 K2	Summarize the functions and structure of general-purpose operating systems.
CO2 K3	Use different scheduling algorithms on processes and threads.
CO3 K2	Interpret a real time operating system along with its synchronization, communication and interrupt handling tools.
CO4 K4	Illustrate task constraints and analyze the different scheduling algorithms on tasks.
CO5 K3	Illustrate the applications of real time operating systems.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1		3										
CO 2	2	3										2
CO 3	2	3					2					2
CO 4	2	2					2					2
CO 5	2	3	2				3				2	2

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	20
Understand	K2	25	25	50
Apply	K3	10	10	20
Analyze	K4	5	5	10
Evaluate				
Create				

Mark distribution:

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance: 10 marks

Continuous Assessment Test (2 numbers): 25 marks

Assignment/Quiz/Case study: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions:

Course Outcome 1 (CO1):

1. List the functions of operating systems.
2. Describe the importance of Kernel in operating system functions.
3. Explain monolithic and layered architecture of operating systems.
4. Draw the process state diagram and explain.

Course Outcome 2 (CO2):

1. Schedule the following processes with FCFS and Round Robin algorithm for a time of2mS. Assuming all the processes arrives at time zero.Also state the performance of the system.

Process	Burst time
P1	4
P2	5
P3	2
P4	3

2. Compare user level threads and Kernel level threads.
3. Discuss the different types of multiprocessor scheduling operations.
4. Explain the possible scheduling of user level threads with a 50mS process quantum and threads that run 5mS per CPU time.

Course Outcome 3 (CO3):

1. Explain the different types of semaphores used for process synchronization.
2. Explain how the priority inversion problem in RTOS is solved.
3. Draw the structure and explain the working of a message queue.
4. Differentiate between exceptions and interrupts.
5. What are the different classifications of exceptions?

Course Outcome 4 (CO4):

1. Explain the different timing constraints of a real time task.
2. Illustrate Jackson's algorithm with an example.
3. Explain EDF algorithm with precedence constraints.
4. Verify the schedulability under EDF and construct the schedule of the following task set

	Ci	Di	T1
Γ_1	2	5	6
Γ_2	2	4	8
Γ_3	4	8	12

5. Draw the state transition diagram of a real time kernel.

Course Outcome 5 (CO5):

1. Illustrate the implementation of a real time system with an example,
2. With a block schematic explain the real time control system used in an adaptive cruise control.

Syllabus

Module	Course contents	Hours
I	Operating system: Types, Objectives and functions , Kernel, Process - States, Process Control Block, Operations on processes.	6
II	Process Scheduling: FCFS, SJF, Priority, Round-Robin, Multilevel Queue and Multilevel Feedback Queue Scheduling. Thread: Structure.User and kernel level threads, multi-threading models, multiprocessor scheduling.	7
III	Real Time Operating Systems: Structure and characteristics of Real Time Systems, Task: Task states, Task synchronization -Semaphores- types, Inter task communication mechanisms: message queues, pipes, event registers, signals, Exceptions and interrupt handling.	8
IV	Task constraints, Task scheduling: Aperiodic task scheduling: EDD. EDF, LDF, EDF with precedence constraints. Periodic task scheduling:Rate monotonic and Deadline monotonic, Real time Kernel- Structure, State transition diagram, Kernel primitives.	8
V	Features of FreeRTOS and Linux Commercial real time operating systems: PSOS, VRTX, RT Linux- Features and application only. Case study of (Kernel design, threads and task scheduling) RTOS: MicroC/OS-II. RTOS control system used in real life applications - in adaptive cruise control.	6

Text Books

1.Abraham Silberschatz- ‘Operating System Principles’: Wiley India,7th edition, 2011
2.William Stallings –‘Operating systems- Internals and design principles’, Prentice Hall, 7th edition, 2011
3.Qing Li – ‘Real-Time Concepts for Embedded Systems ‘, CMP Books, 2013
4.Giorgio C. Buttazzo, -‘HARD REAL-TIME COMPUTING SYSTEMS Predictable Scheduling Algorithms and Applications’, Kluwer Academic Publishers.

Reference Books:

1. Tanenbaum -‘Modern Operating Systems’ ,Pearson Edition, 3/e, 2007.
2. Jean J Labrosse , ‘Micro C/OS-II, The Real Time Kernel’ , CMP Books, 2011
3. Rajib Mall, ‘Real-Time Systems: Theory and Practice ‘ , 2008.
4. David E. Simon ‘An Embedded Software Primer’, Pearson 2012
5. Raj Kamal, ‘Embedded Systems – Architecture, Programming and Design’,Tata McGraw Hill

Course content and Lecture plan

No	TOPIC	No of Lectures
MODULE 1		
1.1	Introduction to Operating system- Types, Objective and functions	2
1.2	Kernel - Importance and functions	2
1.3	Process - States, Process Control Block, Operations on processes	2
MODULE II		
2.1	Process Scheduling: FCFS, SJF, Priority, Round-Robin	2
2.2	Multilevel Queue and Multilevel Feedback Queue Scheduling	2
2.3	Thread- Structure. User and kernel level threads, Multi-threading models	2
2.4	Multiprocessor scheduling	1
MODULE III		
3.1	Real Time Operating Systems: Structure and characteristics of Real Time Systems	1
3.2	Task: Task states	1
3.3	Task synchronization -Semaphores- types	2
3.4	Inter task communication mechanisms: message queues, pipes, event registers, signals	2
3.5	Exceptions and interrupt handling	2
MODULE IV		
4.1	Task constraints	1
4.2	Task scheduling: Aperiodic task scheduling: EDD. EDF, LDF, EDF with precedence constraints	3
4.3	Periodic task scheduling: Rate monotonic, Deadline monotonic	2
4.4	Real time Kernel- Structure, State transition diagram, Kernel primitives	2
MODULE V		
5.1	Features of FreeRTOS and Linux	1
5.2	Commercial real time operating systems: PSOS, VRTX, RT Linux- Features and application only.	2
5.3	Case study of RTOS: MicroC/OS-II real time operating systems.	2
5.4	RTOS control system used in real life applications - in adaptive cruise control.	1

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

VIII SEMESTER B. TECH DEGREE EXAMINATION

Course Code: ECT426

Course Name: REAL TIME OPERATING SYSTEMS

Max. Marks: 100 Duration: 3 Hours

	PART A **Answer all questions, each carries 3 marks**	
1.	List any six functions of an operating system.	3
2	Differentiate microkernel and exokernel structures of operating systems.	3
3	Explain the different operations on processes.	3
4	Explain the differences between Pre-emptive and Non pre-emptive scheduling policies.	3
5	Draw the state diagram of RTOS queue and explain.	3
6	What you mean by priority inversion in real time systems? How the operating system manages this issue?	3
7	Explain EDD algorithm with an example.	3
8	Explain the task control block of a real time kernel.	3
9	List the features of FreeRTOS.	3
10	Illustrate the threads in MicroC/OS-II operating system.	3
	PART B **Answer any one full question from each module, Each question carries 14 marks.**	
	MODULE 1	
11	a. Explain the functions of operating system as Resource Manager.	7
	b. Describe the structure of a Process Control Block	7
	OR	
12	a. Explain the monolithic and microkernel architectures of OS kernel.	7
	b. Draw the process state diagram and explain the different states.	7
	MODULE II	

<table>
<tr><td>13</td><td>a. Explain the Shortest Remaining Time First algorithm with a suitable example.</td><td>7</td></tr>
<tr><td></td><td>b.Schedule the given 5 processes with Round Robin scheduling.
<table><tr><td>Process ID</td><td>Arrival Time</td><td>Burst Time</td></tr><tr><td>P1</td><td>0</td><td>5</td></tr><tr><td>P2</td><td>1</td><td>3</td></tr><tr><td>P3</td><td>2</td><td>1</td></tr><tr><td>P4</td><td>3</td><td>2</td></tr><tr><td>P5</td><td>4</td><td>3</td></tr></table>Draw the Gantt chart and calculate the average waiting time and turn-around time for these processes if time quantum is 2 units,</td><td>7</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>14</td><td>Compare FCFS and Round -Robin scheduling algorithms</td><td>7</td></tr>
<tr><td></td><td>b. Explain thread scheduling algorithms used in operating systems in detail.</td><td>7</td></tr>
<tr><td></td><td>MODULE III</td><td></td></tr>
<tr><td>15</td><td>a .Draw the structure of a real time operating system and explain.</td><td>7</td></tr>
<tr><td></td><td>b. Differentiate between exceptions and interrupts. What are the different classifications of exceptions</td><td>7</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>16</td><td>a. Explain how synchronization is achieved between different tasks in a real time operating system</td><td>7</td></tr>
<tr><td></td><td>b.Describe any two inter task communication mechanisms in a real time operating systems.</td><td>7</td></tr>
<tr><td></td><td>MODULE IV</td><td></td></tr>
<tr><td>17</td><td>a. Illustrate Horn’s algorithm with an example.</td><td>7</td></tr>
<tr><td></td><td>b. Explain EDF algorithm with precedence constraints.</td><td>7</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>18</td><td>a. Explain the precedence constraints of a real time task.</td><td>7</td></tr>
</table>

<table>
<tr><td></td><td>b. Verify the schedulability and construct the scheduling according to the rate monotonic algorithmfor the following set of periodic tasksr_1, r_2 and r_3.
<table>
<tr><td></td><td>Ci</td><td>Ti</td></tr>
<tr><td>r_1</td><td>3</td><td>5</td></tr>
<tr><td>r_2</td><td>1</td><td>8</td></tr>
<tr><td>r_3</td><td>1</td><td>10</td></tr>
</table>
Where Ci and Ti are the computation time activation period of the task.</td><td>7</td></tr>
<tr><td></td><td>MODULE V</td><td></td></tr>
<tr><td>19</td><td>a.Illustrate the implementation of a real time system with an example,</td><td>7</td></tr>
<tr><td></td><td>b. Explain the inter-process communication techniques used in Micro C/OS-II</td><td>7</td></tr>
<tr><td></td><td>OR</td><td></td></tr>
<tr><td>20</td><td>a. Compare the features of PSOS, VRTX and RT Linux</td><td>7</td></tr>
<tr><td></td><td>b. Prepare suitable requirements table for an RTOS control system used in adaptive cruise control.</td><td>7</td></tr>
</table>

ECT436	ADAPTIVE SIGNAL PROCESSING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Prerequisite: Digital Signal processing

Course objectives: The objectives of this course are to:

- Introduce to the concept and need of adaptive filters and popular adaptive signal processing algorithms
- Understand the concepts of training and convergence and the trade-off between performance and complexity.
- Introduce to common linear estimation techniques
- Introduce inverse adaptive modelling.

Course Outcomes: After the completion of the course the student will be able to

CO1 K1	Understand the basic concepts of statistical signal processing
CO2 K2	Devise filtering solutions for optimising the cost function indicating error in estimation of parameters and appreciate the need for adaptation in design.
CO3 K2	Evaluate the performance of various methods for designing adaptive filters through estimation of different parameters of stationary random process clearly considering practical application specifications.
CO4 K2	Analyse convergence and stability issues associated with adaptive filter design and come up with optimum solutions for real life applications taking care of requirements in terms of complexity and accuracy
CO5 K3	Design and implement filtering solutions for applications such as channel equalisation, interference cancelling and prediction considering present day challenges.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3									2
CO 2	3	3	3									2
CO 3	3	3	3									2
CO 4	3	3	3									2
CO 5	3	3	3									2

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	20
Understand	K2	30	30	60
Apply	K3	10	10	20
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. Mark patterns are as per the syllabus with 70 % for theory and 30% for logical/numerical problems, derivation and proof.

Course Level Assessment Questions

Course Outcome 1 (CO1): Adaptive systems

1. Describe the characteristics and applications of adaptive signal processing
2. Describe open and closed loop adaptation

Course Outcome 2 (CO2: Searching performance surface-stability and rate of convergence

1. Compare Newton's & Steepest-descent methods in terms of speed adaptation and mis-adjustment.
2. Discuss about role of Learning curves.

Course Outcome 3 (CO3): LMS algorithm

1. Discuss Correlation properties of lattice Filter

2. Derive LMS adaptive algorithm

Course Outcome 4 (CO4): Kalman filtering, Applications-adaptive modeling and system identification

1. Discuss Kalman filtering.
2. Explain how adaptive filters can be used for single input system identification

Course Outcome 5 (CO5): Inverse adaptive modeling

1. Describe the two types of inverse modelling approaches.
2. Derive the least-square solution to inverse modelling problem

Syllabus

Module	Course contents	Hours
I	Adaptive systems- Definitions and characteristics - applications – properties examples - adaptive linear combiner input signal and weight vectors - performance function-gradient and minimum mean square error - introduction to filtering- smoothing and prediction - linear optimum filtering-orthogonality - Wiener – Hopf equation-performance surface	8
II	Searching performance surface-stability and rate of convergence: Learning curve gradient search - Newton's method - method of steepest descent - comparison - Gradient estimation - performance penalty - variance - excess MSE and time constants – mis adjustments	6
III	LMS algorithm, convergence of weight vector: LMS/Newton algorithm - properties - sequential regression algorithm - adaptive recursive filters - random-search algorithms - lattice structure - adaptive filters with orthogonal signals.	7
IV	Kalman filters-recursive minimum mean square estimation for scalar random variable. Applications-adaptive modeling and system identification: Multipath communication channel, geophysical exploration, Kalman filter as the unifying basis for RLS filters.	7
V	Inverse adaptive modeling: Equalization, and deconvolution adaptive equalization of telephone channels-adapting poles and zeros for IIR digital filter synthesis	7

Text Book:

1.Bernard Widrow and Samuel D. Stearns, ―Adaptive Signal Processing‖, Person Education, 1985.

2.Mons H Hays -Statistical Digital Signal Processing and Modeling -Wiley Publications, 2006.

Reference Books:

1. Simon Haykin, ―Adaptive Filter Theory‖, Pearson Education, 2003.
2. John R. Treichler, C. Richard Johnson, Michael G. Larimore, ―Theory and Design of Adaptive Filters, Prentice-Hall of India, 2002.
3. John G. Proakis, Dimitris G. Manolokis, "Digital Signal Processing", Prentice Hall of India, New Delhi, 2005
4. S. Thomas Alexander, "Adaptive Signal Processing - Theory and Application", Springer-Verlag.
5. D. G. Manolokis, V. K. Ingle and S. M. Kogar, "Statistical and Adaptive Signal Processing", Mc GrawHill International Edition, 2000.

Course content and Lecture plan

No	TOPIC	No of Lectures
	MODULE 1	
1.1	Adaptive systems- characteristics - applications – properties examples	1
1.2	Adaptive linear combiner, input signal and weight vectors performance function-gradient and minimum mean square error	2
1.3	introduction to filtering- smoothing and prediction linear optimum filtering- linear optimum filtering-orthogonality -	3
1.4	Wiener – Hopf equation-performance surface	2
	MODULE II	
2.1	Searching performance surface-stability and rate of convergence:	1
2.2	Learning curve gradient search, Newton's method	1
2.3	Method of steepest descent	2
2.4	Gradient estimation	1
2.5	Performance penalty - variance - excess MSE and time constants – mis-adjustments	1
	MODULE III	
3.1	LMS algorithm, convergence of weight vector	2
3.2	Newton algorithm - properties	1
3.3	sequential regression algorithm RLS	1
3.4	adaptive recursive filters - random-search algorithms	1
3.5	lattice structure - adaptive filters with orthogonal signals	2
	MODULE IV	
4.1	Kalman filters-recursive minimum mean square estimation for scalar random variable.	3
4.2	adaptive modeling and system identification	1
4.3	Multipath communication channel	1
4.4	Geophysical exploration	1
4.5	Kalman filter as the unifying basis for RLS filters.	1

MODULE V		
5.1	Inverse adaptive modeling:	1
5.2	Equalization, and deconvolution	2
5.3	adaptive equalization of telephone channels, Echo, Noise Cancellation.	2
5.4	adapting poles and zeros for IIR digital filter synthesis	2

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

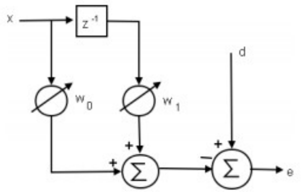
EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

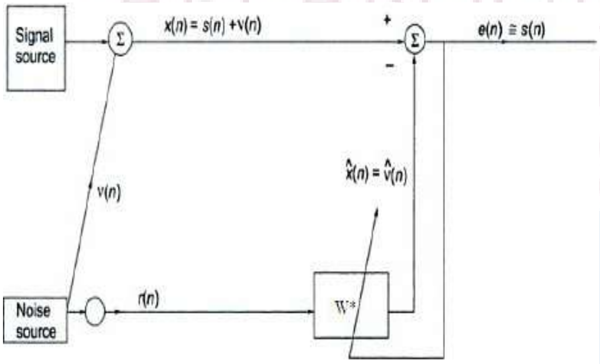
Course Code: ECT436

Course Name: ADAPTIVE SIGNAL PROCESSING

Max. Marks: 100 Duration: 3 Hours

	PART A **Answer all questions, each carries3marks**	
1	Explain the structure of an Adaptive Linear Combiner.	3
2	Describe the characteristics of an Adaptive System	3
3	Which are the three basic forms of estimation	3
4	What is the minimum mean-square error produced by this Wiener filter	3
5	What is Performance Penalty	3
6	Give a note on stability and rate of convergence	3
7	Propose an adaptive modelling for a multipath channel.	3
8	Explain the application of adaptive modelling	3
9	Discuss deconvolution in inverse adaptive modelling	3
10	Explain types of Adaptive Inverse Systems	3
	PART B **Answer any one full question from each module carries14marks.**	
	MODULE 1	
11	Adaptive systems are nonlinear, Justify. Suppose in an adaptive-filtering environment, where input signal, $x_n = \sin(2\pi n/N)$ and Desired signal, $d_n = 2\cos(2\pi n/N)$ sampled sinusoids with same frequency and N samples per cycle(N>2).Calculate R,P, ξ,W*,ξ_{min}	8

		
	b. Derive the expression for gradient and minimum Mean Square Error with 2-Dimensional Performance surface plots.	6
	OR	
12	a. Given a quadratic MSE function for the Wiener filter: $J = 40 – 20W +10W^2$, Use the steepest descent method with an initial guess as w0=0 and μ=0.04 to find the optimal solution for W* and determine ξmin by iterating three times.	7
	b. Derive augmented Wiener-Hopf equation for forward prediction.	7
	MODULE II	
13	a. Explain about Gradient Search methods.	7
	b. Discuss about Stability and Rate of convergence Gradient Searching Algorithm	7
	OR	
14	a. Compare Newton's & Steepest-descent methods in terms of speed adaptation and mis-adjustment.	7
	b. Discuss about role of Learning curves	7
	MODULE III	
15	a. Derive LMS adaptive algorithm.	8
	b. Compare the LMS and the RLS algorithm	6
	OR	
16	a. Prove Correlation properties of lattice Filter.	7
	b. Discuss sequential regression algorithm	7
	MODULE IV	
17	a. Discuss recursive minimum mean square estimation for scalar random variable using Kalman filter.	7
	b. Explain how adaptive filters can be used for single input system identification	7
	OR	
18	a. Illustrate how adaptive filters are used to measure earth's impulse response.	7
	b. Justify the statement 'Kalman filter are the unifying basis for RLS filters' with necessary mathematical equations.	7

	MODULE V	
19	a. Describe the two types of inverse modelling approaches.	7
	b. Derive the least-square solution to inverse modelling problem.	7
	OR	
20	Write a short note on adaptive noise cancelling. Consider the noise canceller, Assume v(n)=Cr(n). Determine the best value of W* that minimise mean square error E[e^2(n)].  	10
	b. Explain how poles and zeros can be adapted for IIR filter synthesis.	5

Simulation Assignments (Using MATLAB/Python)

I. Simulate Normalized LMS algorithm and compare its performance with LMS.

II. Simulate RLS algorithm and compare its performance with LMS and NLMS.

III. (a) Generate the data for LMS algorithm using the model H(z)= (z-0.8)(z+0.7)/{(z-0.9)(z+0.8)(z+65)}(Necessary assumptions can be made)
(b) Get an estimate of signal energy for the above data, and using this estimate determine range for Mu. Select two values for Mu in this range.
(c) Run the LMS algorithm in predictive mode for the data you have generated and for the two choices of Mu.
(d) Do a validation test. You should use the following for the purpose of comparison
(i) Learning curve (i.e. Mean square error curve)
(ii) Convergent values of W(n)
(iii) Whiteness of error
Comment on which choice of Mu gives better results, and why.

ECT446	MICROWAVE DEVICES AND CIRCUITS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to understand with active and passive microwave semiconductor devices, components, microwave sources and amplifiers used in microwave communication systems, analysis of microwave networks and microwave integrated circuits.

Prerequisite: ECT 401 MICROWAVE AND ANTENNAS

Course Outcomes: After the completion of the course the student will be able to:

CO1 **K2**	Understand the limitation of conventional solid state devices at Microwave, Gunn – effect diodes, Microwave generation and amplification, IMPATT and TRAPATT diodes
CO2 **K3**	Design of Bipolar transistors, MESFET, Microwave amplifiers and oscillators
CO3 **K3**	Analysis of Microwave Network Analysis and the corresponding signal flow graphs
CO4 **K3**	Design of Microwave filters, Filter design by image parameter method, Filter transformation and implementation
CO5 **K2**	Understand different MICs, Distributed and lumped elements of integrated circuits, Diode control devices.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									2
CO2	3	3	3									2
CO3	3	3	3									2
CO4	3	3	3									2
CO5	3	3	2									2

Assessment Pattern:

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember			
Understand	20	20	40
Apply	30	30	60
Analyse			
Evaluate			
Create			

Mark distribution:

Total Marks	CIE	ESE	ESE Duration
150	50	100	3Hrs

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern

Maximum Marks: 100 **Time: 3 hours**

There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 subdivisions and carry 14 marks.

Course Level Assessment Questions.

Course Outcome 1 (CO1):

1. Explain Ridley – Watkins-Hilsum theory.
2. Explain in detail Various modes of operation of Gunn Oscillators.

Course Outcome 2 (CO2):

1. Explain GaAs MESFET with structure and principle of operation? Why GaAs MESFETs are preferred over Si MESFETs.
2. Derive the expression for available power gain of microwave amplifier.

Course Outcome 3 (CO3):

1. Explain the importance of impedance matching or tuning.
2. Evaluate the ABCD matrix coefficient computation of a transmission line section with characteristic impedance ‘Zo’ propagation constant ‘β’ and length ‘l’.

Course Outcome 4 (CO4):

1. Design a low-pass composite filter with a cut-off frequency of 2MHz and impedances of 75Ω. Place the infinite attenuation pole at 2.05MHz.
2. With neat circuit explain the Design procedure of an m-derived LPF section and plot the frequency response.

Course Outcome 5 (CO5):

1. Explain the configuration of Planar capacitor film
2. Discuss Strip line in planar transmission and also find the Quality factor.

3. Explain the frequency characteristics of single layer square inductor.

Syllabus

Module	Course contents	Hours
I	Introduction, Characteristic, features of microwaves, Limitation of conventional solid state devices at Microwave. Gunn diodes – Gunn effect, Ridley – Watkins-Hilsum theory, Modes of operation, Limited space – Charge accumulation (LSA) mode of Gunn diode. Microwave generation and amplification. Structure, Operation, Power output and efficiency of IMPATT and TRAPATT diodes	6
II	Bipolar transistors – biasing, FET – biasing, MESFET – Structure, Operation. Microwave amplifiers and oscillators – Amplifiers – Gain and stability, Single stage transistor amplifier design. Oscillator design – One port negative resistance oscillators.	8
III	Microwave Network Analysis – Equivalent voltages and currents, Impedance and Admittance matrices, Scattering matrix, The transmission matrix. Signal flow graphs. Impedance matching and tuning – Matching with lumped elements, Single stub tuning, Double stub tuning. Quarter wave transformer, Theory of small reflections.	6
IV	Microwave filters – Periodic structures – Analysis of infinite periodic structures and terminated periodic structures Filter design by image parameter method – Constant k, m-derived and composite. Filter design by insertion loss method. Filter transformation and implementation.	7
V	Introduction to MICSs:-Technology of hybrid MICs, monolithic MICs. Comparison of both MICs. Planar transmission lines such as strip line, microstrip line, and slot line. Distributed and lumped elements of integrated circuits - capacitors, inductors, resistors, terminations, attenuators, resonators and discontinuities.Diode control devices – switches, attenuators, limiters. Diode phase shifter. Circulators and isolators.	8

Text Books:

1. David M. Pozar, Microwave Engineering, 4/e, Wiley India, 2012.
2. Robert E. Collin, Foundation of Microwave Engineering, 2/e, Wiley India, 2012.
3. Samuel Y. Liao, Microwave Devices and Circuits, 3/e, Pearson Education, 2003.

References:

1. Bharathi Bhat and Shiban K. Koul: Stripline-like Transmission Lines for MIC, New Age International (P) Ltd, 1989.
2. I. Kneppo, J. Fabian, et al., Microwave Integrated Circuits, BSP, India, 2006.
3. Leo Maloratsky, Passive RF and Microwave Integrated Circuits, Elsevier, 2006.

Course Contents and Lecture Schedule.

No	Topic	No.of. Lectures
	Module I	
1.1	Introduction, Characteristic, features of microwaves, Limitation of conventional solid state devices at Microwave	**2**
1.2	Gunn – effect diodes – Gunn effect, Ridley – Watkins-Hilsum theory, Modes of operation, Limited space – Charge accumulation (LSA) mode of Gunn diode.	**2**
1.3	Microwave generation and amplification. Structure, Operation, Power output and efficiency of IMPATT and TRAPATT diodes	**2**
	Module II	
2.1	Bipolar transistors – biasing, FET – biasing, MESFET – Structure, Operation.	**3**
2.2	Microwave amplifiers and oscillators – Amplifiers – Gain and stability, Single stage transistor amplifier design.	**3**
2.3	Oscillator design – One port negative resistance oscillators.	**2**
	Module III	
3.1	Microwave Network Analysis – Equivalent voltages and currents, Impedance and Admittance matrices, Scattering matrix, The transmission matrix	**2**
3.2	Signal flow graphs. Impedance matching and tuning – Matching with lumped elements, Single stub tuning, Double stub tuning.	**2**
3.3	Quarter wave transformer, Theory of small reflections.	**2**
	Module IV	
4.1	Microwave filters, Periodic structures, Analysis of periodic structures	**2**
4.2	Filter design by image parameter method – Constant k, m-derived and composite.	**3**
4.3	Filter design by insertion loss method. Filter transformation and implementation.	**2**
	Module V	
5.1	Introduction to MICSs:-Technology of hybrid MICs, monolithic MICs. Comparison of both MICs.	**2**
5.2	Planar transmission lines such as stripline, microstrip line, and slotline.	**2**
5.3	Distributed and lumped elements of integrated circuits - capacitors, inductors, resistors, terminations, attenuators, resonators and discontinuities.	**2**
5.4	Diode control devices – switches, attenuators, limiters. Diode phase shifter. Circulators and isolators.	**2**

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH EMESTER B. TECH DEGREE EXAMINATION

Course Code: ECT446

Course Name: MICROWAVE DEVICES AND CIRCUITS

Max. Marks:100 Duration: 3 Hours

PART A

(*Answer All Questions*)

1	With a graph explain the characteristics of Gunn diode.	(3)
2	Explain the limitations of conventional solid state devices at microwaves	(3)
3	Design a one port negative resistance oscillator	(3)
4	Discuss different biasing techniques used for microwave bipolar transistor.	(3)
5	Derive expressions for S parameters in terms of Z parameters for a 2-port network.	(3)
6	Explain the principle of double stub matching.	(3)
7	Discuss the significance of k-β diagram in filter characteristics.	(3)
8	List the Kuroda's identity.	(3)
9	The strip line designed with a dielectric material with b = h = 3.1 mm, w = 2.5 mm Find characteristic impedance Zo. $\sqrt{\varepsilon_r} = \sqrt{10.5}$	(3)
10	Explain the configuration of distributed ferrite circulators.	(3)

PART B

(*Answer one question from each module. Each question carries 14 marks*)

MODULE I

11	a)	What does IMPATT diode stand for and with neat diagram mention construction and working of it and derive power and η of the same.	(10)
	b)	Explain modes of operation of Gunn diode.	(4)

OR

12	a)	What are TRAPATT diodes? Explain elaborately their principle of operation with neat diagram.	(10)
	b)	An IMPATT diode has carrier drift velocity Vd = 3 x 107 cm/s, Drift region length L = 6μm, Maximum operating voltage V0max = 100V, Maximum operating current I0max = 200mA, Efficiency η = 15%, Breakdown voltage Vbd = 90V. Find maximum CW output power in watts and the resonant frequency in gigahertz.	(4)

MODULE II

13 a) Design a single stage Transistor Amplifier used in microwave circuits. (10)

b) Why are GaAs MESFET’s preferred to Si MESFET’s (4)

OR

14 a) Discuss in detail the physical structure of MESFET and explain its principle of operation. (10)

b) Discuss briefly the Stability of Amplifier with necessary conditions. (4)

MODULE III

15 a) For a microwave circuit, discuss the equivalent voltage and currents. (6)

b) Explain working of Double Stub tuning and Quarter Wave Transformer. (8)

OR

16 a) Explain in detail the concept of matching with lumped elements. (6)

b) Discuss in detail about impedance and frequency scaling. (8)

MODULE IV

17 a) Explain the steps in designing a composite filter. Also write down the equations and draw the circuit for designing a composite low pass filter. (8)

b) Design a low pass filter for fabrication using microstrip line. The specifications are cut-off frequency of 4 GHz, third order, impedance of 50 Ω and a 3 dB equi-ripple characteristics. The normalized low pass proto-type values are $g_1 = 3.3487 = L_1$ g_3,= $3.3487 = L_3$, $g_2 = 0.7117 = C_2$, $g_4 = 1.000 = R_L$. (6)

OR

18 a) Design a low pass constant K filter using image parameter method. (7)

b) What are the steps required to transfer a LPF from HPF .explain. (7)

MODULE V

19 a) Explain in detail about thick film and thin film technology? (9)

b) Discuss Microwave resonators with neat diagram (5)

OR

20 a) Classify Switches based on Characteristics (8)

b) Discuss briefly about slot line. (6)

ECT456	SPEECH AND AUDIO PROCESSING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Prerequisite: Digital Signal processing

Course objectives:

- To familiarize the basic mechanism of speech production and the basic concepts of methods for speech analysis and parametric representation of speech.
- To give an overall picture about various applications of speech processing
- To impart ideas of Perception of Sound, Psycho-acoustic analysis, Spatial Audio Perception and rendering.
- To introduce Audio Compression Schemes.

Course Outcomes: After the completion of the course the student will be able to

CO1K1	Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech and apply it in practical applications
CO2K3	Develop systems for various applications of speech processing
CO3K2	Learn Signal processing models of sound perception and application of perception models in audio signal processing
CO4K2	Implement audio compression algorithms and standards
C0 5 K2	Perform audio quality analysis

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										2
CO 2	3	3	2									2
CO 3	3	3	2									2
CO 4	3	3										2
CO 5	3	3	2									2

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	20
Understand	K2	30	30	60
Apply	K3	10	10	20
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. Mark patterns are as per the syllabus with 80 % for theory and 20% for logical/numerical problems, derivation and proof.

Course Level Assessment Questions

Course Outcome 1 (CO1): Speech Processing, Parametric representation of speech, LPC analysis

1. Describe algorithm for computing LPC coefficients using autocorrelation method
2. Define short time energy and short time zero crossing rate

Course Outcome 2 (CO2): Frequency domain analysis, Speech coding, Speech enhancement

1. Describe the steps involved in obtaining MFCC coefficients of a speech signal

2. Compare broad categories of speech coding techniques in terms of bitrate and speech quality

Course Outcome 3 (CO3): Models of Audio perception, Psychoacoustic analysis

1. Explain MPEG psycho-acoustic model of audio perception
2. Differentiate between simultaneous masking and temporal masking

Course Outcome 4 (CO4): Audio compression methods, Transform coding of Audio signals

1. Describe various redundancy removal and perceptual irrelevancy removal in audio compression
2. Explain the concept of MDCT and its properties

Course Outcome 5 (CO5): Audio Perception and rendering

1. Explain subjective and objective analysis methods to measure the audio quality
2. What are the physical and psycho-acoustical basis of sound localization and space perception Describe spatial audio standards

Syllabus

Module	Course contents	Hours
I	Speech Production: Acoustic theory of speech production. Speech Analysis: Speech signal, Short-Time Speech Analysis, Time domain analysis (Short time energy, short time zero crossing Rate, ACF).LPC Analysis (LPC model, Auto correlation method).	7
II	Frequency domain analysis (Filter Banks, STFT, Spectrogram), Cepstral Analysis, MFCC. Probabilistic formulation of speech recognition, Speech coding: fundamentals, Comparison of waveform coding, vocoding and hybrid coding, Speech enhancement: fundamentals, basic types, Speaker verification (block diagram), Language Identification (block diagram)	7
III	Signal Processing Models of Audio Perception: Basic anatomy of hearing System. Auditory Filter Banks, Psycho-acoustic analysis: Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking, MPEG psycho-acoustic model.	7
IV	Audio compression methods: Sampling rate and bandwidth requirement for digital audio, Redundancy removal andperceptual irrelevancy removal, Transform coding of digitalaudio: MPEG2-AAC coding standard, MDCT and its properties,Pre-echo and pre-echo suppression, Loss less coding methods.	7

V	Spatial Audio Perception and rendering: The physical and psycho-acoustical basis of sound localization and space perception. Spatial audio standards. Audio quality analysis: Objective analysis methods-PEAQ, Subjective analysis methods - MOS score, MUSHRA score	7

Text Books:
1. Douglas O'Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2/e, 1999; ISBN: 0780334493.
2. Nelson Morgan and Ben Gold, Speech and Audio Signal Processing: Processing and Perception Speech and Music, July 1999, John Wiley & Sons, ISBN: 0471351547

References:
1. Donald G. Childers, Speech Processing and Synthesis Toolboxes, John Wiley & Sons, September 1999; ISBN: 0471349593
2. Rabiner and Juang, Fundamentals of Speech Recognition, Prentice Hall, 1994.
3. Rabiner and Schafer, Digital Processing of Speech Signals, Prentice Hall, 1978.
4. Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall; ISBN: 013242942X; 1/e

Course content and Lecture plan

No	TOPIC	No of Lectures
	MODULE 1	
1.1	Acoustic theory of speech production	2
1.2	Speech signal, Short-time analysis of speech	2
1.3	Time domain analysis (Short time energy, short time zero crossing Rate, ACF)	2
1.4	LPC Analysis	1
	MODULE II	
2.1	Frequency domain analysis (Filter Banks, STFT, Spectrogram)	2
2.2	Cepstral Analysis	1
2.3	MFCC.	1
2.4	Fundamentals of Speech recognition, Speech coding, Speech Enhancement	1
2.5	Speaker Verification,	1
2.6	Language Identification	1
	MODULE III	
3.1	Signal Processing Models of Audio Perception	1
3.2	Basic anatomy of hearing System.	1
3.3	Auditory Filter Banks, Psycho-acoustic analysis.	2
3.4	Critical Band Structure, Absolute Threshold of Hearing.	1

3.5	Simultaneous Masking, Temporal Masking,	1
3.6	MPEG psycho-acoustic model	1
MODULE IV		
4.1	Sampling rate and bandwidth requirement for digital audio,	2
4.2	Redundancy removal and perceptual irrelevancy removal,	1
4.3	Transform coding of digital audio: MPEG2-AAC coding standard	1
4.4	MDCT and its properties,	1
4.5	Pre-echo and pre-echo suppression,	1
4.6	Lossless coding methods.	1
MODULE V		
5.1	Spatial Audio Perception and rendering	2
5.2	The physical and psycho-acoustical basis of sound localization and space perception.	2
5.3	Spatial audio standards.	1
5.4	Audio quality analysis: Objective analysis methods- PEAQ	1
5.5	Subjective analysis methods - MOS score, MUSHRA score	1

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

VIII SEMESTER B. TECH DEGREE EXAMINATION

Course Code: ECT456

Course Name: SPEECH AND AUDIO PROCESSING

Max. Marks: 100 Duration: 3 Hours

	PART A **Answer all questions, each carries 3 marks**	
1.	What is Zero Crossing Rate (ZCR) ? How is it used for differentiating voiced and unvoiced speech?	
2	Why short time analysis is preferred for analysing speech signal	
3	Express speech recognition in terms of probabilistic formulation and justify the importance of each term.	
4	What is the need for Spectrogram representation of speech signals	
5	Differentiate between speaker identification and speaker verification	
6	How is ‘bit allocation’ used in MPEG?	
7	What is threshold of hearing? Explain with the help of a diagram	

8	Draw and explain the concept of threshold of hearing	
9	What is redundancy removal in audio compression?	
10	What is cone of confusion? How do listeners resolve it?	
	PART B **Answer any one full question from each module carries 14 marks.**	
	MODULE 1	
11	a) Draw the source system model of speech production. Derive equations of LP analysis using autocorrelation method.	7
	b) Write mathematical expression for the computation of short time energy and short time auto correlation for a speech segment	7
	OR	
12	Describe human speech production mechanism using a diagram and the role of following organs in speech production (i) Velum (ii) Vocal folds (iii) Lips (iv) Tongue	14
	MODULE II	
13	a) Define mathematically the need of STFT for analyzing speech signals.	7
	b) Describe with the help of a block diagram the steps involved in obtaining MFCC coefficients of a speech signal.	7
	OR	
14	a) Formulate ‘automatic speech recognition’ using probabilistic terms	7
	b) Explain any one speech coding technique in detail	7
	MODULE III	
15	a) Draw and explain the concept of auditory filter banks	7
	b) With the help of neat diagram explain the anatomy of hearing system	7
	OR	
16	a) Differentiate between simultaneous masking and temporal masking	6
	a) Explain MPEG psycho acoustic model. How is masking useful for implementing audio compression?	8

	MODULE IV	
17	a) Explain mathematically the concept of MDCT and its properties.	7
	b) Explain MPEG2-AAC coding standard	7
	OR	
18	a) Describe pre-echo suppression in audio signals	7
	b) Briefly explain lossless coding of audio signals	7
	MODULE V	
19	a) Differentiate between Interaural level difference (ILD) and Interaural time difference (ITD) in perception with help of diagrams	7
	b) Explain any two spatial audio standards.	7
	OR	
20	a) Describe objective analysis method to analyze the audio quality.	8
	b) Mention the significance of MOS score and MUSHRA score	6

ECT466	ANALOG CMOS DESIGN	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to impart the basic knowledge of CMOS analog circuits design and enable the students to design integrated circuits.

Prerequisite: ECT 202 Analog Circuits, ECT 201 Solid State Devices.

Course Outcomes: After the completion of the course the student will be able to,

CO1	Analyze various Single stage Amplifiers with different types of loads
CO2	Design and Analyse Differential Amplifiers
CO3	Design various types of current mirrors
CO4	Plot the frequency response of single stage and differential amplifiers
CO5	Analyse the effect of noise in single stage amplifiers
CO6	Implement PLL for various applications

Mapping of course outcomes with program outcomes

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2
CO 4	3	3										2
CO 5	3	3										2
CO 6	3	3										2

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course level Assessment Questions

CO1. Analyze various Single stage Amplifiers with different types of loads

1. Develop small signal model for various amplifier configurations
2. Calculate the small signal gain of various configurations
3. Analyze the effect of cascading of stages.

CO2. Design and Analyse Differential Amplifiers

1. Perform Qualitative Analysis of Differential Pair.
2. Calculate the small signal gain of differential pair if the bias voltages are equal.
3. Calculate the overdrive voltage of each transistor in differential pair.

CO3. Design various types of current mirrors

1. Explain the use of current mirrors to bias a differential pair
2. Explain the concept of an active current mirror.
3. Analysis of circuits having current mirror.

CO4:Plot the frequency response of single stage and differential amplifiers

1. Calculation of poles associated with the nodes in a circuit
2. Calculate the voltage transfer function of common source stage
3. Modelling the high frequency equivalent circuit of various configurations.

CO5:Analyse the effect of noise in single stage amplifiers

1. Modelling of noise in circuits.
2. Calculation of Input referred noise and output noise in various circuits.
3. Calculation of noise bandwidth

CO6: Implement PLL for various applications

1. Describe the implementation of PLL for Frequency Multiplication, Frequency synthesizer and Skew reduction

SYLLABUS

Module I

Basic MOS Device physics- Review of MOS Characteristics and Second order effects(only basic theoretical concepts).

Single Stage Amplifiers. Common Source Stage with Different Load types , Source Follower, Common Gate and Cascode Stage

Module II

Differential Amplifiers - Single-ended and differential operation, Basic differential pair, Common-mode response, Differential pair with MOS load, Gilbert Cell.

Current Mirror: Simple, Cascode and Basic concepts of active current Mirror

Module III

Frequency Response of Amplifiers: Miller Effect, Poles and Zeros, Frequency Response Analysis of Common Source, Source Follower, Common Gate and Differential Pair.

Module IV

Noise in Amplifiers: Noise in Single Stage amplifier (CS,CG,Source Follower), Noise in Differential Pair, Noise Band Width.

Module V

Phase Locked Loops- Mathematical model of VCO, Phase Detector, Basic PLL Topology, Type I and Type II(Charge Pump) PLL, Stability Analysis of PLL, Non Ideal Effects in PLL, Application of PLL- Frequency Multiplication, Frequency synthesizer and Skew reduction. Block Diagram of Digital PLL.

Text Books:

1. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, McGraw-Hill, 2/e, 2002

References:

1. Phillip E. Allen, Douglas R. Holbery, CMOS Analog Circuit Design, Oxford, 2004.
2. Razavi B., Fundamentals of Microelectronics, Wiley student Edition2014.
3. Baker, Li, Boyce, CMOS: Circuits Design, Layout and Simulation, PHI, 2000

Course Contents and Lecture Schedule

No.	Topic	Hrs.
1	**CMOS Amplifiers**	
1.1	Review of MOS Characteristics, Second order effects(Subtreshold conduction, DIBL,Velocity Saturation etc..)	1
1.3	Single Stage Amplifiers-Basic Concepts	1
1.4	CS with resistive, Diode Connected and Current Source Load, CS with source Degeneration	3
1.5	Source Follower and common Gate Stage	2
1.6	Cascode Stage	1
2	**Differential Amplifier**	
2.1	Single Ended and Differential Operation	1
2.2	Common Mode Response, Differential pair with MOS Load	2
2.3	Concept of Gilbert Cell and Introduction to Basic Current Mirror	1
2.4	Cascode current Mirrors and Basic Concepts of Active Current Mirrors	2
3	**Frequency Response of Amplifiers**	
3.1	Miller Effect, Poles and Zeros	1
3.2	Calculation of poles and zeros of CS, CG and Source follower stage	2
3.3	Stability Analysis of CS, CG and Source Follower	2
3.4	Frequency Response of Differential Pair	1
4	**Noise In Amplifiers**	
4.1	Noise analysis in CS, CG and Source Follower	4
4.2	Noise In differential Pair	2
4.3	Noise Bandwidth	1
5	**Phase Locked Loops**	
5.1	Mathematical model of VCO, Phase Detector, Basic PLL Topology	1
5.2	Type I and Type II(Charge Pump) PLL, Stability Analysis of PLL	2
5.3	Non Ideal Effects in PLL	2
5.4	Application of PLL- Frequency Multiplication, Frequency synthesizer and Skew reduction	2
5.5	Block Diagram of Digital PLL	1
	Total Hours	**35**

Simulation Assignments:

Atleast one assignment should be simulation of the circuits. Simulations can be done in QUCS, KiCad or PSPICE or LT Spice or CADENCE

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT466

Course Name: ANALOG CMOS DESIGN

Max. Marks: 100 Duration: 3 Hours

PART A

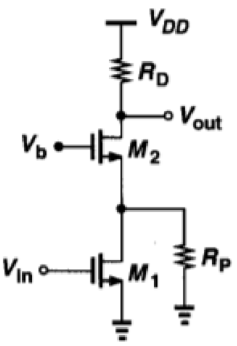
Answer ALL Questions. Each Carries 3 mark.

1	Explain Body effect. How body Effect affect the Threshold voltage	K1
2	Draw the small signal equivalent circuit of a common source stage with diode connected load?	K2/CO1
3	Calculate the Common mode Gain of a differential Pair.	K2/CO2
4	Explain the working of Gilbert Cell as Analog voltage Multiplier	K2/CO3
5	Explain how the addition of capacitor at output node of a single stage amplifier affect the pole zero plot.	K2/CO4
6	Draw the Thevinin Equivalent of a Differential Pair with active current Mirror	K3/CO4
7	Draw the circuit model for a resistor thermal noise and draw its spectral density.	K3/CO5
8	Explain Flicker Noise?	K1/CO5
9	Explain the working of Phase Detectors?	K1
10	Explain the Block diagram of Digital PLL?	K1

PART – B

Answer one question from each module; each question carries 14 marks.

Module – I

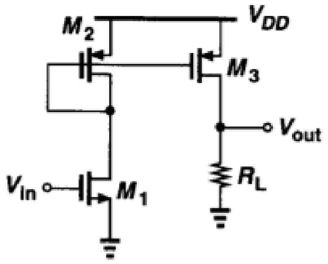
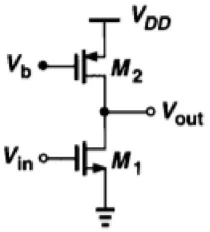
11a.	Derive the expression of a common source stage with diode connected load.	7 CO1/K3
b.	Calculate the voltage gain of the circuit .	7 CO1/K3

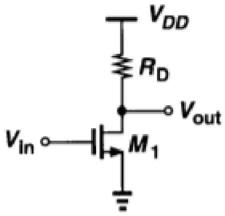
OR

12a.	Derive the expression of Voltage gain of Common Gate Stage?	14 CO1/K3

Module – II

13a.	Explain the working of a basic differential pair	4

		CO2/ K1
b.	Derive the expression of the voltage gain of a differential pair with MOS Load	10 CO2/ K3
	OR	
14	Calculate the small signal voltage gain of the circuit shown below. 	14 CO3/ K3
	Module – III	
15a.	Explain Miller Effect	4 K1
b.	Calculate the input and output impedance of common source stage	10 CO4/K3
	OR	
16	Derive the expression for voltage transfer function and input impedance of common gate configuration.	14 CO4/ K3
	Module - IV	
17a.	Calculate the total input referred thermal noise voltage of the amplifier shown below. 	14 CO5/K3
	OR	

18	Calculate the total output noise of the circuit shown below. 	14 CO5/ K3
	Module – V	
19a.	Explain Type 1 and charge pump PLL?	5 K1
b.	Explain various non ideal effects in PLL?	9 K1
	OR	
20a.	Describe various applications of PLL	10 CO6/ K3
b.	Describe the causes of stability degradation in charge pump PLL.	4/K2

ECT476	ROBOTICS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: The objective of this course is to introduce to the students the emerging field of robotics by imparting the fundamental knowledge on the design and control of robots, theirmulti-disciplinary engineering aspects and applications.

Prerequisite: Nil

Course Outcome: After the successful completion of the course, the student will be able to

CO1	Attain a thorough understanding of different types of Robots and their applications
CO2	Select appropriate sensors and actuators based on the robotic applications
CO3	Perform kinematic and dynamic analyses for robots.
CO4	Carry out the design and control of a simple robot.
CO5	Integrate mechanical and electrical hardware for making a robotic device

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										
CO2	3	3										
CO3	3	3										
CO4	3	3		2								
CO5	3	3		2								

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer anyone. Each question can have a maximum of two sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Appreciate the classification of robots, fundamental systems and their applications in various domains.

1. Write down the brief history and growth of robotics.
2. Describe the different basic components of a robotic system and their functions.
3. Explain the principle of degree of freedom or connectivity in terms of robotic joints.

Course Outcome 2(CO2): Compare and contrast the working principles and applications of various sensors and actuators used in robotic systems.

1. With neat sketches elucidate the working of any one type of tactile sensor used for contact and proximity assessment.
2. Describe the imaging, sensing and digitization processes in a basic robotic vision system.
3. List and justify any two applications where pneumatic actuators are preferred over hydraulic ones.

Course Outcome 3 (CO3): Apply the principles and techniques of kinematic and dynamic modelling in robotics.

1. Describe the techniques and methods for the representation of position and orientation of objects, their translation and rotation, as well as the coordinate transformation in the workspace of a robot.
2. Explain the Denavit-Hartenberg (D-H) convention for selecting frames of reference in robotics applications.
3. Apply the D-H convention to represent the different serial kinematic arrangements fitted with various end effectors.

Course Outcome 4 (CO4): Perform basic programming for the control of robotic devices.

1. Explain the process of control of position and force of manipulators in robots.
2. Illustrate the working of a robotic device using the closed-loop control system with a suitable example.
3. Describe the commonly used methods for robot programming.

Course Outcome 5 (CO5): Design robotic devices by integrating mechanical and electrical hardware.

1. List out the various industrial Applications of Robots with examples.
2. Illustrate the significance of Artificial Intelligence (AI) in Robotics
3. Evaluate the role of robotics and automation in Industry 4.0.

SYLLABUS

MODULE I

Introduction to Robotics: Definition and Origin of Robotics. Robot Anatomy. Robot Specifications. Robot Characteristics – Accuracy, Precision, and Repeatability. Classification of Robots. Advantages and Disadvantages of Robots. Robot Structure - Types of Joints and End Effectors, Mechanisms and Manipulators. Common Kinematic Arrangements. Degree of Freedom. Robot Coordinates. Reference Frames.Robot Workspace.Areas of Application for Robots.

MODULE II

Introduction to Sensors and Actuation Systems for Robots: Actuators: Types of Robotic Drive Systems and Actuators: Hydraulic, Pneumatic and Electric drives. Transmission: Gears, Timing Belts and Bearings. Parameters for selection of actuators. Specification. Areas of Application for: Stepper Motor, Servo Motor and Brushless DC Motor. Microprocessor Control of Motors. Speed Control using PWM and Direction Control using H- Bridge. Sensors: Types and Applications of Sensors in Robotics: Position, Displacement and Velocity Sensors. Tactile Sensors for Contact and Proximity Assessment. Strain Gauge based Force and Torque Sensors. Tachometers, etc. Robotic Vision Systems- Introduction to Cameras, Imaging, Sensing and Digitization. Vision Applications in Robotics.

MODULE III

Introduction to Robot Kinematics and Dynamics: Introduction to Kinematics: Position and Orientation of Objects. Rotation. Euler Angles. Rigid Motion Representation using Homogenous Transformation Matrix. Kinematic Modelling: Translation and Rotation Representation, Coordinate Transformation, Forward and Inverse Kinematics. *Forward Kinematics*-Link Coordinates, Denavit-Hartenberg Representation, Application of DH Convention to Different Serial Kinematic Arrangements. *Inverse Kinematics* – General Properties of Solutions, Kinematic Decoupling, *Velocity Kinematics* – Derivation of the Jacobian, Application of Velocity Kinematics for Serial Manipulators, Importance of Singularities. Introduction to Dynamic Modelling:*Forward and Inverse Dynamics-* Equations of Motion using Euler-Lagrange formulation, Newton Euler Formulation.

MODULE IV

Introduction to Robot Control: Basics of Control: Open Loop- Closed Loop, Transfer Functions, Control Laws: P, PD, PID, Linear and Non-linear Controls; Control Hardware and Interfacing; Embedded Systems: Microcontroller Architecture and Integration with Sensors, Actuators, Components.Introduction to Robot Programming – Programming Methods, Robot

Language Classification, Robot Language Structure, Elements and its Functions. Motion, End-Effecter and Sensor Commands in VAL Programming Language. Simple Programs.

MODULE V

Recent Developments in Robotics. Mobile Robots: Mobile Robot Kinematics, Navigation. Humanoid Robotics: Biped Locomotion, Imitation Learning. Collaborative Robots: Collaborative Robot, Collaborative Operation, Applications. Artificial Intelligence in Robotics: Applications in Unmanned Systems, Defense, Medical, Industries, etc. Industrial Applications of Robots in Material Handling and Assembly. Robotics and Automation for Industry 4.0., Robot Safety. Social Robotics.

Text Books:

1. S.K. Saha, Introduction to Robotics, Tata McGraw Hill, 2nd Edition, 2014
2. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, John Wiley & Sons, 2nd Edition, 2011.
3. Spong and Vidyasagar, Robot Dynamics and Control, John Wiley & Sons, 1990.
4. Mikell P. Groover, et al., Industrial Robotics – Technology, Programming and Applications, McGraw Hill, 2nd Edition, 2012

Reference Books:

1. John. J.Craig, Introduction to Robotics: Mechanics and Control, PHI, 2005.
2. Ashitava Ghosal, Robotics, Fundamental concepts and analysis, OXFORD University Press, 2006
3. Fu, K.S,Gonzalez,R.C,Lee, C.S.G.,Robotics, Control, Sensing, Vision and Intelligence, McGraw-Hill, 1987.
4. Asada, H., and J. J. Slotine. *Robot Analysis and Control*. New York, NY: Wiley, 1986.
5. Robert J. Schilling, Fundamentals of Robotics: Analysis & Control, Pearson Education, 2000
6. Klafter, R.D., Chmielewski, T.A, Negin, M, Robotic Engineering An Integrated Approach, PHI, 2007
7. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi, 1994.

Course PlanCourse Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1: Introduction to Robotics**	
1.1	Definition and Origin of Robotics: What is the basic definition of a robot? How the field of robotics originated? What are the basic components of a robot? How to specify a robot?	1
1.2	Characteristics, Classification, Advantages and Disadvantages of Robots: What are the different characteristic parameters of robots? How robots are	1

	classified? What are the advantages of using robots in various applications?Are there any disadvantages to employing robots?	
1.3	Robot Structure, and Common Kinematic Arrangements: What are the different structural arrangements for robots? What are the different types of joints, end effectors, mechanisms and manipulators commonly used in robotics? How to express the structure of robots in terms of common kinematic arrangements?	1
1.4	Concepts of Degree of Freedom (DOF), Coordinates, Reference Frames, Workspace in Robotics: How to define the degree of freedom of any robot? What are the commonly used coordinate systems for robots? How the concept of reference frames help in a robot design? How to determine the workspace of a robot?	1
1.5	Areas of Application for Robots: What are different fields/areas where robots find applications? How the size, structure, sensors, DOF and end effector change with applications?	1
1.6	Areas of Application for Robots: Suggest some new or futuristic fields/areas where robots may find applications?	1
2	**Module 2: Introduction to Robotic Sensors and Actuators**	
2.1	Robotic Drive Systems and Actuators: What are the different types of drive systems used in robotics? Describe the different transmission systems used in robots and their specific applications.	1
2.2	Types and Applications of Actuators in Robotics: What are the different deciding parameters for selecting appropriate actuators for robots? How areactuators specified? What are the specific applications for stepper motors, servo motors and brushless DC motors in robotics?	1
2.3	Types and Applications of Sensors in Robotics: What are the different position, displacement and velocity sensors used in robots? How do the tactical sensors used in robotic devices sense contact and proximity of objects? What are the commonly used force and torque sensors in robots? How do tachometers help in robotic operation and application?	1
2.4	Control of Motors in Robotics: How to perform microprocessor-based control in electricmotors? How speed control is carried out using pulse-width modulation? Describe direction control using H-Bridge.	1
2.5	Robotic Vision Systems: What is the role of cameras in robots? Describe how imaging, sensing and	1

	digitization processes are performed in robotic applications. What are the vision applications ofrobots?	
2.6	Control of Robotics: Conduct exercises to develop small control programs for joints/links/end effectors of robots.	1
3	**Module 3: Introduction to Robot Kinematics and Dynamics**	
3.1	Introduction to Kinematics: How to specify the position and orientation of links and joints in robotics? What are the common methods for describing robot orientations? Describe how rigid motion representation can be made using a homogenous transformation matrix.	1
3.2	Kinematic Modelling: How to determine the position and orientation of an end effector of a robot under translation and/or rotation? What is the coordinate transformation method? How transformations can be performed between the coordinate frames attached to different robotic links and joints. What arethe purposes for forward and inverse kinematics in robotics?	1
	First Series Examination	
3.3	Forward Kinematics: How to compute the position of the end effector from joint parameters? What is Denavit-Hartenberg representation? How the D-H convention can be applied to different serial kinematic arrangements.	1
3.4	Inverse Kinematics: How to predict the joint angles from the known coordinates of the end effector of a robot? How kinematic decoupling is performed in robotic manipulators?	1
3.5	Velocity Kinematics: How can the linear and angular velocities of the end effector get related to the joint velocities to form the velocity relationship? How can velocity kinematics be applied to serial robots?What are the different singularities that affect the degree of freedom of robots?	1
3.6	Introduction to Dynamic Modelling: What are the functions of forward and inverse dynamicsin robotics? How can we develop the equations of motion using the Euler-Lagrange formulation? What is the role of Newton-Euler formulation in the dynamic modelling of robots?	2
4	**Module 4: Introduction to Robot Control**	
4.1	Basics of Control: Describe the basic control parameters and systems used in robotics? How P, PD, PID, Linear and Non-linear Controls are employed in robotic practices?	2
4.2	Control Hardware and Interfacing:	2

	What are the advantages of using the embedded system in robotics? How microcontrollers can integrate sensors, actuators and components within a robotic system?	
4.3	Introduction to Robot Programming: What is robot programming? What are different programming methods for robots? How the robot languages are classified? Describe the structure, elements, and functions of robot language.	2
4.4	Introduction to Robot Programming: What is the role of variable assembly language (VAL) programming in robotics? What are the common commands used for motion, end effector and sensors?	1
4.5	Introduction to Robot Programming: Using simple programs, conduct exercises to develop the robot programming skills of students.	2
5	**Module 5: Recent Developments in Robotics.**	
5.1	Mobile Robots: What are mobile robots? How the kinematics change with mobile robots? Describe the navigation of mobile robots.	1
5.2	Humanoid Robotics: How to humanoid robots are different from other types? What is biped locomotion? What are the challenges involved in the static and dynamic balance of biped robots?What is the application of imitation learning in humanoid robots?	1
5.3	Collaborative Robots: What are collaborative robots? How can collaborative operation put it into practice for robots? What are the different applications of collaborative robots?	1
5.4	Artificial Intelligence (AI) in Robotics:. What are the different applications of AI in robotics? How AI helps in the development of unmanned robotic systems What are the different applications of AI-based robots in the defense, medical, industrial and other domains?	2
5.5	Industrial Applications of Robots: What are the applications of robots in different industries? How robots have a greater role today in material handling and assembly? What is the contribution of robotics towards Industry 4.0.	1
5.6	Robot Ethics, Robot Safety and Social Robotics What the ethical practices necessary for the design, production and application of robots today? What are the aspects of occupational safety and health of humans when robots are used in the workplace? What are social robots? How are social robots suppose to help humans?	1
	Second Series Examination	

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B TECH DEGREE EXAMINATION
COURSE: ECT476 ROBOTICS
TIME: 3 HRS MAX. MARKS: 100

PART A

Answer All Questions

1	List out the different criteria based on which robots are classified.	3
2	What are the basic components of a robot?	3
3	Determine the advantages of using electric drive systems in robots.	3
4	Identify the sensors used in robots for sensing position and velocity.	3
5	Recognize the need for Denavit-Hartenberg convention in robotics.	3
6	Describe joint angle, joint distance, link length and link twist.	3
7	How is the speed of an electric motor controlled using a microprocessor?	3
8	Distinguish between linear and rotary hydraulic actuation mechanisms.	3
9	Find any four non-industrial applications of robots	3
10	Substantiate the need for robot ethics.	3

PART B

Answer one question from each module. Each question carries 14 marks.

Module I

11(A)	Describe the commonly used types of joints and end effectors in robots.	*8*
11(B)	Explain the basic structure of anyrobotic system. How each component is different from the others in terms of its functionality?	*6*

OR

12(A)	Discuss the common kinematic arrangements in robots and find out the degree of freedom for each.	*8*
12(B)	Write notes on terms like accuracy, precision, and repeatability in connection with a robotic system.	*6*

Module II

13(A)	Compare among hydraulic, pneumatic and electric types of robotic drives and mention the specific area of application for each.	*8*
13(B)	Describe how direction control is carried out on electric motors in robots using H- Bridge.	*6*

OR

14(A)	Discuss the different characteristics of tactile sensors. Describe with the help of a neat diagram the working of commonly used tactile sensors	*8*

14(B) Elaborate on the imaging, sensing and digitization processes in robotic vision systems. *6*

Module III

15(A) A frame 'B' was rotated about the x-axis 90°, then, it was translated about the current a-axis 3 inches before it was rotated about z-axis 90°. Finally, it was translated about the current a-axis 5 inches. *8*

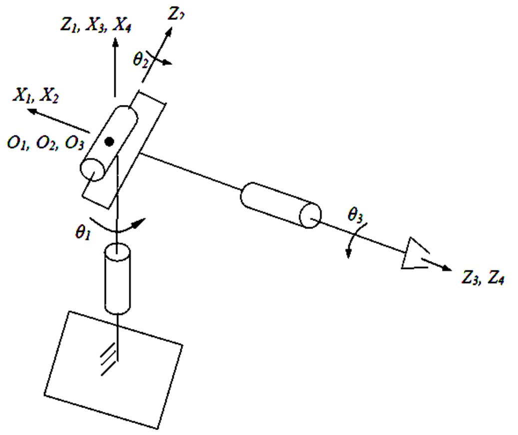
a) Write an equation that describes the motion.

b) Find the final location of a point P $(1, 5, 4)^T$ attached to the frame relative to the reference frame.

15(B) Distinguish between rotation matrix and homogenous transformation matrix. *6*

OR

16(A) Find the Denavit-Hartenberg representation parameters of a spherical arm shown in the figure below: *8*



16(B) Describe the common kinematic arrangements of robots based on Cartesian-coordinate and Cylindrical-coordinate systems *6*

Module IV

17(A) Discuss the different control schemes of robots *8*

17(B) Describe the basic structure of any robot programming language. *6*

OR

18(A) Elaborate the processes involved in robot actuation and the control methods used with block diagrams *8*

18(B) Differentiate between textual and lead through programming methods *6*

Module V

19(A) What are mobile robots: Describe how kinematics involved in mobile *8* robots are different from others.

19(B) Enumerate the challenges involved in biped motion of humanoid robots. *6*

OR

20(A) Discuss the significant roles played by robotics in different areas for realizing Industry 4.0. *8*

20(B) Examine the involvement of artificial intelligence in Robotics *6*

SEMESTER VIII

PROGRAM ELECTIVE V

ECT418	MECHATRONICS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course introduces students to the rapidly emerging, multi-disciplinary, and exciting field of Mechatronics.

Prerequisite: Nil

Course Outcome: After the successful completion of the course the student will be able to

CO1	Understand the working principles of various sensors and actuators in Mechatronics systems and be able to choose the suitable one for the real world application
CO2	Formulate and simulate models of mechatronics systems
CO3	Explain the implementation of PLC in mechatronics applications
CO4	Explain the standard fabrication techniques and principle of operation of MEMS devices
CO5	Design and Analysis of commonly encountered mechatronics systems for real time applications

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										
CO2	3	3										
CO3	3	3	2									
CO4	3	3										
CO5	3	3										

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

: 10 marks
Continuous Assessment Test (2 numbers)
: 25 marks
Assignment/Quiz/Course project
: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the working principles of various sensors and actuators in Mechatronics systems and be able to choose the suitable one for the real world application

1. Illustrate the working of a strain gauged load cell
2. Explain the working of any one non-contact temperature measurement system
3. Explain the principle of operation and suggest two applications of Hall effect sensor in mechatronic systems.
4. With neat sketches explain the working of a double acting hydraulic actuator.
5. Design a hydraulic circuit to operate a winch fitted with a hydraulic motor. The motor should be run clockwise, counter clockwise and stopped. Use a manually operated valve.
6. Explain any two situations when pneumatic actuators are preferred over hydraulic ones.

Course Outcome 2 (CO2): Formulate models of mechatronics systems

1. Derive the mathematical model of a general electrical system and draw its analogy with a mechanical system.
2. Explain the working of a mechanical device using closed loop control system with the help of a suitable example.

Course Outcome 3 (CO3): Explain the implementation of PLC in mechatronics applications

1. Explain ‘latching’ in PLC logic with an example.
2. Illustrate the significance of Internal Relays in PLC program
3. Consider a pneumatic system with single-solenoid controlled valves and involving two cylinders A and B, with limit switches a–, a+, b–, b+ detecting the limits of the piston rod movements. Design a ladder programme with the requirement being when the start switch is triggered, the sequence A+, B+, A–, 10s time delay, B– occurs and stop at that point until the start switch is triggered again.

Course Outcome 4(CO4): Explain the standard fabrication techniques and principle of operation of MEMS devices

1. Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions.
2. Explain the criteria for choice of surface or bulk micromachining techniques in the design of micro systems.
3. Explain with block diagram the steps in LIGA process. State two advantages of LIGA process over other micro machining techniques.

Course Outcome 5 (CO5): Design and Analysis of commonly encountered mechatronics systems for real time applications

1. With the help of a neat sketch explain the different mechatronics modules used in automatic car park barrier system
2. Explain with a neat sketch the mechatronic implementation of a household weighing machine
3. With a neat sketch, explain the physical system and working of a pick and place robot.

SYLLABUS

MODULE I

Introduction to Mechatronics: Structure of Mechatronics system. Comparison between traditional and mechatronics approach. Sensors - Characteristics -Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute. Resolvers and synchros. Piezoelectric sensors. Acoustic Emission sensors. vibration sensors.Force and tactile sensors. Range finders: ultrasonic and light based range finders

MODULE II

Actuators: Hydraulic and Pneumatic actuators - Directional control valves, pressure control valves, process control valves. Rotary actuators. Development of simple hydraulic and pneumatic circuits using standard Symbols. Electrical drives: DC, AC, brushless, servo and stepper motors. Harmonic drive.Magnetostrictive actuators and piezoelectric actuators.

MODULE III

System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools.

Programmable Logic Controllers (PLC) –Basic structure, input/ output processing. Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes.

MODULE IV

Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Micromachining methods for MEMS -Surface and Bulk, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope.

MODULE V

Mechatronics in Robotics- choice of Sensors and Actuators. Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras. Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding.

Case studies of Mechatronics systems: Automatic camera, bar code reader, simple weighing machine, pick and place robot, automatic car park barrier system, automobileengine management system.

Text Books:

1. Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Person Education Limited, New Delhi, 2007
2. Ramachandran K. P., G. K. Vijayaraghavan, M. S. Balasundaram, Mechatronics: IntegratedMechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi, 2008.
3. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Person Education ,Inc., New Delhi, 2006.
4. Devdas Shetty, Richard A. Kolk, “Mechatronics System Design”, Thomson Learning Publishing Company, Vikas publishing house, Second edition, 2001.

Reference Books:

1. David G. Aldatore, Michael B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill Inc., USA, 2003.
2. Gordon M. Mair, Industrial Robotics, Prentice Hall International, UK, 1998.
3. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
4. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, John Wiley & Sons Ltd., England, 2006.
5. Bishop, Robert H. The Mechatronics Handbook-2 Volume Set. CRC press, 2002.

Course Plan Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction to Mechatronics: Structure of Mechatronics system. Comparison between traditional and mechatronics approach	1
	Sensors - Characteristics -Temperature, flow, pressure sensors.	1
	Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods	1
	Encoders: incremental and absolute. Resolvers and synchros.	1
	Piezoelectric sensors. Acoustic Emission sensors. vibration sensors, Force and tactile sensors	1
	Range finders: ultrasonic and light based range finders	1
2	Actuators: Hydraulic and Pneumatic actuators - Directional control valves	1
	pressure control valves, process control valves,	1
	Rotary actuators.	1
	Development of simple hydraulic and pneumatic circuits using standard Symbols.	1
	Electrical drives: DC, AC, and	1
	brushless, servo	1
	stepper motors. Harmonic drive.	1
3	System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems.	2
	Typical elements of open and closed loop control systems, Adaptive controllers for machine tools	1
	Programmable Logic Controllers (PLC) –Basic structure, input/ output processing.	1
	Programming: Timers, Internal Relays, Counters and Shift registers.	2
	Development of simple ladder programs for specific purposes	1
4	Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography	1
	Micromachining methods for MEMS -Surface and Bulk,	2
	Deep Reactive Ion Etching (DRIE) and LIGA processes.	1
	Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope	3
5	Mechatronics in Robotics- choice of Sensors and Actuators.	1
	Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras.	2

	Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding.	2
	Case studies of Mechatronics systems: Automatic camera, bar code reader, simple weighing machine, picks and place robot,	2
	Automatic car park barrier system, automobile engine management system.	1

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B TECH DEGREE EXAMINATION
COURSE: ECT418 MECHATRONICS
TIME: 3 HRS MAX. MARKS: 100

PART A

Answer All Questions

1	Differentiate between absolute and incremental encoders	3
2	List six examples of temperature sensors	3
3	Explain how cushioning is achieved in pneumatic actuators with a sketch.	3
4	Mention any two differences between finite position and infinite position valves	3
5	List any 2 controlling factors in wet etching.	3
6	Sketch and label a MEMS based pressure sensor	3
7	What is latching? Draw a simple latched circuit	3
8	Write down the describing equations of basic mechanical building blocks	3
9	Illustrate the histogram processing technique for enhancing the image contrast	3
10	Bring out any 3 difference between CCD and CID camera.	3

PART B

Answer one question from each module. Each question carries 14 marks.

Module I

11(A)	Explain the working of an optical absolute encoder. How the number of tracks and sectors of absolute encoder is related to the resolution of the encoder?	*6*	
11(B)	Explain the structure of a mechatronics system. How is it different form the traditional approach?	*8*	
	OR		
12(A)	Explain the sensor characteristics to be considered when choosing a sensor for a mechatronics application	*8*	
12(B)	Compare the working of resolver and synchro	*6*	

	Module II		
13(A)	Develop a pneumatic circuit with standard symbols, to operate two cylinders in sequence. Explain its working.	*8*	
13(B)	Explain the constructional features and working of brushless DC motor	*6*	
	OR		
14(A)	Illustrate the working of Harmonic Drives with neat sketches	*8*	
14(B)	Design a hydraulic circuit to operate a winch fitted with a hydraulic motor. The motor should be run clockwise, counter clockwise and stopped. Use a manually operated valve.	*6*	
	Module III		
15(A)	Draw and explain the block diagram of a feedback control system.	*4*	
15(B)	Develop a PLC ladder program for the following sequence: Start a motor with push switch, and then after a delay of 90s, start a pump. When the motor is switched off, the pump will get switched off after a delay of 5s. Mention the logic used for each rung in the program to substantiate your answer.	*10*	
	OR		
16(A)	Explain how a PLC can be used to handle analog inputs?	*4*	
16(B)	Explain the model a fluid flow system with basic building blocks, clearly mention all assumptions	*10*	
	Module IV		
17(A)	Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions	*6*	
17(B)	Compare and contrast various micro manufacturing techniques	*8*	
	OR		
18(A)	Describe the various mechanical problems associated with surface micromachining	*6*	
18(B)	Explain the LIGA process associated with MEMS fabrication	*8*	
	Module V		
19(A)	With the help of a neat sketch explain the different mechatronics modules used in automatic car park barrier system	*10*	

19(B)	List any fourapplications of robotic vision systems	*4*	
	OR		
20(A)	Explain the working of Barcode reader with reference to the coding schemes. Mention the steps to process the digits in a barcode for a particular product. Develop the steps in a program for reading the barcode.	*10*	
20(B)	List the steps in thresholding technique in image processing	*4*	

ECT428	OPTIMIZATION TECHNIQUES	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to provide a broad picture of various applications of optimization methods used in engineering.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1 K4	Formulate and classify different optimisation problems.
CO 2 K3	Apply classical and numerical methods solving linear and non-linear optimisation problems.
CO 3 K3	Apply modern methods of optimisation for solving optimisation problems.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										2
CO 2	3	3										2
CO 3	3	3										2

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember K1	10	10	10
Understand K2	20	20	20
Apply K3	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Formulate optimisation problems. (K3)

1. Understand the different classification of optimization problems
2. Apply basic concepts of mathematics to formulate an optimization problem.
3. Formulation of real world problems as linear programming problems.

Course Outcome 2 (CO2) : Obtain optimised solution using classical methods for constrained and unconstrained problems. (K3)

1. Identify extreme points of a given function and classify as minimum, maximum or saddle point.
2. Formulate Lagragian equation for constrained problems and solution using KKT conditions.
3. Find optimum solution using Simplex method for the given problem.

Course Outcome 2 (CO2): Obtain optimised solution using numerical methods for non-linear problems. (K3)

1. Apply elimination search and direct root methods for finding the optimal solution
2. Find optimal point of a given function using gradient methods.

Course Outcome 3 (CO3): (K3)

1. Explain different steps in the genetic algorithm.

2. Evaluate the strategies to be adopted for players using game theory.
3. Using algorithms find minimum spanning tree and shortest distance for given network path.
4. Two identical sections of the given networks are connected in parallel. Obtain the two port network parameters of the combination.

SYLLABUS

Module 1 : Introduction to classical method

Engineering applications of optimization, Formulation of design problems as mathematical programming problems.

Classification of optimization problems/techniques.

Classical optimization: unconstrained single and multivariable optimisation, Constrained optimization. Linear, Convex and non-convex optimization problems. KKT conditions.

Module 2 : Linear programming problems

Mathematical formulation of LP Problems, Solving using Simplex method and Graphical method

Module 3 :Game Theory, Network path models

Game Theory: Introduction, 2- person zero – sum game -Saddle point; Mini-Max and Maxi-Min Theorems (statement only)- Graphical solution (2x n, m x 2 game), dominance property.

Introduction to network tree - Minimal Spanning Tree - Prim's Algorithm.

Shortest path problems- solution methods – Dijkstra's Method.

Module 4 : Nonlinear unconstrained optimization

Single variable optimization methods- Fibonacci search method, Newton Raphson method

Multi-variable methods- Hook-Jeeves pattern search method, Cauchy's (steepest descent) method

Module 5 : Modern methods of optimization

Introduction to Genetic algorithm, Basic GA framework

GA operators: Encoding, Crossover, Selection, Mutation

Introduction to Fuzzy logic. Fuzzy sets and membership functions. Operations on Fuzzy sets. Optimization of Fuzzy Systems.

Text Books

1. S.S.Rao, Engineering Optimization.; Theory and Practice; Revised 3rd Edition, New Age International Publishers, New Delhi
2.H.A. Taha, " Operations Research", 5/e, Macmillan Publishing Company, 1992.
Kanti Swarup, P.K.Gupta and Man Mohan, Operations Research, Sultan Chand and Sons

Reference Books

1. Kalynamoy Deb. "Optimization for Engineering Design- Algorithms and Examples", Prentice-Hall of India Pvt. Ltd., New Delhi.
2. A. Ravindran, D. T. Phillips, J. J. Solberg, Operations Research – Principles and Practice, John Wiley and Sons.
3. Ashok D Belegundu, Tirupathi R Chandrupatla, "Optimization concepts and Application in Engineering", Pearson Education.
4. Hadley, G. "Linear programming", Narosa Publishing House, New Delhi
5. J. S. Arora, Introduction to Optimum Design, McGraw-Hill Book Company.

Course Contents and Lecture Schedule

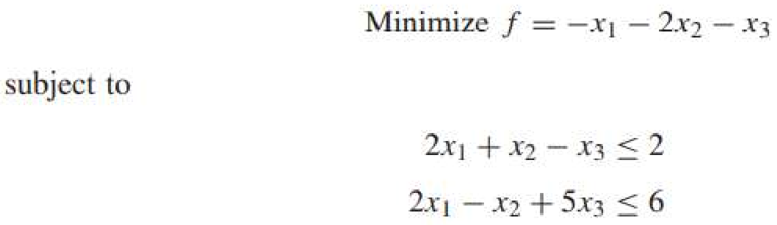
No	Topic	No. of Lectures
1	**Introduction:**	
1.1	Engineering applications of optimization, Formulation of design problems as mathematical programming problems, objective function, constraints	**1**
1.2	Classification of optimization problems/techniques. Linear, convex, and non-convex.	**2**
1.3	**Unconstrained optimization**: Unconstrained one dimensional necessary and sufficient conditions for optimality	**2**
1.4	Algorithms for one-dimensional unconstrained optimization problem – Fibonnacci, golden section	**2**
		7
2	**Algorithms and Constrained Optimization**	
2.1	Unconstrained multi-dimensional necessary and sufficient conditions for optimality	**2**
2.2	Algorithms for multi-dimensional unconstrained optimization problems – Steepest Descent, Newton's methods	**2**
2.3	**Constrained optimization:** Lagrangian method - First order Necessary KKT Conditions, Second order sufficient conditions, Duality (Concept)	**3**
		7
3	**Linear programming problems**	
3.1	Mathematical formulation of LP Problems	**1**
3.2	Slack, surplus and artificial variables, Reduction of a LPP to the standard form, feasible solutions.	**1**
3.3	Graphical solution method	**2**
3.4	simplex algorithm and solution using tabular method,	**1**
3.5	optimality conditions and degeneracy	**1**
3.6	Duality in linear programming	**1**
		7

4	**Nonlinear unconstrained optimization**	
4.1	Single variable optimization methods- Fibonacci search method,	**2**
4.2	Newton Raphson method	**2**
4.3	Multi-variable methods- Hook-Jeeves pattern search method,	**3**
		7
5	**Modern methods of optimization**	
5.1	Introduction to Genetic algorithm, Basic GA framework	**1**
5.2	GA operators: Encoding, Crossover, Selection, Mutation	**2**
5.3	Introduction to Fuzzy logic.	**1**
5.4	Fuzzy sets and membership functions.	**1**
5.5	Operations on Fuzzy sets.	**1**
5.6	Optimization of Fuzzy Systems	**1**
		7

Simulation Assignments:

Atleast one assignment should be simulation of optimization Problems using MATLAB/ Scilab/ Python. The following simulations .

1. Find the solution of the linear programming problem using simplex method.



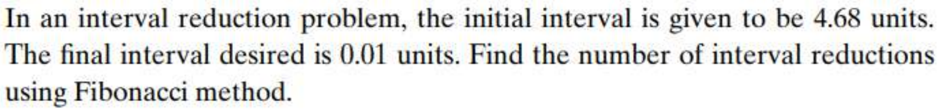
$$\text{Minimize } f = -x_1 - 2x_2 - x_3$$

subject to

$$2x_1 + x_2 - x_3 \leq 2$$
$$2x_1 - x_2 + 5x_3 \leq 6$$

Refer MATLAB Solution of LP Problems SS Rao.

2.



In an interval reduction problem, the initial interval is given to be 4.68 units. The final interval desired is 0.01 units. Find the number of interval reductions using Fibonacci method.

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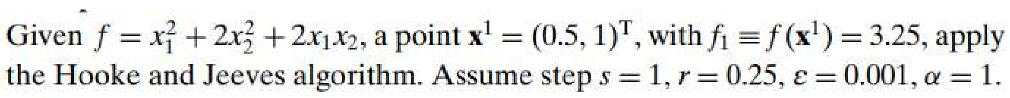
3.



Given $f = x_1^2 + 2x_2^2 + 2x_1x_2$, a point $\mathbf{x}^1 = (0.5, 1)^T$, with $f_1 \equiv f(\mathbf{x}^1) = 3.25$, apply the Hooke and Jeeves algorithm. Assume step $s = 1$, $r = 0.25$, $\varepsilon = 0.001$, $\alpha = 1$.

Ashok D. Belegundu, Tirupathi R. Chandrupatla

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: ECT428

Course Name: OPTIMIZATION TECHNIQUES

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	What are the necessary and sufficient conditions for the relative minimum of a function of a single variable?	K2
2	Find the extreme points of the function $f(x_1, x_2) = x_1^3 + x_2^3 + 2x_1^2 + 4x_2^2 + 6$	K3
3	Give five typical applications of optimization techniques in engineering discipline.	K1
4	What is the significance of gradient function in minimization problem?	K2
5	State the duality principle and write the dual of the following LPP. Minimize $Z = 24x_1 + 30x_2$ subject to $2x_1 + 3x_2 \geq 10, 4x_1 + 9x_2 \geq 15, 6x_1 + 6x_2 \geq 20, x_1, x_2 \geq 0$	K3
6	Write a short note on Dijkstra's shortest path algorithm	K1
7	Explain the transformations needed to represent an LPP in standard form	K1
8	State dominance property in game theory	K1
9	Discuss membership function in fuzzy logic	K2
10	Name and describe the main five features of Genetic Algorithm	K2

PART – B

Answer one question from each module; each question carries 14 marks.

Module - I

11 a.	Maximize $f(x) = 2x_1 + x_2 + 10$ subject to $x_1 + 2x_2^2 - 3 = 0$	7

K3

b. Find the extreme points of the function $f(x_1,x_2,x_3)=x_1+2x_3+x_2x_3-x_1^2-x_2^2-x_3^2$. 7

K3

OR

12 a. Determine whether the following matrix is positive or negative definite. 7 K3

$$A=\begin{pmatrix} 3 & 1 & -1 \\ 1 & 3 & -1 \\ -1 & -1 & 5 \end{pmatrix}$$

b. Using method of Lagrange multipliers, Minimize $f(x_1, x_2, x_3) = x_1{}^2 + x_2{}^2 + x_3{}^2$ subject to constraints $4x_1 + x_2{}^2 + 2x_3 = 14$ 7

K3

Module - II

13 a. Solve the following LPP graphically, 14

Minimize $Z=20x_1 + 40x_2$

Subject to the constraints

$$36\,x_1 + 6\,x_2 \geq 108$$

$$3x_1 + 12\,x_2 \geq 36$$

$$20x_1 + 10\,x_2 \geq 100$$

and $x_1, x_2 \geq 0$

K3

OR

14 Solve the following LPP using simplex method. Maximize $Z=10x_1+15x_2+20x_3$ subject to the constraints 14

$$2x_1+4x_2+6x_3 \le 24, 3x_1+9x_2+6x_3 \le 30, x_1, x_2, x_3 \ge 0.$$

K3

Module - III

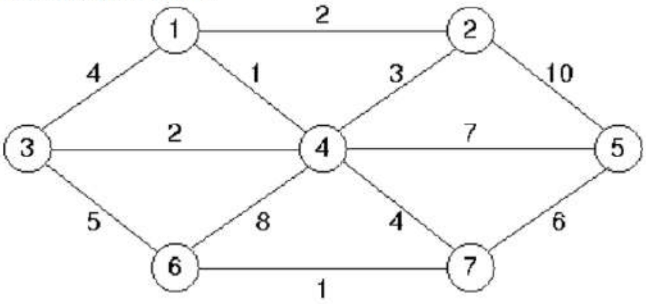
15 a. Solve the game using graphical method. 7

K3

Player	B				
A	2	-4	6	-3	5
A	-3	4	-4	1	0

b. Using Dijkstra's method find the shortest path from node 1 to node 7 from the following network path model. 7

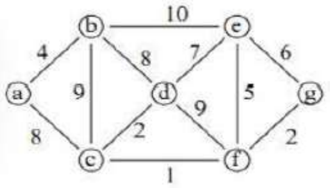
K3



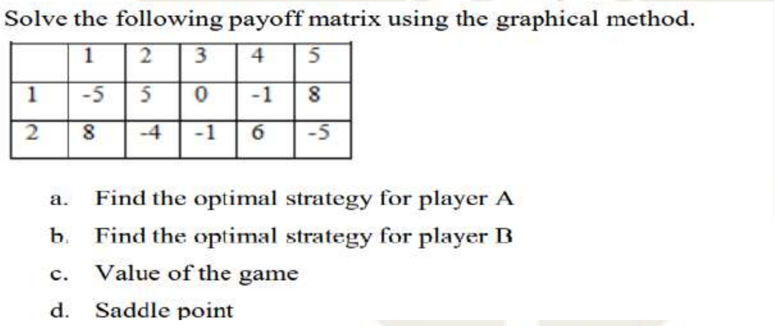
OR

16 a. Using Prim's algorithm find the minimum spanning tree and the shortest distance from node 'a' to node 'b'. 7

K3



b.



Solve the following payoff matrix using the graphical method.

	1	2	3	4	5
1	-5	5	0	-1	8
2	8	-4	-1	6	-5

a. Find the optimal strategy for player A
b. Find the optimal strategy for player B
c. Value of the game
d. Saddle point

7

K3

Module - IV

17 Solve the non linear unconstrained minimised optimisation problem by Hooke-Jeeves pattern search method by taking $\Delta x_1 = \Delta x_2 = 0.5$ and the starting point as $(x_1, x_2) = (2, -1)$ where $f(x_1, x_2) = x_1^2 + 3x_2^2 + 6x_1x_2 - x_1 - x_2$. 14

CO3
K3

OR

18 Using Fibonacci method, minimise $f = x^5 - 5x^3 - 20x + 5$ in the interval (0,5) in six steps. 14
K3

Module - V

19 . Consider membership function of two fuzzy sets $\tilde{A}$ and $\tilde{B}$ are given by $\mu_A(x) = \frac{x}{x+2}$ and $\mu_B(x) = 3^{-x}$. Find the membership function of i) $\tilde{A}^C$ ii) $\tilde{B}^C$, iii) $\tilde{A} \cup \tilde{B}$, iv) $\tilde{A} \cap \tilde{B}$, v) $(\tilde{A} \cup \tilde{B})^C$, where ^{C} is complement. 14

K3

OR

20 Consider the fuzzy relation R defined in A x A. Check whether the fuzzy relation is i) Reflexive, ii) Symmetric and iii) Transitive. 7

$$R = \begin{bmatrix} 0.4 & 0.1 & 0.7 \\ 0.1 & 0.2 & 0.2 \\ 0.4 & 0.5 & 0.3 \end{bmatrix}$$

K3

b. Explain the working principles of Genetic Algorithms. 7,K2

ECT438	COMPUTER VISION	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to develop the knowledge of various methods, algorithms and applications of Computer Vision,

Prerequisite:Digital Image Processing

Course objectives:

- To review image processing techniques for computer vision
- To understand shape and region analysis
- To understand three-dimensional image analysis techniques and motion analysis
- To study some applications of computer vision algorithms
- To introduce methods and concepts which will enable the student to implement computer vision systems with emphasis on applications and problem solving

Course Outcomes: After the completion of the course the student will be able to

CO1	Understand digital filtering operations for CV applications.
CO 2	Apply basic morphological and boundary operators for Computer vision applications
CO3	Apply edge, corner detection algorithms to locate objects in an image.
CO 4	Apply optical flow algorithms to detect moving objects in a video.
CO5	Analyse a given scene using appropriate computer vision algorithms to detect/recognize objects and to implement it in real time practical applications.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3	2		2						2	3
CO 2	3	3	2		2						2	3
CO 3	3	3	3		2						2	3
CO 4	3	3	3		2						2	3
CO 5	3	3	3		2						2	3

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember K1	10	10	10
UnderstandK2	10	10	20
Apply K3	20	20	70
Analyse K4	10	10	
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project) : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Apply digital filtering operations for Computer vision applications

1. Why histogram transformations are applied in a grey scale image and what output is observed in that case.
2. Find filtered image using LP/HP/Smoothing/Median filter.
3. Describe the working principle of Homomorphic filter.
4. Role of thresholding in CV applications

Course Outcome 2 (CO2): Apply basic morphological and boundary operators for Computer vision applications

1. Apply various algorithms for morphological operations and binary shape analysis
2. List different morphological operators and describe about each one in detail.
3. To describe connected component labelling and to apply it in a given image pixel set.
4. Find 8-point connectivity and Chain code of a given image pixel diagram.

Course Outcome 3 (CO3): Apply edge, corner detection algorithms to locate objects in an image.

1. What is the role of edge detection and corner detection in Computer Vision applications?
2. Describe Canny's edge detection algorithm.
3. Mention the steps in Harris corner detection algorithm and explain how it is employed to detect corners in an image.
4. State with necessary mathematical steps, how Hough transform is employed for detecting lines and curves in detecting an image.

Course Outcome 4 (CO4): Apply optical flow algorithms to detect moving objects in a video.

1. To identify shapes from –X in Computer Vision applications?
2. Derive brightness constancy equation
3. Derive Horn-Shunk algorithm.
4. Illustrate the steps in Lucas-Kannade algorithm to detect optical flow.
5. To identify a structure from a moving object.

Course Outcome 5 (CO5): Analyse a given scene using appropriate computer vision algorithms to detect/recognize objects and to implement it in real time practical applications

1. Find Eigen values and Eigen Vectors of agiven square matrix
$$A = \begin{bmatrix} 9 & 4 & 0 \\ 4 & 3 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$
2. To apply PCA for face recognition and face detection.
3. To apply SVM, LDA, Bayes rule andML methods
4. Analyse a given video to track a moving object in it.
5. To detect a particular object from the background.
6. To detect signboards/ pedestrian crossings/pedestrians from a moving vehicle.
7. To classify/segment a particular set of image using CV algorithms.
8. Analyse a given image/video using Machine learning/Deep learning algorithms.
9. Use trained networks to analyse a video using ML algorithms.
10. To use Deep neural networks/CNN/YOLOvx, to analyse images/videos

SYLLABUS

Module 1

Review of image processing techniques: Digital filters, linear filters-Homomorphic filtering, Point operators- Histogram, neighbourhood operators, thresholding

Module 2

Mathematical morphology, Binary shape analysis, Binary shape analysis, Erosion, Dilation, Opening and Closing, Hit-or-Miss Transform ,connectedness, object labelling and counting, Boundary descriptors – Chain codes. Properties of Binary Regions, Geometric Features, Statistical Shape Properties.

Module 3

Feature Detection and Image Synthesis,Edge detection – edges, lines, active contours, Split and merge, Mean shift and mode finding, Normalized cuts, Graph cuts, energy-based methods- Cranny's Algorithm, Corner detection, Harris corner detection algorithm. Hough transform-Line and curve detection.

Module 4

Shape from X - Shape from shading, Photometric stereo, Texture Occluding contour detection. Motion Analysis- Regularization theory,Optical Flow: brightness constancy equation, aperture problem, Horn-Shunck method, Lucas-Kanade method. Structure from motion

Module 5

Object recognition-Shape correspondence and shape matching PCA,SVM, LDA, Bayes rule andML methods. Eigen faces,Face detection, Face recognition, Application: Scene analysis Examples of real time applications: In-vehicle vision system.

Text Books

1. E. R .Davies, Computer and Machine Vision -Theory Algorithm and Practicalities, Academic Press, 2012
2. Richard Szeliski, Computer Vision: Algorithms and Applications, ISBN 978-1-84882-935-0, Springer 2011.
3. David Forsyth and Jean Ponce, Computer Vision: A Modern Approach, Pearson India, 2002.

Reference Books

1. Goodfellow, Bengio, and Courville, Deep Learning, MIT Press, 2006.
2. Daniel Lelis Baggio, KhvedcheniaIevgen, Shervin Emam, David Millan Escriva, NaureenMahmoo, Jason Saragi, Roy Shilkrot, Mastering OpenCV with Practical Computer Vision Projects, Packt Publishing Limited, 2012
3. Simon J D Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.
4. R. J. Schalkoff, Digital Image Processing and Computer Vision, John Wiley, 2004.
5. D. L. Baggio et al., ―Mastering OpenCV with Practical Computer Vision Projects,

Packt Publishing, 2012.

6. Jan Erik Solem, ―Programming Computer Vision with Python: Tools and algorithms for analyzing images‖, O'Reilly Media, 2012.

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Review of image processing techniques	1
1.2	Digital filters, Linear filtering-Homomorphic filtering	2
1.3	Point operators- Histogram, neighbourhood operators, Thesholding	2
2	**Binary operations**	
2.1	Erosion, Dilation, Opening and Closing, Hit-or-Miss Transform, structuring element	2
2.2	Binary shape analysis, Connected components- Connected component labelling,Boundary descriptors – Chain codes.	2
2.3	Properties of Binary Regions , Geometric Features ,Statistical Shape Properties	2
3	**Feature Detection:**	
3.1	Edge detection – edges, lines, active contours, Split and merge,Mean shift and mode finding, Normalized cuts, Graph cuts, energy-based method- Canny's edge detection Algorithm	2
3.2	Corner detection, Harris corner detection algorithm,	1
3.3	Hough transform Algorithm for Line and curve detection.	2
4	**Motion Analysis**	
4.1	Shape from X - Shape from shading, Photometric stereo, Texture	2
4.2	Motion Analysis- Regularization theory, Optical Flow: brightness constancy equation, aperture problem,	3
4.3	Horn-Shunck Algorithm and Lucas-Kanade Algorithm for detection of optical flow.	3
4.4	Structure from motion	2
5.	**Applications of Computer Vision**	
5.1	Object Detection and Object classification algorithms: SVM,PCA,Linear discriminant analysis, Bayes rule, ML methods.	3
5.2	Face detection, Face Recognition, Eigen faces, 3D face models	3
5.3	Applications of computer vision: Scene Analysis and scene understanding, Examples of real time applications: In-vehicle vision system	3

Simulation Assignments

The following simulations can be done in Open CV/SciLab/ MatLab

1. Design and implementation of basic digital filters.
2. Apply thresholding operations in a digital image.
3. Apply point operators in an image –averaging/smoothing, 2D- masks(3 types),
4. Apply morphological operations in a selected image like fingerprint/ archaeological scripts.
5. Implement filters in 2D-frequency domain using Gaussian/Homomorphic filters in a particular satellite image or forensic image.
6. Write algorithms for connected component labelling in a given image pixel set.
7. Detect a coin/ball against the background using background subtraction and with appropriate edge detection algorithms.
8. Locate iris from an image of human eye, using Hough transform algorithm.
9. Locate corners of a particular image like boxes/ building/TV screen etc
10. Write a program to implement brightness constancy equation.
11. Analyse the optical flow of a given video using Horn-Schunk method or/and Lucas-Kannade method/s.
12. Use PCA for dimensionality reduction in detecting faces using Eigen values.
13. Implement SVM/LDA for any practical application.
14. Apply ML/Bayes' rule for CV applications.
15. Create an attendance system by implementing face recognition method, among a set of students.
16. With OpenCV library, implement real time scene analysis for traffic regulation. (Cases such as detecting road signs/ pedestrians/track a particular vehicle/ detect traffic lights/detect number plate of a vehicle/ detect accidents/ accident scene analysisetc., etc.).
17. Use ML/DL algorithms to implement object detection/identification/classification, with trained neural networks for applications in medical/agricultural/sports fields.
18. Write algorithms for the gait analysis of a person with walking difficulty to monitor improvements in his daily activities.
19. Identify a person from his moving mannerisms, using Gait analysis.

20. Use gait analysis to monitor a sports person in any athletic/boxing/power lifting/any sports activity.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: ECT438

Course Name: COMPUTER VISION

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each carries 3 marks.

1	Write down the Sobel, Robert and Prewitt masks	K1
2	Give a 3x3 convolution mask to shift a 256x256 image one pixel position to right.	K2
3	Name three computer vision applications where object labelling and counting is applied.	K2
4	Describe steps in identifying connected components in an 8- connectivity case.	K2
5	Write down basic Hough transform algorithm	K2
6	Compare and contrast normalised cut and graph cut methods.	K2
7	Mention the concept of identifying structure from motion.	K2
8	Define texture? What is its role in object recognition?	K2
9	Define Eigen values and Eigen vectors.	K2
10	Differentiate between SVM and LDA.	K2

PART – B

Answer one question from each module; each question carries 14 marks.

Module - I

11a	Describe point operators with illustrative diagrams.	(6) CO1 K1
11b	What is linear filtering? Describe Homomorphic filtering.	(8) CO1 K1

OR

12a What is thresholding? Briefly describe different methods of thresholding (6) CO1 K1

12b List different histogram operations and explain each one in detail. (8) CO1 K1

Module - II

13 a Describe Geometric features and Statistical properties of a binary region. (6) CO2 K1

13b A structuring element Aand an image B are given. Apply A on B, to find resultant images after the dilation and erosion process. Origin is given as ‘O’ and ‘x’ indicates 1 of the binary image, and note that ‘O’it is not part of the structuring element. (8) CO2 K3

A =

x	O	x

B =

	x	x	x		
	x		x		
	x		x	x	
				x	x
O					

OR

14a List the standard binary morphological operators, with description and give its applications. (8) CO2 K1

14 b. Using Hoshen–Kopelman algorithm, assign connected component labelling for the given image pixels marked as ‘x’in the diagram below. (6) CO2 K3

	x			x					
	x			x			x	x	
	x	x	x	x		x	x	x	x
		x	x				x		x
	x	x					x	x	x
	x								

Module III

15 a	Describe how Mean shift algorithm locate maxima of a density function in computer vision applications.	(7) CO3 K2
15 b	Interpret different steps involved in Harris corner detection algorithm and describe how it is applied to detect corners in an image	(7) CO3 K3

OR

16a	Give Canny's algorithm and describe how it can be applied to detect edges of an image.	(7) CO3 K3
16b	Write down Hough Transform algorithm and explain how it can be can be employed to locate coins in a given image.	(7) CO3 K3

Module - IV

17a	Give Lucas-Kannade algorithmic with each steps and explain how it is employed for motion detection.	(6) CO4 K3
17 b	Briefly explain the following concepts (i) Photometric stereo (ii) Shape from -X	(8) CO4 K3

OR

18 a.	Derive brightness constancy equation.	(6) CO4 K3
18 b.	Describe with algorithmic steps, the Horn-Shunk method used for the estimation of optical flow.	(8) CO4 K3

Module - V

19 a	Describe how LDA is employed for dimensionality reduction, with different mathematical steps involved.	(7) CO5 K3
19 b	Find Principal components of the following matrix	(7) CO5 K3

$$A = \begin{bmatrix} 8 & -8 & -2 \\ 4 & -3 & -2 \\ 3 & -4 & 1 \end{bmatrix}$$

OR

20 a	What is an Eigen face? Derive the equation for Eigen faces and Explain its importance in a face recognition system.	(7) CO5 K3
20b.	Illustrate the operation of an in-vehicle vision system, for locating roadways and pedestrians, as a real time practical application of computer vision.	(7) CO5 K3

<table>
<tr><td rowspan="2">ECT448</td><td rowspan="2">LOW POWER VLSI</td><td>CATEGORY</td><td>L</td><td>T</td><td>P</td><td>CREDIT</td></tr>
<tr><td>PEC</td><td>2</td><td>1</td><td>0</td><td>3</td></tr>
</table>

Preamble: This course aims to impart the basic knowledge in designing of Low power VLSI Circuits .

Prerequisite: Solid State Devices, VLSI Design, Digital Circuit Design.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify various short channel effects and various sources of power dissipation in MOSFET
CO 2	Apply various power reduction techniques to circuits.
CO 3	Apply various clocked and non clocked design styles for logic implementation.
CO 4	Apply Adiabatic and reversible logic for circuit implementation.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	2										
CO 2	3	2										
CO 3	3		3		2							
CO 4	3		3									

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Course project/Assignment	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. Mark patterns are as per the syllabus with 60% for theory and 40% for logical/numerical problems, derivation and proof.

Course Level Assessment Questions

Course Outcome 1 (CO1): Identify various short channel effects and various sources of power dissipation in MOSFET

1. Derive the expression of switching power in static CMOS circuit.
2. Explain impact ionization and Hot electron effect.
3. Explain the various factors causing leakage power in MOSET.

Course Outcome 2 (CO2): Apply various power reduction techniques to circuits**.**

1. Describe the use of transistor and Gate sizing for power deduction.
2. Describe supply voltage scaling method for power reduction.
3. Apply various power reduction schemes to memory cells..

Course Outcome 3 (CO3) : Apply various clocked and non clocked design styles for logic implementation

1. Implement XOR gate in domino logic.
2. Implement the function F= [AB+CD] in DCVS.
3. Implement basic gates in nmos and pseudo nmos logic.

Course Outcome 4 (CO4): Apply Adiabatic and reversible logic for circuit implementation.

1. Implement Y=AB using adiabatic logic
2. Explain one stage adiabatic buffer.
3. Implement logic functions using different Reversible logic structures.

Syllabus

Module 1: Physics of Power dissipation in MOSFET devices
Need for low power circuit design, MIS Structure, Short channel effects-surface scattering, punch through, velocity saturation, impact ionization Hot electron effects, Drain Induced Barrier Lowering, Deep submicron transistor design issues.

Module 2: Sources of power dissipation in CMOS-Dynamic Power Dissipation: Charging and Discharging capacitance power dissipation , Short Circuit Power: Short Circuit Current of Inverter , Short circuit current dependency with input and output load , Glitching Power, Static Power Dissipation, Leakage Power Dissipation,
Gate level power analysis : Capacitive, internal and Static power dissipation of gate level circuit.

Module 3: Power Reduction Techniques :Supply voltage Scaling Approaches**:** Multi VDD and Dynamic VDD, leakage power reduction Techniques – Transistor stacking, VTCMOS,MTCMOS, DTCMOS, Power gating, Clock gating for Dynamic power dissipation, Transistor and Gate Sizing for Dynamic and Leakage Power Reduction.

Module 4: Circuit design style- clocked design style- Basic concept, Domino logic (domino NAND gate), Differential Current Switch Logic. Non clocked circuit design style-fully complementary logic. NMOS and pseudo –NMOS logic, differential cascade voltage switch logic(DCVS)

Module 5: Adiabatic switching – Adiabatic charging, adiabatic amplification, One stage and two stage adiabatic buffer, Adiabatic logic gates, pulsed power supplies, Reversible logic basic concepts.

Text Books:

1. Gray Yeap, Practical low power digital VLSI design, Springer, 1998
2. Kaushik Roy, Sharat C Prasad, Low power CMOS VLSI circuit design, Wiley India, 2000

References:

1. Abdellatif Bellaouar, Mohamed I Elmasry, Low power digital VLSI design, Kluwer Academic, 1995
2. Anatha P Chandrakasan, Robert W Brodersen, Low power digital CMOS Design, Kluwer Academic, 1995
3. Christian Piguet, Low power CMOS circuits, Taylor & Francis, 2006
4. Kiat Seng Yeo, Kaushik Roy, Low voltage, low power VLSI sub systems, Tata McGraw Hill, 2004

Course Contents and Lecture Schedule

No	Topic	No. of Lecture
1	**Physics of Power dissipation in MOSFET devices**	
1.1	Need for low power circuit design, MIS Structure.	2
1.2	Short channel effects-surface scattering, punch through, velocity saturation, impact ionization, Hot electron effects, Drain Induced Barrier Lowering.	3
1.3	Deep submicron transistor design issues.	1
2	**Sources of power dissipation in CMOS**	
2.1	Dynamic Power Dissipation: Charging and Discharging capacitance power dissipation	1
2.2	Short Circuit Power: Short Circuit Current of Inverter , Short circuit current dependency with input and output load .	2
2.3	Glitching Power, Static Power Dissipation, Leakage Power Dissipation,	4
2.4	Gate level power analysis : Capacitive, internal and Static power dissipation of gate level circuit.	2
3	**Power Reduction Techniques**	
3.1	Supply voltage Scaling Approaches**:** Multi VDD and Dynamic VDD	1
3.2	Leakage power reduction Techniques – Transistor stacking VTCMOS,MTCMOS, DTCMOS	2
3.3	Power gating, Clock gating for Dynamic power dissipation,	2
3.4	Transistor and Gate Sizing for Dynamic and Leakage Power Reduction	2
4	**Circuit design style**	
4.1	Clocked design style- Basic concept, Domino logic	2
4.2	Differential Current Switch Logic	1
4.3	**Non clocked circuit design style**-fully complementary logic. NMOS and pseudo –NMOS logic	2
4.4	Differential Cascade Voltage Switch logic(DCVS)	1
5	**Adiabatic switching**	
5.1	Adiabatic charging, adiabatic amplification,.	3

5.2	One stage and two stage adiabatic buffer	2
5.3	Adiabatic logic gates, pulsed power supplies	1
5.4	Reversible logic basic concepts..	1

Simulation Assignments

Atleast one assignment should be simulation based using any simulation software. It can be the design of a circuit in any one of the clocked or non clocked style and perform power analysis. Samples of simulation assignments are given below.

1. Implement NAND gate in conventional CMOS and domino logic and perform power analysis in each case.
2. Implement any sample logic function in DCVS.
3. Apply threshold voltage scaling method to a logic function implemented in conventional style and perform power analysis.

Model Question Paper

Model Question Paper
A P J Abdul Kalam Technological University
EIGHTH SEMESTER B.TECH DEGREE EXAMINATION
BRANCH: ELECTRONICS AND COMMUNICATION ENGINEERING
COURSE: ECT448 LOW POWER VLSI

Time: 3 Hrs **Max. Marks: 100**

PART A

Answer All Questions

1. Define the terms (3)
    a) DIBL
    b) Velocity Saturation

2. Discuss the need for low power VLSI Design (3)
3. Explain the dependency of short circuit current with output load? (3)
4. Explain dynamic power dissipation? (3)
5 Describe leakage power reduction using MTCMOS (3)
6. Define Slack time of logic gate . (3)
7. List the advantages and Disadvantages of Clocked design. (3)
8. Explain the methods to overcome charge sharing problem. (3)
9. Draw the schematic and logic symbol of an Adiabatic amplifier.. (3)

10. List the disadvantages of Retractile cascade of Adiabatic logic Gates. (3)

PART B

Answer one question from each module. Each question carries 14 mark

Module I

11(A) Explain the energy band diagram of MIS structure. (8)

11(B) Describe various transistor leakage mechanisms in deep submicron transistors . (6)

OR

12(A) Explain various short channel effects. (8)

12(B) Explain how the power efficiency of a chip can be measured? (6)

Module II

13(A) Explain how capacitance can be estimated at gate level? (7)

13(B) Explain the formation of glitches in circuits ? Explain various methods for eliminating the glitches (7)

OR

14(A) Explain the various sources of leakage power in MOSFET (7)

14(B) A 16 bit bus operating in 5V and 66MHz clock rate is driving capacitance of 2pF/Bit. Each bit is estimated to have a toggling probability of 0.25 at each clock cycle. Calculate the power dissipated in operating the bus. (7)

Module III

15(A) Illustrate with examples how low threshold device and high threshold device can be effectively used for power reduction. (7)

15(B) Explain dynamic supply voltage scaling mechanism for power reduction. (7)

OR

16(A) Briefly explain dynamic and leakage power reduction using transistor sizing. (7)

16(B) Illustrate various mechanisms by which power consumption of 6T RAM cells can be reduced. (7)

Module IV

17(A) Implement the function $F= [(a+b)(c+d)]'$ in NMOS logic and domino logic. (7)

17(B) Implement the function F= (A+CD) in DCVS logic (7)

OR

18(A) Explain how charge sharing problem occur in logic design. How it can be eliminated? (7)

18(B) Differentiate precharge high and precharge low DCSL. (7)

Module V

19(A) Describe the working of one stage adiabatic buffer. (7)

19(B) Explain pulsed power supply? Describe its importance in adiabatic logic. (7)

OR

20(A) Describe various reversible gate structures. (7)

20(B) Implement OR and AND function using Fredkin gate. (7)

ECT458	INTERNET OF THINGS	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Preamble: This course aims to develop skills in IoT system development and to apply the same in real life applications.

Prerequisite: ECT342 Embedded systems

Course Outcomes: After the completion of the course,a student will be able to

CO 1 K1	Understand the IoT fundamentals and architecture modelling (K1)
CO 2 K2	Understand the smart things in IoT and functional blocks (K2)
CO3 K2	To understand the communication networks and protocols used in IoT. (K2)
CO 4 K3	To understand the cloud resources, data analysis and applications. (K3)
CO5 K3	To apply the IoT processes in embedded applications. (K3)

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3	2		1			2				2
CO 2	3	3	3		3			2				2
CO 3	3	3	3		3			2	3			2

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	20	10	20
Understand	K2	30	20	40
Apply	K3	0	20	40
Analyse				

Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the IoT fundamentals and architecture modelling (K1)

1. What is the definition of IoT and different characteristics of IoT

2. Define the architectural view of IoT and functional blocks

3. What are the different levels of IoT

Course Outcome 2 (CO2): Understand the smart things in IoT and functional blocks (K2)

1. What are the different smart things in IoT

2. How the communication is established among nodes and nodes and cloud.

3. What are the protocols that are used in IoT

Course Outcome 3 (CO3): To understand the communication networks and protocols used in IoT. (K2)

1. Differentiate between IEEE standard protocols

2. Explain the advantages of next generation IP based protocols used in ioT

3. Define different layers used in embedded protocols

Course Outcome 4 (CO4): To understand the cloud resources, data analysis and applications. (K3)

1. Explain how data is stored in IoT environment and processed

2. How to use cloud resources and different options available

3. How end devices can be used to control input and output devices

Course Outcome 5 (CO5): To apply the IoT processes in embedded applications. (K3)

1. What are the security and privacy concerns of IoT

2. Explain the typical applications of IoT.

3. Describe the processes involved in implementing a smart city.

SYLLABUS

Module 1 (7 Hours)

Introduction to IoT technology: Definitions and Characteristics of IoT, IoT Architectural View, Physical Design of IOT, Logical Design of IoT- IoT Functional blocks, IoT communication models, IoT Enabling Technologies, IoT Levels & Deployment Templates.

Module 2 (7 Hours)

IoT and M2M- M2M, Difference between IoT and M2M, SDN and NFV for IoT, Smart Objects: The “Things” in IoT: Sensors, Actuators, and Smart Objects, Sensor Networks- Wireless Sensor Networks (WSNs), Communication Protocols for Wireless Sensor Networks- Connecting Smart Objects- Communication Criteria.

Module 3 (7 Hours)

Unified Data Standards –Protocols –IEEE 802.15.4 -The Physical Layer, The Media-Access Control Layer, Uses of 802.15.4 ,The Future of 802.15.4: 802.15.4e and 802.15.4g–Modbus–ZigBee-Zigbee Architecture- LoRaWAN -Standardization and Alliances, Physical Layer, MAC Layer, Topology, LTE-M, NB-IoT-Network layer –The next generation: IP-based protocols - 6LoWPAN and RPL, Overview of the 6LoWPAN Adaptation Layer .

Module 4 (9 hours)

Data Collection, storage and computing Using a Cloud Platform-Introduction, Cloud Computing Paradigm for Data Collection, Storage and Computing-Cloud Computing Paradigm, Cloud Deployment Models-Everything as a Service and Cloud Service Models-SaaS, PaaS, IaaS, DaaS. Cloud based platforms-XIVELY, NIMBITS.

IoT Physical Devices & Endpoints-IoT Device-Building blocks –Raspberry-Pi -Board-Linux on Raspberry-Pi-Raspberry-Pi Interfaces (serial, SPI, I2C). Raspberry Pi interfacing and programming examples using python (LED, switch, sensor, serial, SPI, I2C devices). Controlling GPIO outputs and displaying sensor readings using web interface/cloud (Python programming is required only for assignments and projects and not for examinations. Other end nodes and platforms can also be used).

Module 5 (6 Hours)

IoT privacy, security and vulnerabilities solutions, vulnerabilities, security requirements, threat analysis, security tomography, layered attacker model, Identity management, access control, secure message communication.

Smart and Connected Cities-An IoT Strategy for Smarter Cities-Vertical IoT Needs for Smarter Cities, Global vs. Siloed Strategies-Smart City IoT Architecture-Street Layer, City Layer, Data Center Layer, Services Layer- Smart City Security Architecture - Smart City Use-Case Examples – Street lighting, smart parking, smart traffic and air pollution monitoring

Maximum 35 /36 Hours

Text Books

1. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on- Approach)”, 1^{st} Edition, VPT, 2014 (Module1,2,4)
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, ―IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017. (Module2,3,5)
3. Rajkamal, “Internet of Things : Architecture and Design Principles”, McGraw Hill (India) Private Limited.
4. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, SimonMonk, O'Reilly (SPD), 2016, ISBN.

Reference Books/Papers

1. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things –Key applications and Protocols”, Wiley, 2012 (Module 3)
2. Al-Fuqaha et al. Internet of things: A survey on enabling technologies, protocols, and applications. IEEE Communications Surveys & Tutorials (2015), pp. 2347- 2376.
3. The Internet of Things (The MIT Press Essential Knowledge series) Paperback – March 20, 2015 by SamuelGreengard
4. The Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, OviduVermesan and Peter Friess, RiverPublishers.
5. Internet of Things - From Research and Innovation to Market Deployment-RIVER PUBLISHERS, PETER FRIESS, OVIDIU VERMESAN (Editors)
6. Internet of Things Security and Data Protection, Sébastien Ziegler,Springer International Publishing 2019.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Internet of Things- 7Hrs**	
1.1	Introduction, definition and characteristics	1
1.2	IoT architectural view, functional blocks	2
1.3	IoT Communication models, enabling technologies	2
1.4	IoT deployment levels	2
2	**Essential components of IoT- 7Hrs**	
2.1	IoT and M2M	2
2.2	Smart objects	2
2.3	Wireless sensor networks	3
3	**IoT protocols- 7Hrs**	
3.1	IEEE 802.15.4 protocols	2
3.2	Zigbee	1
3.3	6LoWPAN and RPL	2
3.4	LoraWAN, LTE-M and NB-IoT	2
4	**Cloud storage and Programming the end device- 9Hrs**	
4.1	Data storage and computation	3
4.2	Physical devices and end points	2
4.3	Raspberry pi programming	4
5	**Security and Applications-6 Hrs**	
5.1	Security and Privacy	2
5.2	Smart city application	2
5.3	Use case examples	2

Simulation Assignments:

1. At least one assignment should be programming examples (python or any other language) using Raspberry pi (Other options like arduino, node mcu etc. can also be used) Include I/O interfacing, SPI, I2C, serial, sensor interfacing and web interface.
2. Another assignment shall be an IoT system implementation of mini project consisting of a sensor, processing device, communication device and cloud storage (This can be individual or group projects). Mini project is essential for understanding the concepts of IoT.
3. Mini project can be done in the following areas.
    a) Smart city (b) Weather monitoring system (c) air pollution monitoring (d) Smart parking (e) smart traffic (f) any other application/s where sensors/actuators devices are used.

4. Programming and mini project are essential for understanding the concepts of IoT.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B.TECH DEGREE EXAMINATION

(**Model Question Paper)**

Course Code: ECT458

Course Name: INTERNET OF THINGS

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer for all questions. Each Question Carries 3 marks)

1. List any five characteristics of IoT
2. What are the IoT enabling technologies?
3. What is a wireless sensor network?
4. What are the limitations of smart objects in WSNs??
5. Explain the need for IP optimization in IoTs?
6. What are the transmission modes used in modbus?
7. What are the 4 different cloud deployment models? Explain
8. What is cloud computing? Explain.
9. List the five functional units of security
10. What is message integrity? How it is checked? [10 X 3 = 30 Marks]

PART – B

(Answer one question from each module; each question carries 14 Marks)

Module – I

11. (a) Write a note on physical design of IoT. [06 Marks]
(b) Give a detailed description of the link layer, network layer, transport layer and application layer protocols. [08 Marks]

OR

12. (a) What are the functional blocks of IoT? Explain? [07 Marks]
(b) Discuss different communication models used in IoT. [07 Marks]

Module – II

13. (a) What are the differences between IoT and M2M? [07 Marks]
(b) What are the issues of conventional networking architectures? How is it solved in SDN? [07 Marks]

OR

14. (a) What are smart objects? What are their characteristics and the trends in smart objects? [07 Marks]

    (b) What are the characteristics and attributes to be considered for connecting smart objects ? [07 Marks]

Module – III

15. (a) Explain IEEE 802.15.4 physical layer, MAC layer and security implementation with the help of frame formats. [09 Marks]

    (b) What are the modifications included in IEEE 802.15.4 e and g versions as compared to IEEE 802.15.4? [05 Marks]

OR

16. (a) With the help of a diagram explain the Zigbee protocol architecture. [07 Marks]

    (b) Explain LoraWAN architecture. Give a detailed description of the physical layer and MAC layer of LoraWAN [07 Marks]

Module – IV

17. (a) Write a note on different cloud service models [06 Marks]

    (b) What is virtualization in cloud computing? Explain the features, advantages and concerns of cloud computing. [08 Marks]

OR

18. (a) With the help of a diagram explain the basic building blocks of an IoT device [07 Marks]

    (b) Explain cloud based data collection, storage and computing services provided by XIVELY cloud platform. [07 Marks]

Module – V

19. (a) What is security and Privacy? List the 10 vulnerabilities of IoT. [07 Marks]

    (b) Explain the layered attacker model. [07 Marks]

OR

20. (a) With the help of a diagram explain the 4 layer smart city architecture. [07 Marks]

    (b) Write a note on street lighting architecture with the help of a diagram [07 Marks]

ECT468	RENEWABLE ENRGY SYSTEMS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course helps the students to understand environmental issues with conventional fuels, the new methodologies/technologies for the effective utilization of renewable energy sources. They will be conversant with the characteristics of solar PV and wind power sources. Also, they will have an in-depth understanding of electronic conversion systems application to renewable energy generation systems and the synchronization with smart grid systems. The courses equip the students to pursue further specialized areas of study such as renewable energy and green consumer electronics, industrial control systems and smart grid, and renewable energy system which are essentially based on this course.

Prerequisite: Nil

Course Outcomes - After the completion of the course the student will be able to

CO1	Understand the need, importance and scope of various Non-Conventional sources of energy
CO2	Outline the concepts and technologies related to renewable energy systems using wind and Solar-PV
CO3	Understand the integration of smart grid with renewable energy systems
CO4	Explain the concept of distribution management system.
CO5	Describe the fundamentals of Smart metering

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2						2					1
CO2	2											
CO3	2		1									
CO4	2											
CO5	3											

Assessment Pattern

Bloom's taxonomy	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test II (Marks)	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation (CIE) Pattern:

Attendance	10 marks
Regular class work/tutorials/assignments	15 marks
Continuous Assessment Test (Minimum 2 numbers)	25 marks

End semester pattern:-There will be two parts; Part A and Part B. Part A contain 10questions with 2 questions from each module, having 3 marks for each question.Students should answer all questions. Part B contains 2 questions from each module ofwhich student should answer any one. Each question can have maximum 2 subdivisionsand carry 14 marks.

Course Level Assessment Questions

Course Outcome 1

1. Describe the energy scenario in India. What are the various non-conventional energy resources relevant to India?
2. Explain how current scenario of world energy consumption leads to the exploitation of renewable energy sources.

Course Outcome 2

1. Explain grid connected solar PV systems with block diagram.
2. Explain solar power extraction using PV-Cells.

Course Outcome 3

1. Describe the sources and potentialsof wind energy power system in India?
2. Give the classification of wind turbines and explainit with neat sketches?

Course Outcome 4

1. Draw and explain intelligent islanding detection techniques.
2. Explain the influence of WECS on system transient response

Course Outcome 5

1. Give the classification of SCADAsystem and what is it application in industry.
2. Draw and explain a smart meter

SYLLABUS

Module I

Introduction to Renewable Energy (RE)Sources:World energy scenario, Over view of conventional energy sources, their limitation, need of renewable energy, potential & development of renewable energy sources,Renewable energy in India, An overview of types of renewable energy systems - Wind power, Hydropower (micro and mini), Solar energy, Biomass, Bio-fuel, Geothermal Heat energy, Pros and cons; Applications.

Module II

Solar Energy: Introduction to photovoltaic (PV) systems - Principle of PV conversion; Commercial solar cell, Thin film PV device fabrication - LPCVD, APCVD, PECVD; Tandem Solar cell fabrication; Solar power extraction using PV-Cells, I-V Characteristics, PV-Inverters without D.C. to D.C. converters, stand alone and grid collected PV systems, Grid interfacing-with isolation, without isolation, Maximum power point tracking-Methods(MPPT), PV-Inverters with D.C. to D.C. converters-on low frequency side and high frequency side with isolation, without isolation.

Module III

Wind Energy: Sources and potentials, Evaluation of Wind Intensity, Topography, General Classification of Wind Turbines-Rotor Turbines, Multiple-Blade Turbines, Drag Turbines, Lifting Turbines, System Toroidal Rotor Amplifier Platform (TARP)–Wind amplified rotor platform (WARP), Generators and speed control used in wind power energy: Fixed speed with capacitor bank, Rotor resistance control, SCIG and DFIG, Synchronous Generator-external magnetized, Synchronous Generator-permanent magnets.

Module IV

Electronic conversion systems application to renewable energy generation systems: Basic schemes and functional advantages, Power control and management systems for grid integration, island detection systems, synchronizing with the grid; Issues in integration of converter based sources; Network voltage management; Power quality management and Frequency management; Influence of PV/WECS on system transient response

Module V

Introduction to grid connectivity of RE systems, smart grid and emerging technologies, operating principles and models of smart gird components, key technologies for generation, networks, loads and their control capabilities; Evolution of electricity metering, key components of smart metering, overview of the hardware used for smart meters, smart metering protocols. Structure and main components of a distribution management system, Supervisory control and data acquisition (SCADA), distribution system modelling, new trends for smart grids, topology analysis, power flow analysis.

Text books:

1. Nayak J. K. and Sukhatme S. P. (2006), Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill.
2. Muhannad H. R. (2004); Power Electronics: Circuits, Devices and Applications, Pearson Prentice Hall.
3. Nick Jenkins, JanakaEkanayake, [et al.] Smart Grid Technology and Applications, Wiley India Ltd.
4. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, Wiley-IEEE Press 2016.

Suggested Readings:

1. Non-Conventional Energy Sources /G.D. Rai
2. Renewable Energy Technologies /Ramesh & Kumar /Narosa
3. Integration of alternative sources of energy /Felix A. Farret, M. Godoy simoes
4. Wind power plants and projects developments, Joshua Earnest and T Wizelius, PHI, New Delhi, 2011.
5. Handbook of renewable energy technology, World Scientific, Singapore, 2011.
6. Garg H. P. and Prakash S. (2000); Solar Energy: Fundamental and Application, Tata McGraw Hill
7. Goswami D. Y. (2015); Principles of Solar Engineering, Taylor and Francis
8. Gellings C. W. (2009); The Smart Grid: Enabling Energy Efficiency and Demand Response, First Edition, CRC Press
9. Teodorescu R. Liserre M. Rodriguez P. (2011); Grid Converters for Photovoltaic and Wind Power Systems, First Edition, Wiley-IEEE Press
10. Ali Keyhani, Muhammad Marwali, *Smart Power Grids 2011*, Springer-Verlag Berlin Heidelberg 2012.

Course Contents And Lecture Schedule

SI No.	Topic	No. of lectures
1	**Module 1:Introduction to Renewable Energy (RE) Sources**	**7**
1.1	World energy scenario, Over view of conventional energy sources, their limitation	1
1.2	Over view of conventional energy sources, their limitation,	1
1.3	need of renewable energy, need, potential & development of renewable energy sources, Renewable Energy in India	1
1.4	An overview of types of renewable energy systems	1
1.5	Wind power, Hydropower (micro and mini)	1
1.6	Solar energy, Biomass, Bio-fuel, Geothermal Heat energy	1
1.7	Pros and cons; Applications	1

2	**Module 2:Solar Energy**	**8**
2.1	Introduction to photovoltaic (PV) systems and Principle of PV conversion	1
2.2	Commercial solar cell, Tandem Solar cell fabrication	1
2.3	Solar power extraction using PV-Cells	1
2.4	PV-Inverters without D.C. to D.C. converters	1
2.5	Stand alone and grid collected PV systems	1
2.6	Grid interfacing-with isolation, without isolation	1
2.7	Maximum power point tracking-Methods	1
2.8	PV-Inverters with D.C. to D.C. converters-on low frequency side and high frequency side with isolation, without isolation.	1
3	**Module 3: Wind energy**	**6**
3.1	Wind energy: Sources and potentials, Evaluation of Wind Intensity, Topography	1
3.2	General Classification of Wind Turbines-Rotor Turbines, Multiple-Blade Turbines, Drag Turbines, Lifting Turbines	1
3.3	Toroidal Rotor Amplifier Platform (TARP)– Wind amplified rotor platform (WARP)	1
3.4	Introduction: Generators used in wind power energy	1
3.5	SCIG, DFIG, Synchronous Generator-external magnetized, Synchronous Generator-permanent magnets	1
3.6	Speed control used in wind power energy, Fixed speed with capacitor bank, Rotor resistance control,	1
4	**Module 4:Electronic conversion systems**	**6**
4.1	Electronic conversion systems application to renewable energy generation systems, Basic schemes and functional advantages	1
4.2	Power control and management systems for grid integration, island detection systems, synchronizing with the grid	1
4.3	Issues in integration of converter based sources	1
4.4	Network voltage management	1
4.5	Power quality management and Frequency management	1
4.6	Influence of PV/WECS on system transient response	1
5	**Module 5:G**rid connectivity of RE systems	**8**
5.1	Introduction to grid connectivity of RE systems, Emerging technologies, operating principles and models of smart gird	1

5.2	Key technologies for generation, networks, loads and their control capabilities	1
5.3	Evolution of electricity metering, key components of smart metering,	1
5.4	An overview of the hardware used for smart meters, smart metering protocols.	1
5.5	Structure and main components of a distribution management system	1
5.6	Supervisory control and data acquisition (SCADA)	1
5.7	Distribution system modelling	1
5.8	New trends for smart grids, topology analysis, power flow analysis.	1

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTERB.TECH DEGREE EXAMINATION

Course Code: ECT468

Course Name: Renewable Energy Systems

Max. Marks:100 Duration: 3 Hours

PART – A

(*ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 3 MARKS*)

1. Explain the present status of various modes of renewable power generations in India?
2. List the merits and de-merits of non-conventional energy resources
3. Explain the principle and working of photo voltaic system.
4. Explain any one method for maximum power point tracking for solar energy system.
5. Draw the basic block diagram of a wind energy conversion system.
6. Explain the principle of DFIG?
7. Discuss the main issues involved with power qualities?
8. Discuss the issues in connecting renewable energy systems to the grid?
9. Describe the future of smart grid.
10. Discuss the distribution management system in power system.

PART – B

(*ANSWER ONE FULL QUESTION FROM EACH MODULE*)

MODULE – 1

11. a) Explain with a neat sketch, the working of hydropower plant system.

(7 marks)

b) List out various types of Biomass resources and the applications of biofuels?

(7 marks)

OR

12. a) Briefly explain the energy resources in India

(7 marks)

b) Explain how current scenario of world energy consumption leads to the exploitation of renewable energy sources?

(7 marks)

MODULE – 2

13. a) Draw and explain the VI characteristics of a solar cell. How does temperature affect the performance of solar cell?

(7 marks)

b) Explain stand-alone and grid connectedsolar PV systems? Explain each type with the help of block diagram and bring out their relative merits.

(7 marks)

OR

14. a) Explain single crystal silicon and tandem solar cell with neat sketches.

(7 marks)

b) Explain the PV invertors with DC – DC converters on high frequency side with isolation.

(7 marks)

MODULE – 3

15. a) Explain the stand alone operation of a fixed speed wind energy conversion system with a neat diagram.

(7 marks)

b) Classify the WECS based on the rotational speed of turbines

(7 marks)

OR

16. a) Differentiate between TARP –WARP systems.

(7 marks)

b) Give the classification of wind turbines. Explain with neat sketches.

(7 marks)

MODULE – 4

17. a) Explain the key issue in generation, integration and control of off shore wind energy conversion systems.

(7 marks)

b) What are the problems that occur whileintegrating renewable energy source in DC – DC converter?

(7 marks)

OR

18. a) Give the classification of island detection systems. With a neat diagram explain intelligent islanding detection techniques.

(7 marks)

b) Explain the transient stability analysis of PV system with shading effects.

(7 marks)

MODULE – 5

19. a)With a neat block diagram explain a smart meter

(7 marks)

b)Explain the power flow analysis in power system.

(7 marks)

OR

20. a) Describe the open control SCADA network architecture.

(7 marks)

b) List the challenges and emerging technologies of smart grid

(7 marks)

ECT478	ORGANIC ELECTRONICS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to impart the basic knowledge in organic electronics.

Prerequisite: Solid State Devices

Course Outcomes: After the completion of the course the student will be able to

CO 1	Describe the principle of charge transport in organic semiconductors.
CO 2	Explain the structure and working of multilayer OLEDs, OFETs and OPVs
CO 3	Distinguish the action of different layers used in organic devices with reference to the materials used.
CO 4	Explain different techniques employed in making organic electronic devices like OLEDs, OPVs and OFETs

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										
CO 2	3	3										
CO 3	3	3										
CO 4	3	3										

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test(2numbers: 25 marks
Course project/Assignment : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. Mark patterns are as per the syllabus with 50% for theory and 50% for logical/numerical problems, derivation and proof.

Course Level Assessment Questions

CO-1

1.Explain the HOMO and LUMO and correlate with similar terms in inorganic semiconductors.
2.Discuss how soliton causes transport of charges in conjugated polymers

CO-2

1.Explain the construction and working of bilayer OLEDs.
2.With the help of energy band diagram, explain why work function matching is required between hole transport layer and emissive layer in PLEDs.
3.Describe the working mechanism of organic FET with relevant diagrams.

CO-3

1.Explain the importance of buffer layers in organic electronic devices.
2.Discuss the features of ITO and also its effect on the performance of organic electronic devices.
3.Explain the different methods by which the efficiency of the organic electronics devices can be improved.

CO-4

1.Compare the vapor deposition and spin coating methods.
2.Explain the screen printing technique.
3.Describe the RF and microwave plasma assisted coating method.
4.Distinguish between doctor blading and ink jet printing methods.

Syllabus

Module 1

Conducting polymer, Organic semiconductor, conduction mechanism, Pi and Sigma electron bandtheory. Polymers fundamentals-conducting polymers. Organic semiconductors, charge transport in conjugated polymers. Conduction mechanism in doped polymeric semiconductors. Physics of organic semiconductors (Luminescence, injection and transports properties)Methods of developing organic semiconductors.

Module 2

Basic device architecture in organic devices. Historical review. Organic light emitting diodes(OLED) and Polymer light emitting diodes (PLED). Multilayer architecture. Single layer architecture. Bulk hetero-junctions. Operating characteristics and electrical characterization. Flexible electronics : new display media. Flexible displays device architecture. Fabrication and characterization. Organic transistors. FETs: Principle and device architecture.

Module 3

Plastic solar cells. Basic principles. Multilayer and heterojunction structures, cell architecture. Charge transport and exciton formation–effects of exciton diffusion, dissociation and luminescence. Photogeneration process in organic heterojunction photovoltaic cells. Processing of organic solar cells. Dyesensitization– dyesensitized solar cell.

Module 4

Essential characteristics of electrode materials for organic electronic devices – work function. Conductivity and transparency factors. Indium Tin Oxide (ITO) as anode material. Effect of ITO oxidative properties on efficiency and shelf life of organic electronic devices, novelinorganic anode materials and their limitations. Buffer organic layer protection to the active layer. Doping the device and annealing the device for increased efficiency and shelf life– architecture.

Module 5

Techniques in Organic electronic Device materials. Thin film coating techniques for devices fabrication. Spin coating, dip coating, doctor blading screen printing, inkjet printing, vapor deposition. R.F and microwave plasma assisted film coating.

Text Books

1. Bernier. Advancn syntheticcmetals.Elsevier(1999)
2. R.Farchioni(Editor)G.Grosso(Editor) Organic Electronic Materials. Conjugated polymers and low molecular weight organic solids. Springer series in materials science (2007)
3. Gregory Crawford. Flexible flat panel display, Wiley series indisplay technology(2005)
4. Klauk Hagen(ED).Wiley VCH. Organic electronics(2006

References:

1. Gil. Semi conductors and Organic Materials for Opto electronic Application. Elsevier (1997)
2. Nalwa. Supra molecular photo sensitive and electro–active materials Elsevier(2001)
3. Equer. Thin film materials for large area electronics. Elsevier(1999)

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Conducting Polymers**	
1.1	Conducting polymer, Organic semiconductor, conduction mechanism, Pi and Sigma electron bandtheory. Conduction mechanism indoped polymeric semiconductors.	3
1.2	Polymers fundamentals-conducting polymers. Organic semiconductors, charge transport in conjugated polymers.	3
1.3	Physics of organic semiconductors (Luminescence, injection and transports properties) Methods of developing organic semiconductors.	2
2	**Organic Electronic Devices**	
2.1	Basic device architecture inorganic devices. Historical review. Organic light emitting diodes(OLED) and Polymer light emitting diodes (PLED).	3
2.2	Multilayer architecture. Single layer architecture. Bulk hetero-junctions. Operating characteristics and electrical characterization. Flexible electronics : new display media. Flexible displays device architecture.	3
2.3	Fabrication and characterization. Organic transistors. FETs: Principle and device architecture.	2
3	**Organic Solar Cells**	
3.1	Plastic solar cells. Basic principles. Multilayer and heterojunction structures, cell architecture.	2
3.2	Charge transport and exciton formation–effects of exciton diffusion, dissociation and luminescence. Photogeneration process in organic heterojunction photovoltaic cells.	3
3.3	Processing of organic solar cells. Dyesensitization– dyesensitized solar cell.	2
4	**Organic Electronics-Materials**	
4.1	Essential characteristics of electrode materials for organic electronic devices – work function. Conductivity and transparency factors.	2
4.2	Indium Tin Oxide (ITO) as anode material. Effect of ITO oxidative properties on efficiency and shelf life of organic electronic devices, novel inorganic anode materials and their limitations	2
4.3	Buffer organic layer protection to the active layer. Doping the device and annealing the device for increased efficiency and shelf life– architecture.	3
5	**Techniques in Device making**	
5.1	Techniques in Organic electronic Device materials. Thin film coating techniques for devices fabrication. Spin coating, dipcoating, doctor blading screen printing, inkjet printing,	3
5.2	Vapor deposition. R.F and microwave plasma assisted film coating. Vacuum Deposition Techniques	2

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B. TECH DEGREE EXAMINATION
COURSE: ECT478 ORGANIC ELECTRONICS
TIME:3HRS. MAX. MARKS: 100

PART A

Answer All Questions

1. Explain the concept of pi and sigma bond formation. (3)
2. Define the terms a) conjugated polymers (3)
   b) luminescence
3. Explain the working principle of OLEDs. (3)
4. Obtain the electrical characterization of OLEDs. (3)
5. Give the significance of hetrojunctions in plastic solar cell. (3)
6. Briefly explain the theoretical concept of the working of dye sensitized solar cell (3)
7. Distinguish between electron affinity and ionization potential with reference to energy bands. (3)
8. Mention the basic properties needed for an anode material. (3)
9. Write down the advantages of vapor deposition method? (3)
10. What is spin coating? Where is it applicable? (3)

PART B

Answer one question from each module. Each question carries 14 mark

Module I

11(A) Explain the HOMO and LUMO and correlate with similar terms in inorganic semiconductors. (7)

11(B)Discuss how soliton causes transport of charges in conjugated polymers. (7)

OR

12(A)Describe the methods for developing organic semiconductors. (7)

12(B)Explain the conduction mechanisms in organic semiconductors. (7)

Module II

13(A) Explain the construction and working of bilayer OLEDs. (7)

13(B) With the help of energy band diagram, explain why work function matching is required between hole transport layer and emissive layer in PLEDs. (7)

OR

14(A) Describe the working mechanism of organic FET with relevant diagrams. (7)

14(B) Discuss the construction and features of flexible displays. (7)

Module III

15(A) What are the photovoltaic process in plastic solar cells? Discuss each. (7)

15(B) What are the different types of plastic solar cells? Explain each with its structure.(7)

OR

16(A)Explain the fabrication steps involved in the construction of plastic solar cells. (7)

16(B) Describe the electrical characterization of plastic solar cells. (7)

Module IV

17(A) What are the essential characteristics needed for materials to act as electrodes? (7)

17(B)Explain the importance of buffer layers in organic electronic devices. (7)

OR

18(A) Discuss the features of ITO and also its effect on the performance of organic electronic devices. (7)

18(B)Explain the different methods by which the efficiency of the organic electronics devices can be improved. (7)

Module V

19(A) Compare the vapor deposition and spin coating methods. (7)

19(B)Explain the screen printing technique. (7)

OR

20(A) Describe the RF and microwave plasma assisted coating method. (7)

20(B) Distinguish between doctor blading and ink jet printing methods. (7)

SEMESTER VIII

MINOR

<table>
<tr><td rowspan="2">ECD482</td><td rowspan="2">MINIPROJECT</td><td>CATEGORY</td><td>L</td><td>T</td><td>P</td><td>CREDIT</td></tr>
<tr><td>PWS</td><td>0</td><td>0</td><td>3</td><td>2</td></tr>
</table>

Preamble: The course aims

- To estimate the ability of the students in transforming the theoretical knowledge studied in to a working model of an electronic system
- For enabling the students to gain experience in organisation and implementation of small projects.
- Design and development of Small electronic project based on hardware or a combination of hardware and software for electronics systems.

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex electronic system with practical applications, this should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews.

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

Course Outcomes

CO1	Be able to practice acquired knowledge within the selected area of technology for project development.
CO2	Identify, discuss and justify the technical aspects and design aspects of the project with a systematic approach.
CO3	Reproduce, improve and refine technical aspects for engineering projects.
CO4	Work as a team in development of technical projects.
CO5	Communicate and report effectively project related activities and findings.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	2		3						2
CO 2	3	3	3	2		3					3	2
CO 3	3	3	3	2		3					3	2
CO 4								3		3	3	2
CO 5								3	3	3		2

Evaluation

The internal evaluation will be made based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, Academic coordinator for that program, project guide/coordinator.

The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	1 hour

Split-up of CIE

Component	Marks
Attendance	10
Marks awarded based on guide's evaluation	15
Project Report	10
Evaluation by Committee	40

Split-up of ESE

Component	Marks
Level of completion	10
Demonstration of functionality	25
Project Report	10
Viva-voce	20
Presentation	10

SEMESTER VIII

HONOURS

ECD496	MINIPROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble: The course aims

- To estimate the ability of the students in transforming the theoretical knowledge studied in to a working model of an electronic system
- For enabling the students to gain experience in organisation and implementation of small projects.
- Design and development of Small electronic project based on hardware or a combination of hardware and software for electronics systems.

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In this course, each group consisting of three/four members is expected to design and develop a moderately complex electronic system with practical applications, this should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews.

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Course Outcomes

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CO3	Reproduce, improve and refine technical aspects for engineering projects.
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CO5	Communicate and report effectively project related activities and findings.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	2		3						2
CO 2	3	3	3	2		3					3	2
CO 3	3	3	3	2		3					3	2
CO 4								3		3	3	2
CO 5								3	3	3		2

Evaluation

The internal evaluation will be made based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, Academic coordinator for that program, project guide/coordinator.

The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	1 hour

Split-up of CIE

Component	Marks
Attendance	10
Marks awarded based on guide’s evaluation	15
Project Report	10
Evaluation by Committee	40

Split-up of ESE

Component	Marks
Level of completion	10
Demonstration of functionality	25
Project Report	10
Viva-voce	20
Presentation	10