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 ABCD+AB$\overline{C}$+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

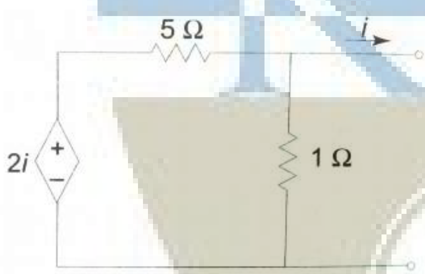
Course Name: NETWORK THEORY

Max. Marks: 100 Duration: 3 Hours

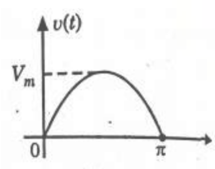
PART A

Answer ALL Questions. Each Carries 3 mark.

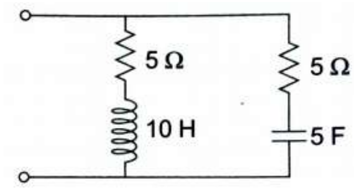
1	Illustrate the source-transformation techniques.	K2
2	Explain the concept of supernode.	K2
3	State and prove Maximum Power Transfer theorem	K1
4	Evaluate the Norton's equivalent current in the following circuit.	K3



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

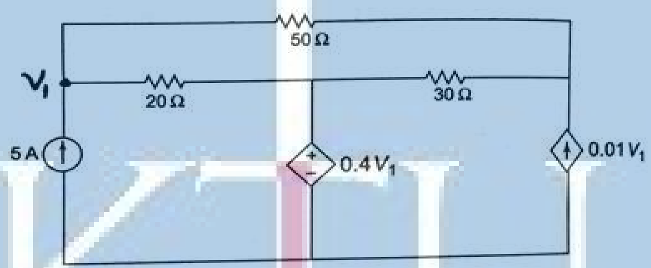
Answer one question from each module; each question carries 14 marks.

Module - I

11 a. Find the voltage V_1 using nodal analysis. 7

CO1

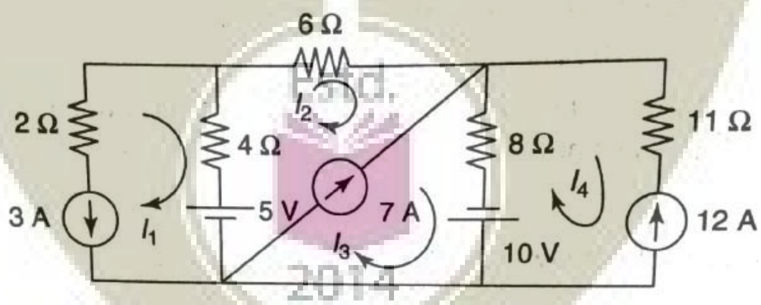
K3



b. Find the current through 8 ohms resistor in the following circuit using mesh analysis. 7

CO1

K3

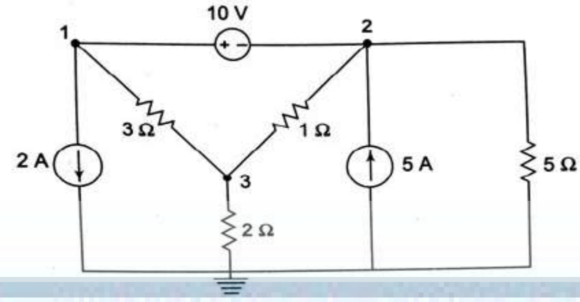


OR

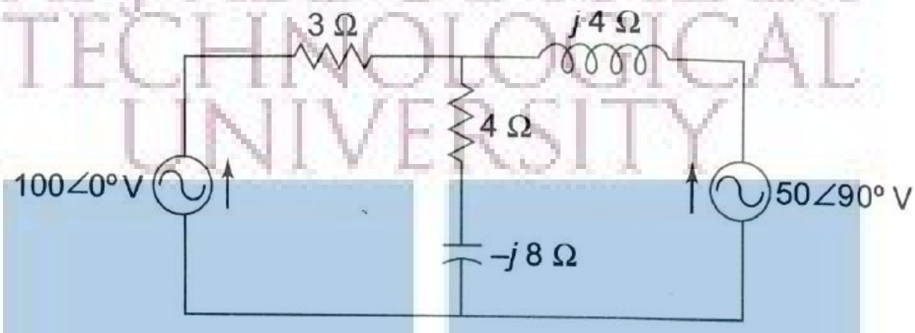
12 Find the power delivered by the 5A current source using nodal analysis method. 7

CO1

K3



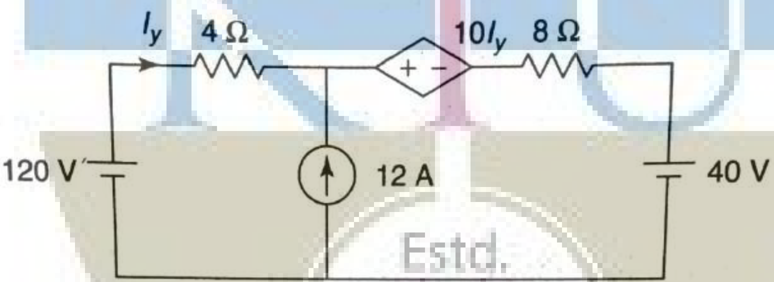
b. Determine the values of source currents using Mesh analysis — 7



CO1 K3

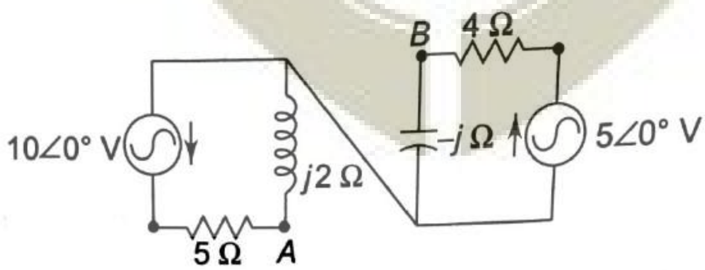
Module - II

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

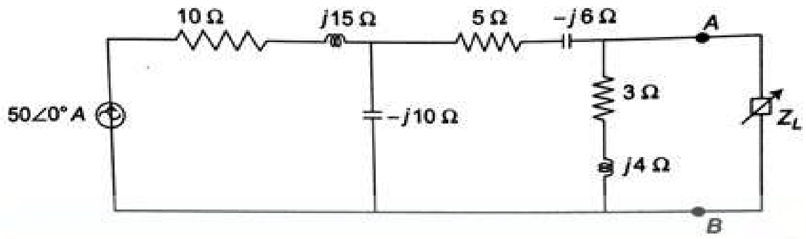


CO1

K3

OR

14 Determine the maximum power delivered to the load in the circuit. — 14

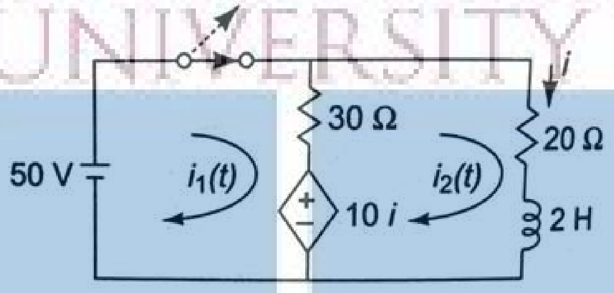


CO1 K3

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



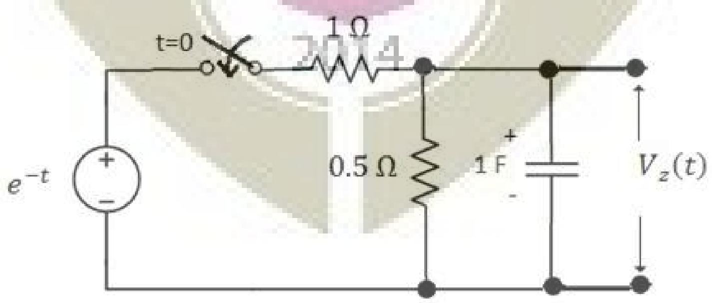
b. A voltage pulse of unit height and width **‘ *T* ’** is applied to a low pass RC circuit at time t=0. Determine the expression for the voltage across the capacitor C as a function of time. 6

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

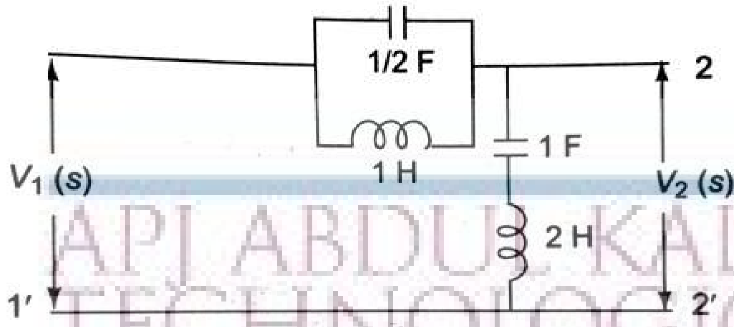
CO2 K3



Module - IV

17 For the network, determine Driving point impedance ***Z_{11} (s)***, Voltage gain Transfer 14

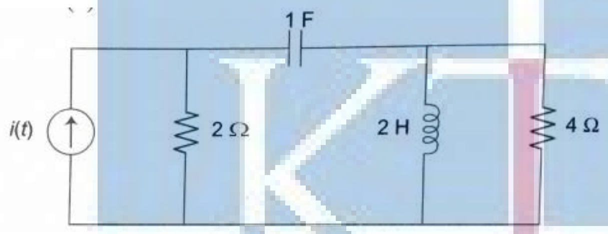
function $G_{21}(s)$ and Current gain Transfer function $\alpha_{21}(s)$. CO3 K3



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

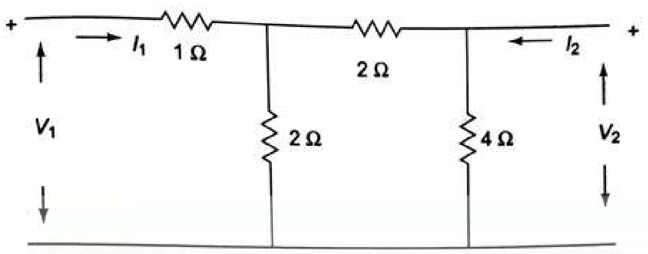
(i) Z-parameters, (ii) Y-parameters and (iii) Hybrid parameters. CO4 K2

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


I1
1 Ω
2 Ω
I2
V1
2 Ω
4 Ω
V2

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)=∑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

AET281	INTRODUCTION TO SIGNALS AND SYSTEMS	CATEGORY	L	T	P	CREDIT
		VAC	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 : 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): 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 output of a continuous time LTI system
3. Give the meaning of impulse response of LTI systems

Course Outcome 3(CO3): Spectra of Signals
1. State and prove Parsevals theorem
2. State and prove the modulation property of Fourier transform
3. Find the continuous time Fourier transform a pulse of width w and amplitude unity and centered 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, JohnWiley
2. Hwei P.Hsu, Theory and problems of signals and systems, Schaum Outline Series,MGH.
3. A Anand Kumar, Signals and systems, PHIlearning

Reference Books

1.Anders Brandt, Noise and Vibration Analysis,Wileypublication.
2.Sanjay Sharma, Signals andsystems

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	2
1.3	Basic operation on signals	1
1.4	Classification of continous-time signals	2
1.5	Noise and Vibration signals	1

2	**Discrete Time Signals**	
2.1	Basic discrete-time signals and its frequency	4
2.2	Classification of discrete-time signals	5
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	3
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	1
5.3	DTFT and spectra	2
5.4	DFT	1
5.5	Parsevals theorem	1
5.6	Case study of a vibration signal	1
5.7	The sampling theorem	2

Simulation Assignments (AET281)

The following simulation assignments can be done with Python/MATLAB/ SCILAB/OCTAVE

1. Generate the following discretesignals
   - Impulsesignal
   - Pulse signaland
   - Triangularsignal
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. Computethelinearconvolutionbetweenthesequences x=[1,3,5,3]with h=[2,3,5,6]. Observe the stem plot of both signals and the convolution.
   - Nowlet h=[1,2,1]and x=[2,3,5,6,7].Computetheconvolutionbetween 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 afunctiontogenerateaunitpulsesignalasasummationofshiftedunitimpulse 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 DegreeExamination

Course: AET 281 Introduction to Signals and Systems

1	Differentiate between energy and power signal with example.	3	K2
2	Find the even and odd components of x(t) = ejt.	3	K2
3	Define discrete time signal and comment about its frequency range.	3	K2
4	Sketch the sequence x(n) = 2δ(n-3) – δ(n-1) + δ(n) + δ(n+2).	3	K2
5	State and explain BIBO condition for system.	3	K1
6	Distinguish between continuous time and discrete time systems.	3	K2
7	Derive a relationship between input and output for a discrete LTI system	3	K2
8	Compute the energy of the signal x(n) = 0.8n u(n)	3	K2
9	State and explain sampling theorem.	3	K2
10	Comment about the input output characteristics of continuous time Fourier transform.	3	K2

PART B

Answer one question from each module. Each question carries 14 mark.

Module I

11 a)	Determine whether or not the signal x(t) = cos t + sin (√2t) is periodic. If periodic determine its fundemental period.	7	K2
11 b)	Define, sketch and list the properties of continuous time impulse function	7	K2
	OR		
12 a)	Determine whether the signal $x(t) = e^{-2t} u(t)$ is energy signal, power signal or neither.	7	K2
12 b)	Define unit step function and plot u(t + 2) − u(t − 2).	7	K2

Module II

13 a)	Given the sequence x(n) = {1, 2, 1, 1, 3 }, -1 ≤ n ≤ 3. Sketch • x(−n + 2) • x(n/2)	8	K3
13 b)	Show that any signal x(n) can be represented as the summation of an even and odd signal.	6	K2
	OR		
14	Discuss briefly the basic discrete time signals.	14	K2

Module III

15 a)	Explain linear and nonlinear systems.	6	K2
15 b)	Apply the properties of system to check whether the following systems are linear or nonlinear • $y(t) = tx(t)$ • $y(n) = x^2(n)$	8	K3
OR			
16	A sytem has an input-output relation given by $y(n) = T\{x(n)\} = nx(n)$. Determine whether the system is a) Memoryless b) Causal c) Linear d) Time invariant e) Stable	14	K3

Module IV

17	The impulse response of a linear time invariant system is $h(n) = \{1, 2, 1, -1\}$, $-1 \le n \le 2$. Determine the response of the system for the input signal $x(n) = \{1, 2, 3, 1\}$	14	K3
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	K3

Module V

19 a)	Find the Nyquist rate of $x(t) = \sin 400\pi t + \cos 500\pi t$.	7	K2
19 b)	State and prove modulation property of Fourier Transform	7	K2
OR			
20 a)	Find the CTFT of the signal $x(t) = te^{-at}u(t)$	7	K2
20 b)	State and prove Parsevals theorem.	7	K2

AET283	DIGITAL CIRCUIT DESIGN	CATEGORY	L	T	P	CREDIT
		VAC	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	Implement a combinational logic function described by a truth table using and/or/inv gates/ multiplexers.
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.

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	2									
CO 3	3	2										
CO 4	3	2	2									1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	50
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(2numbers) : 25 marks
Course project : 15marks

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. BCD Subtractor

- Make 4 -bit parallel adder circuit inverilog.
- Make a one digit BCD subtracter in Verilog, synthesize and write into a tiny FPGA.
- Test the circuit with BCD inputs.

2. Digital Thermometer

- Develop a circuit with a temperature sensor and discrete components to measure and dispaly temperature.
- Solder the circuit on PCB and testit.

3. Electronic Display

- This display should receive the input from an alphanumeric keyboard and display it on an LCD display.
- The decoder and digital circuitry is to developed in Verilog and programmed into a tiny FPGA.

4. 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 init.
- 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.

5. Three Bit Carry Look Ahead Adder

- Design the circuit of a three bit carry look aheadadder.
- Develop the verilog code for it and implement and test it on a tiny FPGA. item Compare the performance with a paralleladder.

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 isto 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 $F(a,b,c,d) = \Sigma m(4,5,7,8,9,11,12,13,15)$
3. Explain the operation of a 8x1 multiplexer and implement the following using an 8x1 multiplexer $F(A, B, C, D) = \Sigma m(0, 1, 3, 5, 6, 7, 8, 9, 11, 13, 14)$

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 mentionedterms.
2. Draw the circuit and explain the operation of a TTL NANDgate
3. Compare TTL, CMOS logic families in terms of fan-in, fan-out and supplyvoltage

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 characteristicequation
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 itsworking

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.

Module 2: Boolean Postulates and Fundamental Gates

Boolean postulates and laws – Logic Functions and Gates De-Morgan's Theorems, Principle of Duality, Minimization of simple Boolean expressions, Sum of Products (SOP), Product of Sums (POS), Karnaugh map Minimization.

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.

Module 4: Sequential Logic Circuits:

Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Excitation table and characteristic equation. Implementation with verilog codes. Ripple and Synchronous counters, Shift registers - SIPO, SISO, PISO, PIPO. Ring counter and Johnsons counter. Asynchronous and Synchronous counter, Mod N counter.

Module 5: Logic families and its characteristics:

Comparison of logic families - TTL, ECL, CMOS, concepts of logic levels, 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.

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", McGrawHill

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, 4th2008
.
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;	3
1.2	Binary, octal and hexadecimal arithmetic;	3
1.3	Representation of signed numbers; Fixed and floating point numbers;	3
1.4	Binary coded decimal codes; Gray codes; Excess 3 code :	3
2	**Boolean Postulates and Fundamental Gates:**	
2.1	Boolean postulates and laws – Logic Functions and Gates, De-Morgan's Theorems, Principle of Duality	3
2.2	Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS)	2
2.3	Karnaugh map Minimization	2
3	**Combinatorial and Arithmetic Circuits**	
3.1	Combinatorial Logic Systems - Comparators, Multiplexers, Demultiplexers	4
3.2	Encoder, Decoder, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder	4
4	**Sequential Logic Circuits:**	
4.1	Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF	3
4.2	Conversion of Flipflops, Excitation table and characteristic equation.	3
4.3	Ripple and Synchronous counters, Shift registers-SIPO.SISO,PISO,PIPO	2
4.4	Ring counter and Johnsons counter	1
4.5	Asynchronous and Synchronous counter , Mod N counter	2
	.	
5	**Logic families and its characteristics**:	

5.1	Comparison of logic families - TTL, ECL, CMOS, concepts of logic levels, noise margins, fan-out, propagation delay, transition time, power consumption and power-delay product.	3
5.2	TTL inverter - circuit description and operation	2
5.3	CMOS inverter - circuit description and operation	2

Simulation Assignments (AET283)

The following simulations can be done in QUCS, KiCad or PSPICE.

BCD Adder

- Realizeaonebitparalleradder,simulateandtestit.
- Cascadefoursuchadderstoformafourbitparalleladder.
- Simulate it and make it into asubcircuit.
- Develop a one digit BCD adder, based on the subcircuit, simulate and testit

BCD Subtractor

- Use the above 4 -bit adder subcircuit, implement and simulate a one digit BCDsubtractor.
- Test it with two BCDinputs

Logic Implementation withMultiplexer

- Developan8:1multiplexerusinggates,simulate,testandmakeitintoasubcircuit.
- Use thissubcircuittoimplementthelogicfunction $f(A,B,C) = \sum m(1,3,7)$
- Modifythetruthtableproperlyandimplementthelogicfunction $f(A,B,C,D) = \sum m(1,4,12,14)$ using one 8 : 1 multiplexer.

BCD to Seven Segment Decoder

- Develop a BCD to seven segment decoder using gates and make it into asubcircuit.

- simulate this and testit

Ripple Counters

- Understand the internal circuit of 7490 IC and develop it in thesimulator.
- Make it into a subcircuit and simulate it. Observe the truth table and timing diagrams for mod-5, mod-2 and mod-10 operation.

Synchronous Counters

- Design and develop a 4-bit synchronous counter using J-Kflip-flops.
- Performdigitalsimulationandobservethetimingdiagramandtruthtable.

Model Question Paper

A P J Abdul Kalam Technological University
Third Semester B Tech Degree
Examination Branch: Electronics and Communication

Course: AET283 Digital Circuit Design

Time:3Hrs **Max. Marks:100**

PART A
Answer All Questions

1	Convert 203.52_{10} to binary andhexadecimal.	(3)	K_2
2	Compare bitwise and logical verilogoperators	(3)	K_2
3	ProvethatNANDandNORarenotassociative.	(3)	K_2
4	Convert the expression ABCD+AB*C*+ACD tominterms.	(3)	K_2
5	Interpret the perm Principle of Duality.	(3)	K_2
6	Explain the working of adecoder.	(3)	K_2
7	What is race aroundcondition?	(3)	K_2
8	Convert a T flip-flop to Dflip-flop.	(3)	K_2
9	Define fan-in and fan-out of logiccircuits.	(3)	K_2
10	Define noise margin and how can you calculateit?	(3)	K_2

PART B
Answer one question from each module. Each question carries 14 mark.

Module I

11(A)	Subtract 4610 from 10010 using 2's complement arithmetic.	(7)	K_2
11(B)		(7)	K_2
	OR		
12(A)	Explain the floating and fixed point representation of num-bers	(7)	K_2
12(B)	Illustrate the method for conversion of Gray to Binary code and Binary to Gray code with examples.	(7)	K_2

Module II

13(A)	Simplify using K-Maps $f(A,B,C,D) = \sum m\,(4,5,7,8,9,11,12,13,15)$	(8)	K3
13(B)	Develop a circuit to implement the above function.	(6)	K2
	OR		
14(A)	Implement the universal gates using basic gates.	(6)	K2
14(B)	Reduce the following Boolean function using K-Map and implement the simplified function using the logic gates $$f(A,B,C,D) = \sum m\,(0,1,4,5,6,8,9,10,12,13,14)$$	(8)	K3

Module III

15(A)	Design a 3-bit magnitude comparator circuit.	(8)	K3
15(B)	Develop a full adder circuit and explain.	(6)	K2
	OR		
16(A)	Explain the operation of a 4:1 multiplexer using necessary diagrams.	(6)	K2
16(B)	Implement the logic function $f(A,B,C,D) = \sum m\,(0,1,4,7)$using 8 : 1 and 4 : 1 multiplexers.	(8)	K3

Module IV

17	Design MOD 12 asynchronous counter using T flip-flop.	(14)	K3
	OR		
18(A)	Explain the operation of Master Slave JK flipflop.	(7)	K2
18(B)	Derive the ouput Q_{n+1} in Terms of J_n, K_n and Q_n	(7)	K3

Module V

19(A)	Explain in detail about TTL with open collector output con- figuration.	(7)	K2
19(B)	Draw an ECL basic gate and explain.	(7)	K2
	OR		
20A)	Demonstrate the CMOS logic circuit configuration and char- acteristics in detail.	(8)	K2
20(B)	Compare the characteristics features of TTL and ECL dig- ital logic families	(6)	K2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
AET285	INTRODUCTION TO MEASUREMENTS AND INSTRUMENTATION	VAC	3	1	0	4

Preamble: The syllabus is prepared with a view of giving the student a broad overview of the basic elements of an electronic measurement and instrumentation system. Due to the vastness of the field, only representative instruments are discussed in the syllabus.

Prerequisite: NIL

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

CO	Description	Knowledge Level
CO1	**Illustrate the working principles of electronic measuring instruments.**	**K2**
CO2	**Identify various types of errors in measuring systems and choose methods for minimization of the errors.**	**K3**
CO3	**Summarize the concepts of DC and AC bridges used in measurement systems.**	**K2**
CO4	**Apply the principles and functions of various types of Transducers in measuring systems.**	K3
CO5	**Explain the concepts of CRO, DSO, various recording devices .**	K2

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											1
CO2	3	2										1
CO3	3				1							1
CO4	3				1							1
CO5	2											1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20

Understand	30	30	70
Apply	10	10	10
Analyse			
Evaluate			
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 14marks.

Course Level Assessment Questions

Course Level Assessment Questions

Course Outcome 1 (CO1): With detailed diagrams explain the principles working and limitations of CRO s?

Course Outcome 2 (CO2) :What are the design steps which can be used to improve the accuracy and resolution of deflection type voltmeters and ammeters?

Course Outcome 3(CO3):List and explain various applications of AC and DC bridges.

Course Outcome 4 (CO4): Design a remote temperature measuring system for furnace operating in 1000K- 1500K temperature range

Course Outcome 5 (CO5): What are the functions of various recording devices . What are their design limitations .

Syllabus

Module 1

Principles of measurements, Standards-calibration of meters - qualities of measurements- accuracy, precision sensitivity, resolution, Loading effect- characteristics, safety measures, Errors in measurements .

Module 2

Indicating instruments, deflection type meters – principles and operation - moving coil, moving iron, dynamo meter, induction, thermal, electrostatic and rectifier type meters.

Module 3

Transducers, principles and applications of basic transducers: LVDT, temperature sensors, thermocouples, RTD, LDR, displacement transducers, strain gauges, accelerometers, piezo electric transducers, Hall Effect transducers.

Module 4

DC bridges: introduction, sources and detectors for DC bridges. General equation for bridge at balance .Types of bridges –Wheatstone, Kelvin, Carry Foster slide wire bridge .

AC bridges: introduction, sources and detectors for AC bridges. General equation for bridge at balance. Maxwell's inductance and Maxwell's inductance -capacitance bridge.

Module 5

Cathode ray oscilloscopes, principles, construction and limitations –Delayed time base, Analog storage and Sampling oscilloscopes.

Digital storage oscilloscopes – principles. Measurements using CRO s and DSO s. Recording instruments: Strip chart recorder, X-Y Plotter, LCD displays.

Text Books

1. David A Bell , Electronic Iinstrumentation and Measurements , 3 nd Edition Oxford 2017
2. D .Patranabis , Sensors and Transducers, PHI 2nd edition 2003
3. Golding E W and Widdis F C Electrical Measurements and Measuring systems, Wheeler &co 1993

Reference books

1. Kim R Fowler ,Electronic Instrument Design , Oxford reprint 2015
2. Kalsi HS , Electronic Instrumentation and Measurements, Mc Graw hill , 4 ed 2019.
3. A K Swahny ,A Course in Electronic Measurements and Instrumentation , 2015, Dhanpath Rai & Co

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Principles of measurements**	**9**
1.1	Introduction to the principles of measurements	3
1.2	Qualities of measurements, Principles of loading and characteristics of measuring instruments	3
1.3	Errors in measurements	3
2	**Indicating instruments**	**9**

2.1	Deflection type meters	3
2.2	Thermal , electrostatic and other types of meters	3
2.3	Grounding and shielding	3
3	**Transducers**	**9**
3.1	Introduction to transducers	3
3.2	LVDT, temperature sensors, thermocouples, RTD, LDR, displacement transducers. Strain gauges, Accelerometers, Piezoelectric transducers,	3
3.3	Hall Effect transducers, Strain gauges, Accelerometers, Piezoelectric transducers,	3
4	**Bridges**	**9**
4.1	Introduction to bridges	1
4.2	General equation for bridge at balance.	2
4.3	DC bridges: Types of bridges –Wheatstone, Kelvin, Carry Foster slide wire bridge .	3
4.4	AC bridges: Maxwell's inductance and Maxwell's inductance - capacitance bridge	3
5	**Oscilloscopes and Plotters**	**9**
5.1	Cathode ray oscilloscopes, principles and construction	3
5.2	Delayed time base, analog storage and sampling oscilloscopes.	3
5.3	Digital storage oscilloscopes and Recording instruments	3

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: AET285

Program: Applied Electronics and Instrumentation Engineering

Course Name: Introduction to Measurements and Instrumentation

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	What is the difference between the terms accuracy and precision	CO1	K2
2.	What are the reasons for the development of errors in measuring devices.	CO2	K2
3.	What is meant by the term ''grounding '' . Explain	CO2	K2
4.	Sketch a graph to show normal distribution of random errors. Discuss its shape.	CO2	K2
5.	List the forces involved in a moving instrument and explain each.	CO3	K2
6.	With a diagram explain a potentiometer type transducer.	CO4	K2
7.	Draw the circuit diagram of a capacitance bridge . derive the balance equation.	CO3	K2
8.	Briefly explain the factors which limit the maximum frequency which be displayed buy an oscilloscope .	CO5	K2
9.	Explain the principle of liquid crystal displays.	CO5	K2
10.	With a diagram briefly explain the working principle of a watt –hour meter	CO4	K2

PART-B

Answer any one question from each module

Module I

11	What are the major categories of measurement errors. Define and explain each . How can these errors be minimized?	14	CO2	K2
	OR			
12. a)	Define the ten ‘‘resolution ’’ with reference to measurements. What are the factors which limit the resolution of an instrument ?	10	CO1	K2
b)	What are the major categories of measuring instruments. Explain with suitable examples.	4	CO1	K2

Module II

13.	With suitable diagrams analyze the functioning of a permanent magnet moving coil instrument ?.Derive the torque equation.	14	CO1	K3
	OR			
14. a)	With suitable diagrams explain the working principles of an electrostatic voltmeter. Derive and explain its torque equation.	10	CO1	K2
b)	List merits and demerits of thermocouple instruments.	4	CO1	K2

Module III

15	Llist transducers used to measure low ,medium and high values of temperature .Describe their principles . what kind a temperature transducer will be suitable to measure the temperature of a blast furnace . Justify your selection.	14	CO4	K2
	OR			
16.a)	What is the working principle of a strain guage transducer .Explain in detail .	7	CO4	K2
b)	What is the importance of bridges in measurements. Explain how bridges can be used to increase the sensitivity of transducer based	7	CO4	K2

	measurements.			

Module IV

17	With a diagram explain the functioning of wheat stone bridge. Derive the equation for the bridge at balance condition. **OR** Carry Foster slide wire bridge	14	CO3	K2
18	With a diagram explain the functioning of Carry Foster slide wire bridge. Derive the equation for the bridge at balance condition.	14	CO3	K2

Module V

19	With a detailed diagram explain the functioning of a digital storage oscilloscope.	14	CO5	K2
	OR			
20	Explain electromagnetic and electrostatic deflection of electron beams, derive the relevant equations . Discuss relative merits and demerits.	14	CO5	K2

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

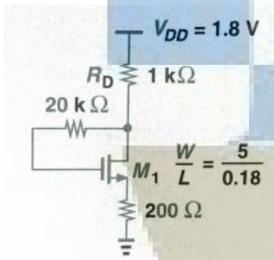
Course Name: ANALOG CIRCUITS

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 $\lambda = 0$ in the following circuit.	3	K3



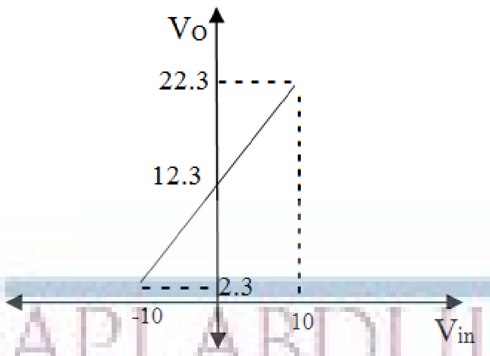
7	Illustrate the effect of negative feedback on bandwidth and gain of the amplifier.	3	K2
8	Explain the criteria for an oscillator to oscillate.	3	K1
9	How to eliminate cross over distortion in class-B power amplifier?	3	K2
10	What is line regulation and load regulation in the context of a voltage regulator?	3	K2

PART – B

Answer one question from each module; each question carries 14 marks.

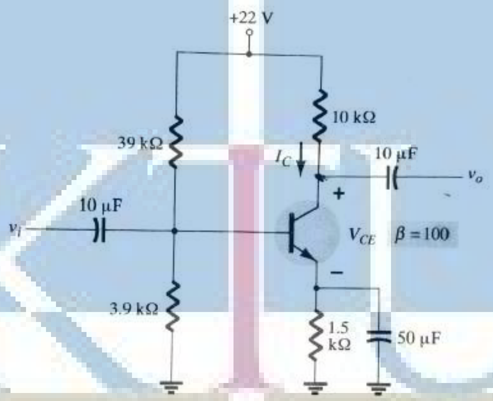
Module - I

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



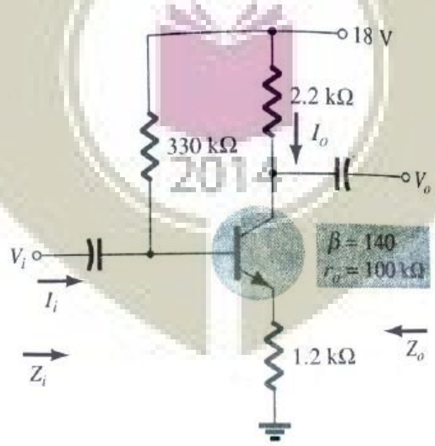
OR

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 $x(t) = A[1 - \frac{\|t\|}{T}]$	(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 $$x(t) = \cos \pi t + 3\sin 2\pi t + \sin 4\pi t$$	(6)	K_2
15(B)	Analyze and characterize the LTI system $x(t)$ using Laplace Transform $$x(t) = \frac{2}{3}e^{-t}u(t) + \frac{1}{3}e^{2t}u(t)$$	(8)	K_2

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 $$y[n] = 0.1y[n-1]+0.1y[n-3]+x[n]+0.2x[n-1]+0.1x[n-2]$$ in terms of the DTFTs	(7)	K_2

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

CODE AET206	COURSE NAME MEASUREMENTS AND INSTRUMENTATION	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: The syllabus is prepared with a view of giving the student a broad overview of the basic elements of an electronic measurement and instrumentation system. Due to the vastness of the field, only representative instruments are discussed in the syllabus.

Prerequisite: NIL

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

CO	Description	Knowledge Level
CO1	**Illustrate the working principles of electronic measuring instruments.**	**K2**
CO2	**Identify various types of errors in measuring systems and choose methods for minimization of the errors.**	**K3**
CO3	**Summarize the concepts of DC and AC bridges used in measurement systems.**	**K2**
CO4	**Apply the principles and functions of various types of Transducers in measuring systems.**	K3
CO5	**Explain the concepts of CRO, DSO, various recording devices and waveform analyzing instruments.**	K2

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											1
CO2	3	2										1
CO3	3				1							1
CO4	3				1							1
CO5	2											1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	70
Apply	10	10	10
Analyse			
Evaluate			
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): With detailed diagrams explain the principles working and limitations of CRO s and DSOs?

Course Outcome 2 (CO2) : What are the design steps which can be used to improve the accuracy and resolution of deflection type voltmeters and ammeters?

Course Outcome 3(CO3): List and explain various applications of AC and DC bridges.

Course Outcome 4 (CO4): Design a remote temperature measuring system for furnace operating in 1000K- 1500K temperature range**.**

Course Outcome 5 (CO5): What are the functions of a spectrum analyzer . What are the design limitations and specifications of a spectrum analyzer.

Syllabus

Module 1

Principles of measurements, Standards-calibration of meters - qualities of measurements- accuracy, precision sensitivity, resolution, Loading effect- characteristics, safety measures. Errors in measurements and its analysis.

Module 2

Indicating instruments deflection type meters –principles and operation.- moving coil , moving iron ,dynamo meter , induction , thermal , electrostatic and rectifier type meters. Grounding and Shielding of measuring systems.

Module 3

Transducers, principles and applications of basic transducers: LVDT, temperature sensors, thermocouples, RTD, LDR, displacement transducers, strain gauges, accelerometers, piezo electric transducers, Hall Effect transducers, manometers, photo electric transducers.

Module 4

DC bridges: introduction, sources and detectors for DC bridges. General equation for bridge at balance .Types of bridges –Wheatstone, Kelvin, Carry Foster slide wire bridge .

AC bridges: introduction, sources and detectors for AC bridges. General equation for bridge at balance. Maxwell's inductance and Maxwell's inductance -capacitance bridge, Anderson bridge, Shering bridge.

Module 5

Cathode ray oscilloscopes, principles, construction and limitations –Delayed time base, Analog storage and Sampling oscilloscopes.

Digital storage oscilloscopes – principles. Measurements using CRO s and DSO s. Recording instruments: Strip chart recorder, X-Y Plotter, LCD displays.

Waveform analyzing instruments : Spectrum analyzer , Distortion meter , Watt-hour meter, Q-meter ,Power factor meter . Instrument transformers, Peak response voltmeter , True RMS meter

Text Books

Text books

1. David A Bell , Electronic Iinstrumentation and Measurements , 3 nd Edition Oxford 2017
2. D .Patranabis , Sensors and Transducers, PHI 2nd edition 2003
3. Golding E W and Widdis F C Electrical Measurements and Measuring systems, Wheeler &co 1993

Reference books

1. Kim R Fowler ,Electronic Instrument Design , Oxford reprint 2015
2. Kalsi HS , Electronic Instrumentation and Measurements, Mc Graw hill , 4 ed 2019.
3. A K Swahny ,A Course in Electronic Measurements and Instrumentation , 2015, Dhanpath Rai & Co

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Principles of measurements**	9
1.1	Introduction to the principles of measurements	2
1.2	Qualities of measurements, Principles of loading and characteristics of measuring instruments	3
1.3	Errors in measurements and analysis	4
2	**Indicating instruments**	8
2.1	Deflection type meters	3
2.2	Thermal , electrostatic and other types of meters	3
2.3	Grounding and shielding	2
3	**Transducers**	9
3.1	Introduction to transducers	2
3.2	LVDT, temperature sensors, thermocouples, RTD, LDR, displacement transducers, strain gauges, accelerometers, piezoelectric transducers,	5
3.3	Hall Effect transducers, manometers, photo electric transducers	3
4	**Bridges**	9
4.1	Introduction to bridges	1
4.2	General equation for bridge at balance.	2
4.3	DC bridges: Types of bridges –Wheatstone, Kelvin, Carry Foster slide wire bridge .	3
4.4	AC bridges: Maxwell’s inductance and Maxwell’s inductance - capacitance bridge, Anderson bridge, Shering bridge	3
5	**Oscilloscopes and Plotters**	10

5.1	Cathode ray oscilloscopes, principles, construction and limitations	1
5.2	Delayed time base, analog storage and sampling oscilloscopes.	2
5.3	Digital storage oscilloscopes and Recording instruments	3
5.4	Spectrum analyzer, distortion meter, watt-hour meter, Q-meter and power factor meter	2

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: AET206

Program: Applied Electronics and Instrumentation Engineering

Course Name: Measurements and Instrumentation

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	What is the difference between the terms accuracy and precision	CO1	K2
2.	What are the reasons for the development of errors in measuring devices.	CO2	K2
3.	What is meant by the term ‘’grounding ‘’. Explain	CO2	K2
4.	Sketch a graph to show normal distribution of random errors. Discuss its shape.	CO2	K2
5.	List the forces involved in a moving instrument and explain each.	CO3	K2
6.	With a diagram explain a potentiometer type transducer.	CO4	K2
7.	Draw the circuit diagram of a capacitance bridge . derive the balance equation.	CO3	K2
8.	Briefly explain the factors which limit the maximum frequency which be displayed buy an oscilloscope .	CO5	K2
9.	Explain the principle of liquid crystal displays.	CO5	K2
10.	With a diagram briefly explain the working principle of a watt –hour meter	CO4	K2

PART-B

Answer any one question from each module

Module I

11	What are the major categories of measurement errors. Define and explain each. How can these errors be minimized?	14	CO2	K2
	OR			
12. a)	Define the term ''resolution '' with reference to measurements. What are the factors which limit the resolution of an instrument ?	10	CO1	K2
b)	What are the major categories of measuring instruments. Explain with suitable examples.	4	CO1	K2

Module II

13.	With suitable diagrams analyze the functioning of a permanent magnet moving coil instrument? Derive the torque equation.	14	CO1	K3
	OR			
14. a)	With suitable diagrams explain the working principles of an electrostatic voltmeter. Derive and explain its torque equation.	10	CO1	K2
b)	List merits and demerits of thermocouple instruments.	4	CO1	K2

Module III

15	List transducers used to measure low, medium and high values of temperature .Describe their principles . what kind a temperature transducer will be suitable to measure the temperature of a blast furnace . Justify your selection.	14	CO4	K2
	OR			
16.a)	What is the working principle of a hall effect transducer .Explain in detail .	7	CO4	K2
b)	What is the importance of load cells in measurements. Explain the	7	CO4	K2

	factors on which the sensitivity of a a load cell depends.			

Module IV

17	With a diagram explain the functioning of wheat stone bridge. Derive the equation for the bridge at balance condition.	14	CO3	K2
	OR			
18	With a diagram explain the functioning of Shering bridge. Derive the equation for the bridge at balance condition.	14	CO3	K2

Module V

19	With a detailed diagram explain the functioning of a digital storage oscilloscope.	14	CO5	K2
	OR			
20	With a detailed diagram explain the functioning of a spectrum analyzer. Explain the factors which limit the performance of a spectrum analyzer.	14	CO5	K2

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)

AEL 204	TRANSDUCERS AND MEASUREMENTS LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This course aims to

(i) Familiarize the students with various types of sensors and transducers

(ii) Enable students to select and design suitable instruments to meet requirements of various industrial applications

Prerequisite: Nil

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

CO 1	Make use of basic transducers for the measurement of physical variables like pressure ,temperature etc.
CO 2	Experiment with various measuring instruments and bridges
CO 3	Implement sensor based measurement systems using modern 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	2		1
CO 2	3		2	1	3			3	3	2		2
CO 3	3		2	2	3	3		3	3	2	2	3

Assessment

Mark distribution

Total Marks	**CIE**	**ESE**	**ESE Duration**
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15marks

Continuous Assessment : 30 marks

Internal Test (Immediately before the second series test) : 30marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work : 15Marks

(b) Implementing the work/Conducting the experiment : 10Marks

(c) Performance, result and inference (usage of equipments and troubleshooting) : 25Marks

(d) Viva voice : 20marks

(e) Record : 5Marks

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 8 experiments are mandatory)

1 Determination of characteristics optical transducers using LDR

2. Determination of characteristics of LVDT

3 Measurement of strain and load using strain gauge

4. Level measurement using capacitive/resistive transducer

5 Determination of characteristics of RTD

6 Determination of characteristics of thermocouple

7 Determination of characteristics of thermistor

8. Determination of pressure using strain gauge/piezoelectric pickup

9. Determination of sound pressure level using sound level meter

10. Calibration of pressure gauge using dead weight tester

11 Measurement of speed using photoelectric pickup

12 Measurement of speed using stroboscope

13 Determination of characteristics of hall effect transducer

14 Measurement of displacement using inductive transducer

15 Determination of characteristics of capacitive displacement transducer

16. Pressure measurement using U-tube manometer

17 Study of loading effect in potentiometer

18. Measurement of frequency and phase using Lissajous figures

Part B (At least 4 experiments are mandatory)

Experiments (1-4) shall be done using python/Labview-Aurdino interface

1. Measurement of temperature
2. Measurement of level in water tank
3. Measurement of pressure
4. Wind velocity measurement
5. Measurement of humidity
6. Simulation of Wheatstone bridge using Labview

7. Simulation of Anderson’s bridge using Labview
8. Simulation of Maxwell’s inductance bridge and Maxwell’s inductance capacitance bridge using Labview

* Manual has to be prepared by the college

SEMESTER -4

MINOR

AET282	INTRODUCTION TO DIGITAL SIGNAL PROCESSING	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to give an introduction to digital signal processing

Prerequisite: AET251 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 : 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 14marks.

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 timesignal.

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 aunit impulse sequence.

2. Derive the raddix-2 decimation in time algorithm forN=8.

Course Outcome 3 (CO3): Implementation of Digital Filters

1. Give the difference equation of an IIR filter. Give an example and draw itsstructure

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 block

Syllabus

Module 1: Signal ProcessingFundamentals
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.
Reference Books
1.Mitra, S.K., “Digital Signal Processing: A Computer-Based Approach”, McGraw Hill, NY,1998
2.Monson H Hayes, Schaums outline: Digital SignalProcessing.

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.	3
4.2	Truncation-Rounding - Quantization error in ADC - Overflow error - product round off error - Scaling - Limit cycleoscillation.	4
5	**DSP Architecture**	
5.1	Von Neumann and Harvard architecture, Comparison	2
5.2	Data paths of fixed and floating point DSP processors. Functions of various blocks Architecture of a typical DSP processor	4
5.3	Implementation of systems on DSP chip	3

Simulation Assignments (AET282)

The following simulation assignments can be done with Python/MATLAB/ SCILAB/OCTAVE

1. Generate the following discretesignals
   - Impulsesignal
   - Pulse signaland
   - Triangularsignal
2. WriteafunctiontocomputetheDFTofadiscreteenergysignal.Testthisfunctionona few signals and plot their magnitude and phasespectra.

- 3. Computethelinearconvolutionbetweenthesequences$x$=[1,3,5, 3]with$h$=[2,3,5,6]. Observe the stem plot of both signals and theconvolution.
    - Nowlet$h$=[1,2,1]and$x$=[2,3,5,6,7].Computetheconvolutionbetween$h$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 previousresult.

- Repeat the above two steps with h = [1, 2, 3, 2, 1] and h = [1, 2, 3, 4, 5, 4, 3, 2, 1]
- Give yourinference.

4. - Compute the DFT matrix for N = 8, 16, 64, 1024 and4098
   - Plot the first 10 rows in each case and appreciate these basisfunctions
   - Plot the real part of these matrices as images and appreciate the periodicities and half periodicities in the pattern
   - Normalizeeachmatrixbydividingby $\sqrt{N}$.Computetheeigenvaluesofevery normalized matrix and observe that all eigenvalues belong to the set $\{1, j, -j, -1\}$.

5. - Realize a continuous time LTI system with systemresponse

$$H(s) = \frac{5(s+1)}{(s+2)(s+3)}$$

   . 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 andcompare.

6. - Download a vibration signal in *.wav*format.
   - Loadthissignalintoanarray.Onemayusethe*scipy.io.wavfile*moduleinPython.
   - understand the sampling rate of thissignal.
   - Plot and observe the vibration signalwaveform.
   - Compute the absolute squared value of the FFT of the vibrationsignal.
   - Plotitandobservethespectralcomponentsinthediscretefrequencydomain.
   - 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:AET282 Introduction to Digital Signal Processing

Time:3Hrs **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 alinear transformation. (3) K_2

4 Explain how FFT reduces the computational complexity ofDFT. (3) K_2

5 Write the expresssion for the Hamming window and plotit. (3) K_1

6 Give the expression for bilinear tranformation and explain the term frequency warping. (3) K_2

7 Explain the quantization errorinADCs. (3) K_2

8 Explainthe1sand2s complementrepresentationofnumbersin DSP processor. (3) K_2

9 Compare floating point and fixed point data paths in a DSP processor. (3) K_2

10 Explain function ofabarrelshifterinaDSPprocessor. (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 sig- nal 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

using radix-2 DIFalgorithm

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 $x(n) = \{1,2,3,4,4,3,2,1\}$	(10)	K_3
14(B)	How is bit reverse addressing used in FFT	(4)	K_3

Module III

15(B)	Convert the analogfilter $H(s) = \frac{1}{(s+1)(s+2)}$ into digital filter using impulse invariance method.	(7)	K_3

OR

16(A)	Implement the FIR filter $h[n]$ = [1, 2, 4, 6, 4, 2,1] with mini- mum 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 bandand passs band attenuations are 0.1respectively.	(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 transferfunction $H(z) = \frac{1}{1-az^{-1}}$ that is driven by a zero mean white Gaussian noise of vari- ance σ^2	(8)	K_3
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 DSPprocessor.	(14)	K_2

OR

20(A)	CompareVonNeumannarchitecturewithHarvardarchitec-ture	(7)	K_2
20(B)	Explain the significance and operation of the MAC unit in a DSP processor	(7)	K_2

AET284	Introduction to Analog Circuits	CATEGORY	L	T	P	CREDITS
		VAC	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	Analyze simple circuits using diodes, resistors and capacitors
CO 2	Build amplifier and oscillator circuits
CO 3	Develop Power supplies, D/A and A/D convertors for various applications
CO4	Develop and analyze circuits using operational amplifiers and explain concepts of PLL.

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							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	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/Courseproject : 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): 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. ExplaintheworkingofRCdifferentiatorandintegratorcircuitsandsketchtheou tput 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 zenerdiode.
3. Ina10bitDAC,foragivenreferencevoltage,findtheanalogoutputforthegivendigita l 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 outputvoltage.

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, Basics of PLL.

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, Basics of PLL	3

Assignment:

Atleast one assignment should be simulation of transistor amplifiers and opamps on any circuit simulation software.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: AET284

Program: Applied Electronics and Instrumentation Engineering

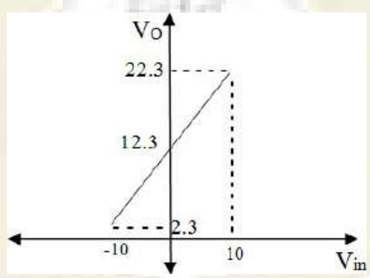
Course Name: Introduction to Analog Circuits

Max.Marks: 100 Duration: 3Hours

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:- — K2

5 What is the effect of cascading in gain and bandwidth of amplifier? — K3

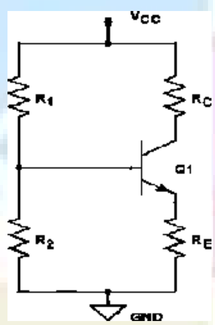
6	Discuss about simple zener shunt voltage regulator:-	K2
7	Realize a circuit to obtain Vo= -2V1+3V2+4V3 using operational amplifier. Use minimum value of resistance as 10KΩ.	K3
8	Design a monostable multivibrator using IC 555 timer for a pulse period of 1 ms.	K3
9	Describe the working of a Flash type A/D Converter, with example.	K2
10	Define: (1) Slew rate, (2) CMRR, (3) offset voltage and current:-	K2

PART – B

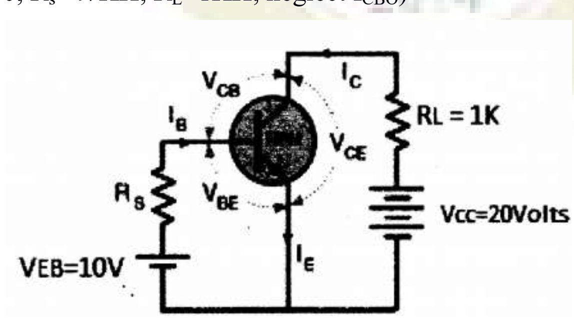
Answer one question from each module; each question carries 14 marks.

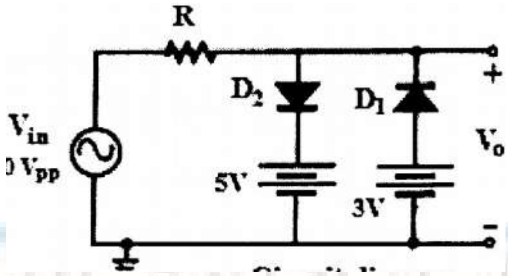
Module – I

11. a)	Design a differentiator circuit for a square wave signal with Vpp=10 and frequency 10KHz.	5	CO1	K3
11. b)	Consider a self-biasing circuit shown in figure below with Vcc=20V, Rc=1.5KΩ, which is operated at Q-point (Vce=8V, Ic=4mA), If hFE=100, find R1, R2 and Re. Assume VBE=0.7V.	9	CO2	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	CO1	K3
12.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, R_s=47KΩ, R_L=1KΩ, neglect I_{CBO})	5	CO2	K3

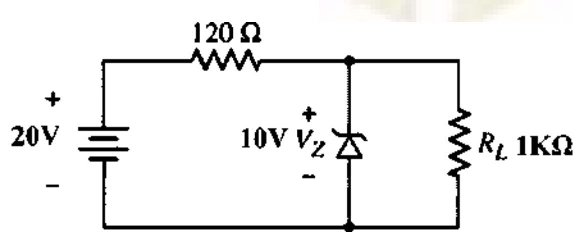


12.c)	Draw the output waveform and transfer characteristics of the given clipper circuit. 	4	CO1	K3

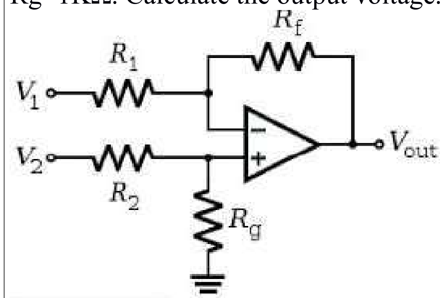
Module – II

13 a)	With neat sketches, explain the construction, principle of operation and characteristics of an N-channel enhancement MOSFET:-	9	CO2	K2
13 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
14 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
15 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
16 b)	Derive the expression for the frequency of oscillation of Wien bridge oscillator using BJT	4	CO2	K2
16 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:-	9	CO4	K2
17 b)	The difference amplifier shown in the figure have R1=R2=5KΩ, RF=10KΩ, Rg=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
18 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
19 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 VR= 10 V. Find its resolution and output voltage for an input 1101.	4	CO4	K3
20 b)	Design an astable multivibrator using IC 555 timer for a frequency of 1KHz and a duty cycle of 70%.Assume c=0.1µF.F.	5	CO4	K3
20 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 (AET284)

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. rent IO = 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.

CODE AET286	COURSE NAME INTRODUCTION TO INDUSTRIAL INSTRUMENTATION	CATEGORY	L	T	P	CREDIT
		VAC	3		0	4

Preamble: The syllabus is prepared with a view of giving the student a broad overview of the basic elements of industrial instrumentation system. Due to the vastness of the field, only representative systems and devices are discussed in the syllabus.

Prerequisite: NIL

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

CO	Description	Knowledge Level
CO1	**Explain the working principles of electronic measuring instruments and different standards.**	**K2**
CO2	**Identify various principles employed in measuring systems and explain basic recording devices.**	**K3**
CO3	**Summarize the concepts of transducers used in industrial measurement systems.**	**K2**
CO4	**Understand the principles of calibration of measurement systems.**	K3
CO5	**Environmental concerns regarding industrial measurement systems and concepts of reliability.**	K2

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											1
CO2	3	2										1
CO3	3				1							1
CO4	3				1							1
CO5	2											1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	70
Apply	10	10	10
Analyse			
Evaluate			
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):differentiate and explain in detail the concepts of accuracy, precision sensitivity, resolution?

Course Outcome 2 (CO2) : What are the design steps which can be used to improve the accuracy and resolution of deflection type voltmeters and ammeters?

Course Outcome 3(CO3):List and explain the principle construction and various applications of LVDT s **.**

Course Outcome 4 (CO4): what are the industrial applications of DC and AC bridges ,explain

Course Outcome 5 (CO5): How temperature affects industrial instrumentation systems . What are the methods employed to remove heat produced from instrumentation systems.

Syllabus

Module 1

Principles of measurements, qualities of measurements- accuracy, precision sensitivity, resolution, Loading effect- characteristics, safety measures :Standards –Military , Industrial , and Commercial standards .

Module 2

Indicating instruments deflection type meters –principles and operation.- moving coil , moving iron ,dynamo meter , induction , thermal , electrostatic and rectifier type meters. Grounding and Shielding of measuring systems. Cathode ray oscilloscopes, Recording instruments: Strip chart recorder, X-Y Plotter, LCD displays.

Module 3

Transducers, principles and applications of basic transducers: LVDT, temperature sensors, thermocouples, RTD, LDR, displacement transducers, strain gauges, accelerometers Smart transmitters, range specifications and standards. Interfacing of sensors and end devices.

Module 4

Calibration and testing standards for instruments transducers and display devices. Measurement and performance tests – impedance, resolution, noise, threshold and life tests.

DC bridges: introduction, sources and detectors for DC bridges. General equation for bridge at balance .Types of bridges –Wheatstone, Kelvin, Carry Foster slide wire bridge . AC bridges: introduction, Shering bridge.

Module 5

Operating console and control room panel design . Control of room environment for electronic equipment . Heat dissipation forced air circulation and humidity considerations . Grounding and shielding. .Protection against electrostatic discharge .Reliability: Principles, MTTR, MTBF, Failure rate analysis,

Text Books

1. David A Bell , Electronic Instrumentation and Measurements , 3 nd Edition Oxford 2017
2. D .Patranabis , Sensors and Transducers, PHI 2nd edition 2003
3. Golding E W and Widdis F C Electrical Measurements and Measuring systems, Wheeler &co 1993
4. Bela G Lipton Process Control, instrument engineers handbook 3 rd Edition Elsevier 1995
5. D .Patranabis , Sensors and Transducers, PHI 2nd edition 2003

Reference books

1. Kim R Fowler ,Electronic Instrument Design , Oxford reprint 2015
2. Kalsi HS , Electronic Instrumentation and Measurements, Mc Graw hill , 4 ed 2019.
3. A K Swahny ,A Course in Electronic Measurements and Instrumentation , 2015, Dhanpath Rai & Co
4. Golding E W and Widdis F C Electrical Measurements and Measuring systems, Wheeler &co 1993
5. E Balaguruswamy , Reliability engineering , Mc Graw Hill-2017

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Principles of measurements**	**9**
1.1	Introduction to the principles of measurements	2
1.2	Qualities of measurements, accuracy, precision sensitivity, resolution Principles of loading and characteristics of measuring instruments	4
1.3	Standards –Military , Industrial , and Commercial standards .	3
2	**Indicating instruments**	**9**
2.1	Deflection typemeters	3
2.2	Thermal , electrostatic and other types of meters	3
2.3	Cathode ray oscilloscopes, Recording instruments: Strip chart recorder, X-Y Plotter, LCD displays.	3
3	**Transducers**	**9**
3.1	Introduction to transducers	2
3.2	LVDT, temperature sensors, thermocouples, RTD, LDR, displacement transducers, strain gauges, accelerometers, piezoelectric transducers,	5
3.3	Smart transmitters, range specifications and standards. Interfacing of sensors and end devices.	3
4	**Calibration and bridges**	**9**
4.1	Calibration and testing standards for instruments transducers and display devices	2
4.2	Measurement and performance tests – impedance, resolution, noise, threshold and life tests.	3
4.3	DC bridges: Types of bridges –Wheatstone, Kelvin, Carry Foster slide wire bridge .	3

4.4	AC bridges	1
5	**Reliability**	**9**
5.1	Control of room environment for electronic equipment . Heat dissipation forced air circulation and humidity considerations .	3
5.2	Grounding and shielding	2
5.3	Protection against electrostatic discharge	2
5.4	MTTR, MTBF, Failure rate analysis	2

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: AET286

Program: Applied Electronics and Instrumentation Engineering

Course Name: INTRODUCTION TO INDUSTRIAL INSTRUMENTATION

Max.Marks: 100 Duration: 3Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	What is the difference between the terms accuracy and precision?	CO1
2.	What are the reasons for the development of errors in measuring devices?	CO2
3.	What is s pyrometer. What are its applications?	CO1
4.	Sketch a graph to show normal distribution of random errors. Discuss its shape.	CO2
5.	List the forces involved in a moving instrument and explain each.	CO3
6.	What is the principle of an LDR?	CO3
7.	Draw the circuit diagram of a wheat stone bridge. Derive the balance equation.	CO4
8.	Briefly explain the factors which limit the maximum frequency which be displayed buy an oscilloscope.	CO4
9.	Explain the principle of liquid crystal displays.	CO3
10.	What is meant by shielding, explain?	CO5

PART-B

Answer any one question from each module

Module I

11	Why different standards for electronic devices and measuring equipments are needed? Elaborate on the differences between military, industrial and commercial standards.	14	CO1	K2
	OR			
12. a)	Define the ten ''resolution '' with reference to measurements. What are the factors which limit the resolution of an instrument?	10	CO1	K2
b)	Briefly explain the concept of ''loading '' of a measuring device.	4	CO2	K2

Module II

13.	With suitable diagrams analyse the functioning of a permanent magnet moving coil instrument? Derive the torque equation.	14	CO1	K2
	OR			
14. a)	With suitable diagrams explain the working principles of an electrostatic voltmeter. Derive and explain its torque equation.	10	CO1	K2
b)	Briefly explain the principle of an LCD display.	4	CO3	K2

Module III

15	List transducers used to measure low ,medium and high values of temperature. Describe their principles. what kind a temperature transducer will be suitable to measure the temperature of a blast furnace? Justify your selection.	14	CO3	K2
	OR			
16.a)	What is the working principle of an accelerometer. Explain in detail.	7	CO3	K2

b)	What is the importance of load cells in measurements? Explain the factors on which the sensitivity of a load cell depends.		CO3	K2

Module IV

17	With a diagram explain the functioning of Carry Foster slide wire bridge. Derive the equation for the bridge at balance condition.	14	CO4	K
	OR			
18	With a diagram explain the functioning of Sheering bridge. Derive the equation for the bridge at balance condition.	14	CO4	K

Module V

19	What are the various passive and active heat removal schemes. Explain why heat removal is of critical importance?	14	CO5	K2
	OR			
20	)What is meant by the term ''reliability'' of a machine. what are the factors which affect reliability? what are the possible design enhancements which can increase reliability. discuss in detail.	14	CO5	K2

SEMESTER -4
HONOURS

CODE AET 292	COURSE NAME INSTRUMENTATION SYSTEM DESIGN	CATEGORY	L	T	P	CREDIT
		VAC	4	0	0	4

Preamble: The syllabus is prepared with a view of giving the student a broad overview of the basic concepts of design of design of instruments and instrument systems and their evaluation and quality control.

Prerequisite: NIL

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

CO	Description	Knowledge Level
CO1	**Identify different standards employed in the manufacture of devices and instruments.**	**K2**
CO2	**Utilize the selection criteria employed in the selection of transducers and instruments in instrumentation.**	**K3**
CO3	**Summarize the calibration employed for transducers and instruments..**	**K2**
CO4	**Apply the principles governing installation of control panels and their operation.**	K3
CO5	**Explain the concepts of various control schemes used in feedback systems and the principles of reliability, failure analysis and quality control**	K2

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											1
CO2	3	2										1
CO3	3				1							1
CO4	3				1							1
CO5	2											1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	70
Apply	10	10	10
Analyse			
Evaluate			
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): What are the reasons for the existence of different operational standards for instruments

Course Outcome 2 (CO2) : What are the functional and practical difference between the measuring systems used to measure extremely low and extremely high temperature

Course Outcome 3(CO3): What are the reasons for periodic recalibration for instruments.

Course Outcome 4 (CO4): what are the major factors taken into consideration ofor the design of control panels

Course Outcome 5 (CO5): what are the factors which limit the useful life of transducers and measurement systems . what steps can be taken to improve MTBF and MTTR

Syllabus

Module 1

Concepts of instrument design: functional requirements and specifications : Standards – Military , Industrial , and Commercial standards. BIS standards, ANSI standards, NEMA standards, DIN standards. Instruments symbols and signals.

Module 2

Performance characteristics and selection criteria: Performance characteristics and selection criteria for flow, pressure and level transducers. Smart transmitters, range specifications and standards. Interfacing of sensors and end devices. Display devices and plotting devices.

Module 3

Calibration and testing standards: Calibration and testing standards for instruments transducers and display devices. Measurement and performance tests – impedance, resolution, noise, threshold and life tests. Measurements of voltage current, phase and frequency. Design of instrumentation amplifier, isolation amplifier, active filter. Guidelines for the design of electronic circuits.

Module 4

Control panel design: Operating console and control room panel design . Control of room environment for electronic equipment . Heat dissipation forced air circulation and humidity considerations . Grounding and shielding. .Protection against electrostatic discharge . Electromagnetic interference and compatibility . Design guidelines for PCB s: layout schemes, PCB sizes design rules digital, analog, single and multilayer PCB s. Automated PCB design, CAD packages and tools.

Module 5

Principles and design of controllers : Proportional , Proportional Integral , Proportional Integral Derivative controllers and their characteristics. Relative merits and demerits. Microprocessor based control. Control valves –applications , design and control .

Reliability: principles, MTTR, MTBF, Failure rate analysis, Product quality variance report. Control charts, SQC, TQM Principles. ISO series, Quality standards procedure, certification, Quality audit.

Text Books

1. Bela G Lipton Process Control, instrument engineers handbook 3 rd Edition Elsevier 1995
2. D .Patranabis , Sensors and Transducers, PHI 2nd edition 2003
3. Golding E W and Widdis F C Electrical Measurements and Measuring systems, Wheeler &co 1993
4. R S Handpick, Printed Circuit Boards, **McGraw Hill Professional, 2005**
5. E Balaguruswamy , Reliability engineering , Mc Graw Hill-2017
6. Dale Besterfield et al, Total Quality Management, Pearson 5e 2017

Reference books

1. Waren boxleitner ,Electrostatic Discharge and Electronic Equipment , IEEE Press 1999
2. Kim R Fowler , Electronic Instrument Design , Oxford reprint 2015
3. Kalsi HS, Electronic Instrumentation and Measurements, Mc Graw hill, 4 ed 2019.
4. A K Swahny, A Course in Electronic Measurements and Instrumentation , 2015, Dhanpath Rai & Co

Course Contents and Lecture Schedule

No	**Topic**	**No. of Lectures**
1	Concepts of instrument design	9
1.1	functional requirements and specifications	3

1.2	Standards –military, industrial, and commercial standards	3
1.3	BIS standards, ANSI standards, NEMA standards, DIN standards. Instruments symbols and signals	3
2	Performance characteristics and selection criteria	9
2.1	Performance characteristics and selection criteria for flow, pressure and level transducers	3
2.2	Smart transmitters	3
2.3	display devices and plotting devices	3
3	Calibration and testing standards	9
3.1	Calibration and testing standards for instruments transducers and display devices	3
3.2	Measurement and performance tests	4
3.3	Design of instrumentation amplifier, isolation amplifier, active filter	2
4	Control panel design	9
4.1	Operating console and control room panel design	2
4.2	Control of room environment for electronic equipment	1
4.3	Heat dissipation , forced air circulation and humidity considerations . Grounding and shielding. .Protection against electrostatic discharge . Electromagnetic interference and compatibility	3
4.4	Design guidelines for PCB s: layout schemes, PCB sizes design rules digital, analog, single and multilayer PCB s. automated PCB design, CAD packages and tools.	3
5	Principles and design of controllers	9
5.1	Proportional controllers, Proportional Integral, controllers and their characteristics	2
5.2	Proportional Integral Derivative controllers and their characteristics	1

5.3	Microprocessor based control.	1
5.4	Control valves –applications, design and control	1
5.5	principles of MTTR, MTBF	1
5.6	Failure rate analysis, Product quality variance report	1
5.7	Control charts, SQC ,TQM Principles.	1
5.8	Quality standards procedure, Certification, Quality audit	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

MODEL QUESTION PAPER

AET 292- INSTRUMENTATION SYSTEM DESIGN

TIME: 3HR **MARKS:100**

PART A

(Answer ALL Questions. Each Carries 3 marks)

1.	What is the difference between the terms ''military standard ''and ''commercial standard''.	CO1	K2
2.	What are the basic functional desirable characteristics of an instrument.	CO2	K2
3.	What is meant by the term ''smart transmitter ''. Explain	CO2	K2
4.	Describe how noise degrades performance of transducers.	CO2	K2
5.	List the forces involved in an electrodynamic instrument.	CO3	K2
6.	Discuss the need for an isolation amplifier.	CO2	K2
7.	Discuss the need for electromagnetic interference reduction in instrumentation systems.	CO3	K2
8.	What steps can be taken to reduce the buildup of static electricity in instruments. Explain.	CO4	K2
9.	Explain the desirable characteristics of a control valve.	CO4	K2
10.	What are the major environmental factors which degrades the useful life of an instrumentation system, briefly explain	CO5	K2

PART-B

Answer any one question from each module

Module I

11	Differentiate between the terms ''functional requirements '' and ''specifications''. With a suitable example, explain these two for a machine?	14	CO1	K2
	OR			
12. a)	What is meant by the terms ''accuracy '' and ''precision'' with reference to measuring instruments. What are the factors which limit the ''accuracy '' and ''precision'' of a measuring instruments?	10	CO2	K2
b)	What are the major categories of measuring instruments. Explain with suitable examples.	4	CO2	K2

Module II

13.	With suitable diagrams analyze the functioning of a flow transducer based measurement system? Analyze how the resolution and accuracy of the system can be improved.	14	CO2	K3
	OR			
14. a)	With suitable diagrams explain the working principles of CRT based display system.	10	CO4	K2
b)	List merits and demerits of smart transducers .	4	CO2	K2

Module III

15	List transducers which can be used to measure low, medium and high values of voltages and currents. Describe their principles. What kind a transducer will be suitable to measure the voltage existing in an EHT transmission line. Justify your selection .	14	CO2	K3
	OR			
16.a)	What is the different types of noises encountered in instrument systems. how can the effects of noise have mitigated? explain in detail	10	CO3	K2
b)	What is the importance of an instrumentation amplifier. What are its	4	CO3	K2

	desirable characteristics?			

Module IV

17	Explain how temperature, humidity and ambient pressure affect the functioning of measurement systems. what can be done to overcome the variations due to those factors?	14	CO3	K2
	OR			
18	What are the various passive and active heat removal schemes. Explain why heat removal is of critical importance	14	CO3	K2

Module V

19 a)	What is meant by the term ''reliability'' of a machine. what are the factors which affect reliability? what are the possible design enhancements which can increase reliability. discuss in detail.	10	CO5	K2
b)	What are the relative merits of P, PI and PID controllers? Briefly explain.	4	CO5	K2
	OR			
20	What are the various failure matrices in common use? Explain in detail.	14	CO5	K2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
AET294	SYSTEM DESIGN USING VERILOG	VAC	4	0	0	4

Preamble: The syllabus is prepared with a view of giving the student a broad overview of the basic elements of an electronic system design using Verilog hardware description language. Due to the vastness of the field, only basic design techniques are discussed in the syllabus.

Prerequisite: Basic concept of logic circuit design

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

CO1	**Describe Verilog hardware description, languages(HDL)**
CO2	**ExplainLanguage Constructs and Conventions**
CO3	**Design digital circuits**
CO4	**Verify Behavioural models of digital circuits**
CO5	**Design Register Transfer Level (RTL) models of Digital Circuits.**
CO6	**Synthesize RTL 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											1
CO 2	3											1
CO 3	3		2		1							1
CO 4	3		2		1							1
CO 5	3		2		1							1
CO 6	3		2		1							1

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	10	10	20
Understand	10	10	20
Apply	20	20	40
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):

1. Explain with examples: a) Display tasks b) Strobe tasks c) Monitor tasks
2. Using example, explain about concurrent and statement with syntaxes
3. What is functional verification?

Course Outcome 2 (CO2)

1. Define Keywords and Identifiers.
2. Explain with examples. a) White space b) strengths c) Operators
3. Classify and explain strengths and contention resolution

Course Outcome 3(CO3):

1. Design module and a test bench for a half-adder.
2. What is array of Instances of primitives?
3. Write Verilog code for 1 to 4 demultiplexer module by using 2 to 4 decoder?

Course Outcome 4 (CO4):

4. Write Verilog code using case statement for any one example.
5. Design a counter module and test bench to illustrate the use of WAIT.
6. Write Verilog module for a positive edge triggered flip flop.

Course Outcome 5 (CO5):

7. Design Verilog module using path delay
8. Explain the operation of PMOS switch.
9. Design a Verilog module of a 4-bit bus switcher at the data flow level

Course Outcome 6 (CO6):

10. Write a test bench for moore detector to control the delay.
11. Design Verilog module for CMOS flip-flop.
12. Write syntax for while loop and write a Verilog code for n-bit Johnson counter.

Model Question paper

QPCODE: PAGES:3

RegNo:______________

Name :______________

APJABDULKALAMTECHNOLOGICALUNIVERSITYFIRSTSEMESTERB.TECHDEGREEEXAMINATION, MONTH &YEAR

***Course Code:* AET 294**

Course Name: System Design Using Verilog

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Define logic levels relevant to verilog HDL
2. Classify the data types and explain.
3. Explain NOR gate primitive with example.
4. How is delay modeled in data flow level.
5. Write Verilog code using if-else statement for any one example.
6. Describe assignment to Vector Operators.
7. Write about switch primitives
8. Describe instantiation with 'Strengths' and 'Delays'
9. DescribeCapacitiveModel
10. What is sequential synthesis of digital system

(10x3=30)

Part B

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

11. Explain the following

- ***i.*** Keywords
- ***ii.*** Identifiers
- ***iii.*** Numbers
- ***iv.*** Strings **(14)**

OR

12. (a) Explain different levels of design description in verilog.**(10)**

(b) Explain a) White space b) strengths **(4)**

13. (a) Write Verilog module for a delay flip flop **(6)**

(b)Write about i) array of instances of primitive

ii) model structures with an example. **(8)**

OR

14. (a)Write notes on tristate gates. Give the relevant syntax, logic diagrams and excitation tables.**(10)**

(b)What is array of Instances of primitives? **(4)**

15. (a) Explain with an example showing how 'while' construct is used **(6)**

(b) Design a counter module and test bench to illustrate the use of WAIT. **(8)**

OR

16. (a) Write Verilog code for 1 to 8 demultiplexer module by using 1 to 4 demultiplexer**(10)**

(b) Explain continuous assignment structures with examples **(4)**

17. (a)Discuss the basic transistor switches **(6)**

(b)Design a Mod 10 up counter using Behavioural modelling **(8)**

OR

18. (a)Explain the Strength Contention with Trireg Nets. **(7)**

(b) Explain cross coupled NOR latch. **(7)**

19. (a) Explain the Sequential Model-Feedback Model. **(6)**
(b)What is Functional Register. Explain in detail. **(8)**

OR

20. (a) Explain the Static Machine Coding. **(6)**
(b) What are the various sequential memory storage models explain in detail. **(8)**

Syllabus

Module 1

Introduction to Verilog HDL: Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Function Verification, System Tasks, Programming Language Interface, Module, Simulation and Synthesis Tools

Language Constructs and Conventions: Introduction, Keywords, Identifiers, White Space, Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Operators.

Module 2

Gate Level Modelling: Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples, Tristate Gates, Array of Instances of Primitives, Design of Flip-Flops with Gate Primitives, Delay, Strengths and Construction Resolution, Net Types, Design of Basic Circuit.

Modelling at Dataflow Level: Introduction, Continuous Assignment Structure, Delays and Continuous Assignments, Assignment to Vector Operators.

Module 3

Behavioural Modelling: Introduction, Operations and Assignments, Functional Bifurcation, 'Initial' Construct, Assignments with Delays, 'Wait' Construct, Multiple Always Block, Designs at Behavioural Level, Blocking and Non-Blocking Assignments, The 'Case' Statement, Simulation Flow, 'If' an 'if-Else' Constructs, 'Assign- De-Assign' Constructs, 'Repeat' Construct, for loop, 'The Disable' Construct, 'While Loop', Forever Loop.

Module 4

Switch Level Modelling: Basic Transistor Switches, CMOS Switches, Bidirectional Gates, Time Delays with Switch Primitives, Instantiation with 'Strengths' and 'Delays' Strength Contention with Trireg Nets. Behavioural models of digital circuits-examples

Module 5

Sequential Circuit Description: Sequential Models - Feedback Model, Capacitive Model, Implicit Model, Basic Memory Components, Functional Register, Static Machine Coding, Sequential Synthesis.

Text Books

1. T.R. Padmanabhan, B Bala Tripura Sundari, Design Through Verilog HDL, Wiley 2009.
2. Zainalabdien Navabi, Verliog Digital System Design,TMH, 2nd Edition.

Reference books

1. Fundamentals of Digital Logic with Verilog Design - Stephen Brown, Zvonkoc Vranesic, TMH, 2nd Edition.
2. Advanced Digital Logic Design using Verilog, State Machines & Synthesis for FPGA - Sunggu Lee, Cengage Learning, 2012.
3. Verilog HDL - Samir Palnitkar, 2nd Edition, Pearson Education, 2009.
4. Advanced Digital Design with Verilog HDL - Michel D. Ciletti, PHI,2009.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**INTRODUCTION TO VERILOG HDL, LANGUAGE CONSTRUCTS AND CONVENTIONS**	**9**
1.1	**Introduction to Verilog HDL:** Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Function Verification, System Tasks, Programming Language Interface, Module, Simulation and Synthesis Tools	5
1.2	**Language Constructs and Conventions:** Introduction, Keywords, Identifiers, White Space, Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Operators.	4
2	**GATE LEVEL MODELLING,MODELLING AT DATAFLOW LEVEL**	**9**
2.1	**Gate Level Modelling**: Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples, Tristate Gates, Array of Instances of Primitives, Design of Flip-Flops with Gate Primitives, Delay, Strengths and Construction Resolution, Net Types, Design of Basic Circuit.	5

2.2	**Modelling at Dataflow Level**: Introduction, Continuous Assignment Structure, Delays and Continuous Assignments, Assignment to Vector, Operators.	4
3	**BEHAVIOURAL MODELLING**	**9**
3.1	Introduction, Operations and Assignments, Functional Bifurcation, 'Initial' Construct, Assignments with Delays	3
3.2	'Wait' Construct, Multiple Always Block, Designs at Behavioural Level	2
3.3	Blocking and Non-Blocking Assignments, The 'Case' Statement, Simulation Flow, 'If' an 'if-Else' Constructs, 'Assign- De-Assign' Constructs, 'Repeat' Construct, for loop, 'The Disable' Construct, 'While Loop', Forever Loop	4
4	**SWITCH LEVEL MODELLING**	**9**
4.1	Basic Transistor Switches, CMOS Switches, Bidirectional Gates	3
4.2	Time Delays with Switch Primitives	2
4.3	Instantiation with 'Strengths' and 'Delays' Strength Contention with Trireg Nets.	2
4.4	Behavioural models of digital circuits-examples	2
5	**SEQUENTIAL CIRCUIT DESCRIPTION**	**9**
5.1	Feedback Model, Capacitive Model, Implicit Model	3
5.2	Basic Memory Components	2
5.3	Functional Register, Static Machine Coding	2
5.4	Sequential Synthesis	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
AET296	Linear Algebra	VAC	4	0	0	4

Preamble: The syllabus is prepared with a view of giving the student a broad overview of the abstract algebra, and to solve linear e

Prerequisite: NIL

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

CO1	To develop the skills in abstract algebra
CO2	To develop the skills to solve linear equations
CO3	To develop the skills to formulate linear transformation problems in matrix form
CO4	To understand and apply the concept of inner product to perform orthogonalization
CO5	To apply and analyse Eigen vector decomposition of matrices for diagonalization and analyse Singular Value Decomposition of matrices

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**											**1**
CO2	**3**	**2**										**1**
CO3	**3**	**3**										**1**
CO4	**3**	**3**										**1**
CO5	**3**	**3**										**1**

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination**
	1	**2**	
Remember	20	10	30
Understand	20	10	30
Apply	10	20	30
Analyse		10	10
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) : 15marks

Assignment/Quiz/Courseproject : 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): Abstract algebra

1) Define the algebraic structure group. Give an example for finite group

2) Define the following terms with respect to a vector space
i) Linear independence ii) Basis iii)Dimension

Course Outcome 2 (CO2): Solution to linear system

1) Find the inverse of B without finding the determinant

$$B = \begin{bmatrix} 1 & 0 & 2 \\ 2 & -1 & 3 \\ 4 & 1 & 8 \end{bmatrix}$$

2) Solve and find the solutions to the system of equations

$$\begin{gathered} x_1 + x_2 - 2x_3 + 4x_4 = 5 \\ 2x_1 + 3x_2 - 3x_3 + x_4 = 3 \\ 3x_1 + 3x_2 - 4x_3 - 2x_4 = 1 \end{gathered}$$

Course Outcome 3(CO3): Linear transformation

1) Change the basis of $A = \begin{bmatrix} 7 & 2 \\ -4 & 1 \end{bmatrix}$ using the following vectors $v1 = \begin{bmatrix} 1 \\ -1 \end{bmatrix}, v2 = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$

2) Find a basis for row space and null space of the following linear transformation

$$A = \begin{bmatrix} -3 & 6 & -1 & 1 & 7 \\ 1 & -2 & 2 & 3 & -1 \\ 2 & -4 & 5 & 8 & -4 \end{bmatrix}$$

Course Outcome 4 (CO4): Inner product

1) Define inner product space

2) If V be a vector space of polynomial with inner product given by $f, g \geq \int_0^1 f(t)g(t)dt$ if $f(t) = 3t - 5, g(t) = t^2$
Find i) $f, g >$ (ii) $\| f \|, \| g \|$

Course Outcome 5 (CO5): Eigen values

1) Find all the Eigen values and Eigen vectors of $B = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$

2) Express the linear transformation matrix $A = \begin{bmatrix} 1 & -3 & 3 \\ 3 & -5 & 3 \\ 6 & -6 & 4 \end{bmatrix}$ in Eigen vector basis

3) Obtain the SVD of the given matrix $A = \begin{bmatrix} 0 & 1 & 1 \\ \sqrt{2} & 2 & 0 \\ 0 & 1 & 1 \end{bmatrix}$

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Syllabus

Module 1

Algebraic Structures: Group, Ring, Field Vector Spaces, Subspaces, Linear Combinations, Subspace spanned by set of vectors, Linear dependence and Linear independence, Spanning set and basis, Finite dimensional vector spaces

Module 2

Solutions to Linear System of Equations : Simple systems, Homogeneous and Non-homogeneous systems, Gaussian elimination, Null Space and Range, Rank and nullity, Consistency conditions in terms of rank, General Solution of a linear system, Elementary Row and Column operations, Row Reduced Form, existence and uniqueness of solutions, projection, least square solution -pseudo inverse.

Module 3

Linear Transformations -four fundamental subspaces of linear transformation -inverse transformation -rank nullity theorem - Matrix representation of linear transformation, Change of Basis operation,

Module 4

Inner product, Inner product Spaces, Cauchy – Schwarz inequality, Norm, Orthogonality, Gram – Schmidt orthonormalization, Orthonormal basis, Expansion in terms of orthonormal basis, Orthogonal complement, Decomposition of a vector with respect to a subspace and its orthogonal complement – Pythagoras Theorem

Module 5

Eigenvalue – Eigenvector pairs, characteristic equation, Algebraic multiplicity, Eigenvectors, Eigenspaces and geometric multiplicity, Diagonalization criterion, The diagonalizing matrix, Projections, Decomposition of the matrix in terms of projections, Real Symmetric and Hermitian matrices , Properties of Eigen values, Eigen vectors, Unitary/Orthogonal diaganalizability of Comples Hermitian/Real Symmetric Matrices, Spectral Theorem, Positive and Negative Definite and Semi Definite matrices.

General Matrices : Rank, Nullity, Range and Null Space of AAT and ATA, Singular Values, Singular Value Decomposition,

Text books

1) G.F.Simmons, Topology and Modern Analysis , McGraw Hill
2) Frazier, Michael W. An Introduction to Wavelets through Linear Algebra, Springer Publications.

Reference Books

1) Hoffman Kenneth and Kunze Ray, Linear Algebra, Prentice Hall of India.

2) Reichard Bronson, Academic Press

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Vector Spaces, Subspaces,	2
2	Linear Combinations, Subspace spanned by set of vectors,	3
3	Linear dependence and Linear independence,	2
4	Spanning set and basis, Finite dimensional vector spaces	2
5	Solutions to Linear System of Equations : Simple systems, Homogeneous and Non-homogeneous systems, Gaussian elimination,	2
6	Null Space and Range, Rank and nullity, Consistency conditions in terms of rank	1
7	General Solution of a linear system, Elementary Row and Column operations, Row Reduced Form, existence and uniqueness of solutions,	3
8	Projection, least square solution -pseudo inverse.	2
9	Linear Transformations -four fundamental subspaces of linear transformation	2
10	inverse transformation - rank nullity theorem -	2
11	Matrix representation of linear transformation	1
12	Change of Basis operation	2
13	Inner product, Inner product Spaces, Cauchy – Schwarz inequality	2
14	Norm, Orthogonality, Gram – Schmidt orthonormalization, Orthonormal basis, Expansion in terms of orthonormal basis, Orthogonal complement,	3
15	Decomposition of a vector with respect to a subspace and its orthogonal complement – Pythagoras Theorem	2
16	Eigenvalue – Eigenvector pairs, characteristic equation, Algebraic multiplicity, Eigenvectors, Eigenspaces and geometric multiplicity, Diagonalization criterion, The diagonalizing matrix,	3
17	Projections, Decomposition of the matrix in terms of projections	2

18	Real Symmetric and Hermitian matrices , Properties of Eigen values, Eigen vectors, Unitary/Orthogonal diaganalizability of Comples Hermitian/Real Symmetric Matrices,	2
19	Spectral Theorem, Positive and Negative Definite and Semi Definite matrices.	2
20	General Matrices : Rank, Nullity, Range and Null Space of AAT and ATA,	3
21	Singular Values, Singular Value Decomposition	2

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B. Tech. Degree Examination

Branch: Electronics and Communication

Course:AET296 Linear Algebra

Time:3Hrs **Max. Marks:100**

PART A

Answer All Questions

	questions		
1	Define basis and dimension for a vector space	3	K1
2	If V denotes a vector space over a field F the show that $(-\alpha)v = -(\alpha v)$ for $\alpha \in F$, $v \in V$	3	K2
3	Define inverse of a linear transformation	3	K1

4	State and prove any one property of a projection matrix	3	K2
5	What is null space of a linear transformation? Give an example	3	K1
6	If $P^{-1}AP = D$ where D is a diagonal matrix show that columns of P are Eigen vectors of matrix A	3	K2
7	If $\text{Dim}(\text{Null}(A)) > 1$ Can you Find a common vector, u_1 in $\text{Null}(A^2)$ and $\text{Null}(A^T A)$ justify your answer	3	K3
8	What is an Eigen vector of a linear transformation? What is meant by geometric multiplicity of an Eigen value?	3	K1
9	If V denote a finite dimensional vector space over the field F then show that $T \in A(V)$ is invertible if T^{-1} is a polynomial expression in T over F.	3	K2
10	Define unitary transformation? Give an example	3	K1

PART B

Answer one question from each module. Each question carries 14 mark.

	Module 1	marks	K level
11	a)If V be a vector space and $u, v \in V$ then prove the triangular inequality $\lor u + v \lor \leq \| u \| + \| v \|$	4	K1
	(b) Find the basis and dimension for the space spanned by the following vectors $v1 = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}, v2 = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix}, v3 = \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix}$	10	K2
	OR		
12a	Define the following terms with respect to a vector space i) Linear independence ii) Basis iii) Dimension	6	K1
b	Check whether the following vectors form a basis for the space spanned by them $v1 = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}, v2 = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix}, v3 = \begin{bmatrix} 2 \\ 1 \\ 0 \end{bmatrix}$	8	K2
	Module 2		
13a	Find the inverse of B without finding the determinant $B = \begin{bmatrix} 1 & 0 & 2 \\ 2 & -1 & 3 \\ 4 & 1 & 8 \end{bmatrix}$	6	K2
b	Solve and find the solutions to the system of equations $x_1 + x_2 - 2x_3 + 4x_4 = 5$ $2x_1 + 3x_2 - 3x_3 + x_4 = 3$ $3x_1 + 3x_2 - 4x_3 - 2x_4 = 1$	8	K2
	OR		
14a	What is the least square solution to the equationAx $= b$?	14	K1
b	Find the least square solution to the equation Ax $= b$, where $A = \begin{bmatrix} 1 & 2 \\ 1 & 3 \\ 0 & 0 \end{bmatrix}$ and $b = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix}$		K2
	Module3		
15a	If u and v are elements of the null space of a linear transformation defined by the matrix A, show that $u + v$ is in $Null(A)$	4	K2

b	Change the basis of A using the vectors $v1 = \begin{bmatrix}1\\-1\\1\end{bmatrix}, v2 = \begin{bmatrix}1\\-2\\4\end{bmatrix}, v3 = \begin{bmatrix}1\\-3\\9\end{bmatrix}, A = \begin{bmatrix}1&1&1\\1&1&1\\1&1&1\end{bmatrix}$	**10**	**K3**
	OR		
16a	what is null space of a linear transformation? Find the basis and dimension for the null space of $A = \begin{bmatrix}1&2&0&1\\0&1&1&0\\1&2&0&1\end{bmatrix}$	**8**	**K2**
b	Show that null space is the orthogonal complement of row space of a linear transformation matrix	**4**	**K1**
	Module4		
17a	Define inner product space? If $u, v \in V$ where V denote an inner product space then prove the Schwartz inequality $u, v > \leq \parallel u \parallel \parallel v \parallel$	**8**	**K1**
b	If V be a vector space of polynomial with inner product given by $f, g \geq \int_0^1 f(t)g(t)dt$ if $f(t) = 3t - 5, g(t) = t^2$ Find i) $f, g >$ (ii) $\parallel f \parallel, \parallel g \parallel$	**6**	**K3**
18a	Show that similarity transformation doses not change the Eigen values of a linear transformation matrix	**7**	**K2**
b	What is similarity transformation?. Let $F: R^2 \rightarrow R^2$be the linear operator defined by$F(x, y) = (2x + 3y, 4x - 5y)$. Find the matrix representation of Frelative to the basis $S = \{u1, u2\} = \{(1,2), (2,5)\}$	**7**	**K3**
	Module 5		
19a	State and prove any one property of a projection matrix?	**4**	**K1**
b	Find the projection of *b* on to the column space of *A* $A = \begin{bmatrix}1&-6\\1&-2\\1&1\\1&7\end{bmatrix} b = \begin{bmatrix}-1\\2\\1\\6\end{bmatrix}$	**10**	**K3**
20a	Diagonalize the matrix A if possible $A = \begin{bmatrix}1&-3&3\\3&-5&3\\6&-6&4\end{bmatrix}$	**7**	**K3**
b	Obtain the SVD of the given matrix $A = \begin{bmatrix}0&1&1\\\sqrt{2}&2&0\\0&1&1\end{bmatrix}$	**7**	**K3**