APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd.
2014

SEMESTER VII

APPLIED ELECTRONICS AND INSTRUMENTATION

AET401	COMMUNICATION ENGINEERING	CATEGORY	L	T	P	CREDITS
		PCC	2	1	0	3

Preamble: This course aims to study about analog communication and digital communication systems

Prerequisite: ECT204 Signals and System

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

CO 1	Explain the basic components of a communication system
CO 2	Apply the concepts of random processes to LTI systems.
CO 3	Illustrate the concepts of various analog communication techniques.
CO 4	Apply source coding techniques in digital communication system
CO5	Apply digital modulation techniques in communication system

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	20
Understand	K2	30	30	60
Apply	K3	10	10	20
Analyse				
Evaluate				
Create				

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the basic components of a communication system

1. What is the need of a modulator in a radio communication system?
2. What are the various frequency bands used in radio communication
3. Why base band communication is infeasible for terrestrial air transmission?

Course Outcome 2 (CO2): Apply the concepts of random processes to LTI systems.

1. Compute the entropy of a Gaussian random variable.
2. Explain the pdf and CDF for the random variable.
3. Discuss about LTI system.

Course Outcome 3 (CO3): Illustrate the concepts of various analog communication techniques.

1. What are the needs for analog modulation
2. Give the mathematical model of FM signal and explain its spectrum

Course Outcome 4 (CO4): Apply source coding techniques in digital communication system

1. Compute the A and mu law quantized values of a signal that is normalized to 0.8 with A=32 and mu=255.
2. Define Delta modulation.

Course Outcome 5 (CO5): Apply digital modulation techniques in communication system

1. Give the mathematical model of a BPSK signal and plot its signal constellation.
2. Draw the BER-SNR plot for the BPSK system

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SYLLABUS

Module 1:

Basics of communication systems

Introduction, Elements of communication systems, Examples of analog communication systems, Frequency bands, Need for modulation. Noise in communication system, Definitions of Thermal noise (white noise), Various types of noise -- Shot noise, Partition noise, Flicker noise, Burst noise, (No analysis required) Signal to noise ratio, Noise factor, Noise temperature, Narrow band noise.

Module 2:

Review of Random Variables and Random Processes

Review of random variables – both discrete and continuous. CDF and PDF, statistical averages. (Only definitions, computations and significance) Entropy, differential entropy. Conditional entropy, mutual information. Stochastic processes, Stationarity. Conditions for WSS and SSS. Autocorrelation and power spectral density. LTI systems with WSS as input.

Module 3:

Analog Communication

Block diagram of a communication system. Need for analog modulation. Amplitude modulation. Equation and spectrum of AM signal. DSB-SC and SSB systems. Block diagram of SSB transmitter and receiver. Frequency and phase modulation. Narrow and wide band FM and their spectra. FM transmitter and receiver.

Module 4:

Source Coding

Source coding theorems I and II (Statements only). Waveform coding. Sampling and Quantization. Pulse code modulation, Transmitter and receiver. Companding. A and mu-law companders. DPCM transmitter and receiver. Design of linear predictor. Delta modulation. Slope overload.

Module 5:

Digital Modulation Schemes

Pass band transmission model, Coherent Modulation Schemes- BPSK, QPSK, BFSK. Non Coherent orthogonal modulation schemes - Detection of Binary modulation schemes in the presence of noise, BER for BPSK, QPSK.

Text Books

1. "Communication Systems", Simon Haykin, Wiley.
2. "Digital Communications: Fundamentals and Applications", Sklar, Pearson.

Reference Books

1. "Principles of Digital Communication," R. Gallager, Oxford University Press
2. "Digital Communication", John G Proakis, Wiley

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Basics of communication systems**	
1.1	Introduction, Elements of communication systems	1
1.2	Examples of analog communication systems, Frequency bands	1
1.3	Need for modulation	1
1.4	Noise in communication system, Definitions of Thermal noise (white noise), Various types of noise -- Shot noise, Partition noise, Flicker noise, Burst noise, (No analysis required)	2
1.5	Signal to noise ratio, Noise factor, Noise temperature, Narrow band noise.	1
2	**Review of Random Variables and Random Processes** .	
2.1	Review of random variables – both discrete and continuous.	2
2.2	CDF and PDF, statistical averages. (Only definitions, computations and significance)	1
2.3	Entropy, differential entropy. Conditional entropy, mutual information.	1
2.4	Stochastic processes, Stationarity. Conditions for WSS and SSS.	2
2.5	Autocorrelation and power spectral density. LTI systems with WSS as input	2
3	**Analog Communication**	
3.1	Block diagram of a communication system. Need for analog modulation.	2
3.2	Amplitude modulation. Equation and spectrum of AM signal. DSB-SC and SSB systems. Block diagram of SSB transmitter and receiver	3
3.3	Frequency and phase modulation. Narrow and wide band FM and their spectra. FM transmitter and receiver.	2
4	**Source Coding**	

4.1	Source coding theorems I and II (Statements only). Waveform coding. Sampling and Quantization.	1
4.2	Pulse code modulation, Transmitter and receiver	2
4.3	Companding. A and mu-law companders. DPCM transmitter and receiver.	2
4.4	Design of linear predictor. Delta modulation. Slope overload.	2

5	**Digital Modulation Schemes**	
5.1	Pass band transmission model, Coherent Modulation Schemes- BPSK, QPSK, BFSK.	2
5.2	Non Coherent orthogonal modulation schemes - Detection of Binary modulation schemes in the presence of noise	2
5.3	BER for BPSK, QPSK.	3

Assignment:
At least two assignments should be given.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Program: Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation Engineering

Course Code: AET401

Course Name: COMMUNICATION ENGINEERING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 marks.

1.	Explain the need for modulation	K2
2	A receiver connected to an antenna whose resistance is 50 ohm has an equivalent noise resistance of 30 ohm. Calculate receiver noise figure in decibels & its equivalent noise temperature?	K3
3	Give the conditions for WSS.	K1
4	In a game a six faced die is thrown. If 1 or 2 comes the player gets Rs 30, if 3 or 4 the player gets Rs 10, if 5 comes he loses Rs. 30 and in the event of 6 he loses Rs. 100. Plot the CDF and PDF of gain or loss.	K3
5	Plot the spectrum of an FM signal.	K2
6	Draw the block diagram of a communication system	K2
7	State source coding theorems I and II.	K1
8	Define companding.	K1
9	Plot BER against SNR for a BPSK system	K2
10	Draw the signal constellation of a QPSK system	K2

PART – B

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

Module – I

11.a)	Explain the following (i) Thermal noise (ii) Flicker noise	6	CO1	K2
11.b)	Explain the elements of communication systems in detail?	8	CO1	K2

OR

12.a)	Define the signal to noise ratio and noise and noise figure of a receiver? How noise temperature related to noise figure?	9	CO1	K1
12.b)	List the basic functions of a radio transmitter & the corresponding functions of the receiver?	5	CO1	K2

Module – II

13.a)	Compute the entropy of Gaussian random variable	8	CO2	K3
13.b)	Explain mutual information. Give its relation with self-information.	6	CO2	K2

OR

14.a)	Explain a LTI systems with WSS as input.	8	CO2	K2
14.b)	Give the relation between autocorrelation and power spectral density of a WSS.	6	CO2	K2

Module – III

15.a)	Give the model of AM signal and plot its spectrum.	9	CO3	K2
15.b)	Write short notes about narrow band FM.	5	CO3	K2

OR

16.a)	Explain how SSB is transmitted and received.	8	CO3	K2
16.b)	Explain DSB-SC transmitter and receiver.	6	CO3	K2

Module – IV

17	With figure, Explain Pulse code modulation Transmitter and receiver	14	CO4	K2

OR

18.a)	Describe about Delta modulation with suitable figures.	10	CO4	K2
18.b)	Define A and mu-law companders	4	CO4	K1

Module – V

19.a)	Derive the probability of error for a QPSK system with Gray coding.	10	CO5	K3
19.b)	Draw the BER-SNR plot for a QPSK system	4	CO5	K1

OR

20.a)	Derive the probability of error for a BPSK system	10	CO5	K3
20.b)	Compare coherent and non-coherent modulation	4	CO5	K2

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

AET413	NONLINEAR AND ADAPTIVE CONTROL SYSTEMS	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to develop the skill to design and analyze Nonlinear and Adaptive Control Systems

Pre-requisites: AET301 CONTROL SYSTEM

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

CO 1	Explain Phase plane analysis of Linear and Non-Linear Systems.
CO 2	Analyze stability of a Non-Linear Systems using Lyapunov Theory.
CO 3	Analyze a Non-Linear Systems using Describing Function.
CO4	Explain SISO LTI Identification Algorithms.
CO5	Describe various Adaptive Control Schemes and analyze its stability.

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		2								3
CO 2	3	2		2								3
CO 3	3	2		2								3
CO 4	3	2		2								3
CO 5	3	2		2								3

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyse	K4			
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain Phase plane analysis of Linear and Non-Linear Systems.

1. Explain how the properties of a system can be best explained by analyzing the nature of singular points.
2. Generate the phase portrait of system by employing the method of isoclines.
3. Explain the concept of limit cycles in the stability analysis of non-linear systems.
4. Explain the Poincare -Bendixson theorems.

Course Outcome 2 (CO2): Analyze stability of a Non-Linear Systems using Lyapunov Theory.

1. Differentiate between autonomous and non-autonomous systems.
2. Discuss about asymptotic stability and exponential stability.
3. State and explain the Lyapunov’s linearization method.
4. Explain Lyapunov’s direct method and apply it to a non-linear mass damper spring system.
5. Explain Lyapunov’s theorem for local stability.

Course Outcome 3 (CO3): Analyze a Non Linear Systems using Describing Function.

1. Define Describing function. Explain how describing functions can be used to discover the existence of limit cycles and their stability.
2. Compute the describing function for saturation non-linearity.
3. Deduce the describing function for backlash non-linearity.
4. Explain the Limit cycle detection for frequency dependent describing functions.
5. State and explain the criterion for existence and stability of limit cycles.
6. Comment on the reliability of describing function analysis.

Course Outcome 4 (CO4): Explain SISO LTI Identification Algorithms.

1. Explain identification error. Elaborate on the applicability of gradient and least squares algorithms in minimizing identification error.
2. Explain model reference identifier structure and its implementation.
3. Differentiate between positive real and strictly positive real error functions.
4. Deduce the condition for convergence of parameter error to zero.
5. State and explain partial convergence theorem.

Course Outcome 5 (CO5): Describe various Adaptive Control Schemes and analyze its stability.

1. Obtain the controller and identifier structure in the input error direct adaptive control scheme.
2. Explain the implementation of output error direct adaptive control algorithm.
3. Differentiate between input error and output error direct adaptive control schemes.
4. Explain the implementation of indirect adaptive control algorithm
5. Perform the stability analysis of input error direct adaptive control scheme.

SYLLABUS

AET413 NON-LINEAR AND ADAPTIVE CONTROL SYSTEMS

Module 1:

Introduction: Common Physical Nonlinearities in control systems-accidental and Intentional. **Phase Plane Analysis**: Concept of Phase plane analysis- phase portraits- singular points- symmetry. Construction of phase portraits-the method of isoclines-Phase plane analysis of linear systems, Phase plane analysis of non-linear systems- local behaviour of non-linear systems-limit cycles- Poincare-Bendixson theorems.

Module 2:

Stability of nonlinear systems-Lyapunov theory- Non-Linear systems- autonomous and non-autonomous- equilibrium points, Concept of Stability in the sense of Lyapunov, asymptotic stability and exponential stability, Local and Global stability- Linearization and local stability, Lyapunov's direct method, positive definite functions and Lyapunov functions, Lyapunov theorems for local stability and global stability

Module 3:

Describing Function: Describing Function Fundamentals -Describing functions of common nonlinearities- saturation, dead-zone, backlash – Describing Function analysis- Non-Linear Systems-Limit Cycles- Stability of Limit Cycles.

Module 4:

Adaptive Control: Parametric models of dynamical systems-SISO LTI Identification- Linear Error Equation- Gradient Algorithm-Least Squares Algorithm-Model Reference Identifier.

Module 5:

Adaptive Control Schemes: Model Reference Adaptive Control-Input Error Direct Adaptive Control- Output Error Direct Adaptive Control- Indirect Adaptive Control, Stability- Input Error Direct Adaptive Control- Output Error Direct Adaptive Control- Indirect Adaptive Control.

Text Books:

1. Jean- Jacques Slotine and Weiping Li, Applied nonlinear Control, Prentice Hall,1991, ISBN: 0-13-040890.
2. Shankar Sastry, Nonlinear Systems; Analysis, Stability and Control, Springer. 1999
3. Sankar Sastry and Marc Bodson, Adaptive Control- Stability, Convergence and Robustness, Springer, 2011.
4. K.J. Astrom and B. Wittenmark, Adaptive Control, 2nd ed., Pearson Education, 1995.

References:

1. H.K. Khalil, Nonlinear Systems, 3rd ed., Prentice hall, 2002.
2. M Gopal "Digital Control and State Variable Methods", Tata McGraw-Hill Ltd, New Delhi, 2003.
3. Nagoor Kani, "Advanced Control System", Rba Publications

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Non-Linear Control System**	
1.1	Introduction: Common Physical Nonlinearities in control systems-accidental and Intentional.	1
1.2	Concept of Phase plane analysis- phase portraits- singular points-symmetry.	1
1.3	Construction of phase portraits-the method of isoclines	2
1.4	Phase plane analysis of linear systems, Phase plane analysis of non-linear systems- local behaviour of non-linear systems-limit cycles-Poincare- Bendixson theorems.	3
2	**Stability of nonlinear systems**	
2.1	Lyapunov theory- Non-Linear systems- autonomous and non-autonomous-equilibrium points.	1

2.2	Concept of Stability in the sense of Lyapunov, asymptotic stability and exponential stability, Local and Global stability- Linearization and local stability,	2
2.3	Lyapunov's direct method, positive definite functions and Lyapunov functions,	2
2.4	Lyapunov theorems for local stability and global stability	2
3	**Describing Function**	
3.1	Describing Function Fundamentals	1
3.2	Describing functions of common nonlinearities- saturation, dead-zone, backlash	2
3.3	Describing Function Analysis- Non-Linear Systems-Limit Cycles- Stability of Limit Cycles.	3
4	**Adaptive Control**	
4.1	Parametric models of dynamical systems	1
4.2	SISO LTI Identification - Frequency Domain Approach- Time Domain Approach-Linear Error Equation	2
4.3	Gradient Algorithm	2
4.4	Least Squares Algorithm	1
4.5	Model Reference Identifier	3
5	**Adaptive Control Schemes**	
5.1	Model Reference Adaptive Control-Input Error Direct Adaptive Control	1
5.2	Output Error Direct Adaptive Control	1
5.3	Indirect Adaptive Control	1
5.4	Stability- Input Error Direct Adaptive Control- Output Error Direct Adaptive Control- Indirect Adaptive Control.	3

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B. TECH DEGREE EXAMINATION
Applied Electronics and Instrumentation Engineering/ Electronics & Instrumentation Engineering
Course Code: AET 413

Course Name: NON-LINEAR AND ADAPTIVE CONTROL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART-A
Answer all Questions. Each carry 3 marks.

1.	Define linear and non-linear control systems and explain their differences.	CO1
2.	Differentiate between inherent and intentional non-linearities.	CO1
3.	Explain phase plane and phase trajectory with neat sketch.	CO2
4.	Explain about the Singular points in phase plane analysis.	CO2
5.	Derive the describing function of Saturation Non-Linearity.	CO3
6.	Explain the design of nonlinear system using describing function method.	CO3
7.	Obtain and explain the update law for standard gradient algorithm.	CO4
8.	Explain the frequency domain approach to identification of single input single output linear time invariant systems.	CO4
9.	Explain the bounded input bounded state stability concept for adaptive systems.	CO5
10.	Explain the major differences between input error and output error adaptive control schemes.	CO5

PART-B
Answer **ONE** question from each module. Each carries 14 marks.

Module 1

11.	Explain the construction of phase trajectories and explain procedure for constructing phase trajectories by Isocline method.	(14)	CO1
	OR		
12.	What is phase plane, phase trajectory and phase portrait? Draw and explain how to determine the stable and unstable limit cycles using phase portrait.	(14)	CO1
	Module 2		
13.	What is a limit cycle? Discuss about the theorems, by which, the existence of limit cycle can be predicted	(14)	CO2
	OR		
14.	Define the following: (i) System. (ii) Equilibrium state (iii) Stability in the sense of Lyapunov (iv) Asymptotic stability (v) Instability.	(14)	CO2
	Module 3		
15 a).	Derive the describing function of Dead-zone non-Linearity?	(7)	CO3
15 b)	Derive the describing function of Backlash Non-Linearity?	(7)	CO3
	OR		
16 a).	What is the significance of describing function analysis?	(5)	CO3
16 b).	Derive the describing function of Relay with Dead-zone and Hysteresis Non-Linearity?	(9)	CO3

Module 4

17 a).	Define the update law for standard gradient algorithm. Explain the implementation of identifier with normalized gradient algorithm.	(7)	CO4
17 b).	Define covariance propagation equation for least squares algorithm. Explain the implementation of identifier with normalized least squares algorithm and covariance resetting.	(7)	CO4
	OR		
18.	Explain the implementation of model reference identifier algorithm and obtain the Identifier structure.	(14)	CO4

Module 5

19.	Obtain the input error identifier structure and explain the implementation of input error direct adaptive control algorithm.	(14)	CO5
	OR		
20.	Explain the implementation of indirect adaptive control algorithm.	(14)	CO5

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

AET423	SCADA AND DISTRIBUTED CONTROL SYSTEMS	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to provide concepts of PLC, SCADA and DCS used in industrial automation.

Prerequisite: AET303 Industrial Instrumentation

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

CO 1	Explain the architecture and I/O processing of PLC
CO 2	Apply the concepts of PLC programming and apply it to solve real life problems
CO 3	Describe the implementation of SCADA system in industrial automation
CO 4	Illustrate DCS architecture
CO 5	Explain various interfacing techniques and algorithms used in DCS

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
CO 2	3	3	3									3
CO 3	3	3										3
CO 4	3	3										3
CO 5	3	3										3

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	20
Understand	K2	35	35	70
Apply	K3	5	5	10
Analyze				

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. PartA contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which

student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the architecture and I/O processing of PLC (K2)

1. Explain the internal architecture of PLC with neat diagram.
2. Explain in detail about some input output units used in PLC.
3. Why the signal conditioning is important in PLC I/O units?

Course Outcome 2 (CO2): Apply the concepts of PLC programming and apply it to solve real life problems (K3)

1. Write a PLC ladder program to operate 3 motors M1,M2 and M3 according to the following conditions of switches S1,S2 and S3
   When any one of the switches are ON M1 is ON.
   When any two of the switches are ON M2 is ON.
   When all the three switches are ON M3 is ON. And only one motor should work at a time.
2. Draw the PLC ladder for Bottle filling system

Course Outcome 3 (CO3): Describe the implementation of SCADA system in industrial automation (K2)

1. Describe the elements of a SCADA system.
2. What is RTU? Explain its significance.

Course Outcome 4 (CO4): Illustrate DCS architecture (K2)

1. Explain automation pyramid with reference to a DCS system.
2. Explain the functions of local and global highways in DCS

Course Outcome 5 (CO5): Understand interfaces in DCS (K2)

1. Explain the hardware elements in high level operator interface in DCS.
2. List and explain the various functions of an operator interface in a DCS.

SYLLABUS

Module 1:

Introduction to the programmable logic controller (PLC) - hardware, internal architecture, PLC Systems, The IEC Standard, **I/O Processing** - Input/output Units, Signal Conditioning, Remote Connections, Examples of Commercial Systems, Processing Inputs, I/O Addresses

Module 2:

Ladder and Functional Block Programming: - **Ladder Diagrams**- Logic Functions, Latching, Multiple Outputs, and Entering Programs. **Function Blocks**- Logic gates, Boolean algebra, Programming examples.

Timers- Types of Timers, On-Delay Timers, Off-Delay Timers, Pulse Timers, Retentive Timers, Programming Examples. **Counters**-Forms of Counter, Programming, Counter Application, Up- and Down-Counting, Timers with Counters, Sequencer.

Data Handling, Arithmetic Functions, Closed Loop Control.

Module 3: Introduction to SCADA- applicable processes and elements of a SCADA system, a limited two-way system. **History of SCADA**-development from telemetry, Dependence on communications and computers. **Real time systems**- introduction to real time system, communication access and master slave. **Remote terminal units**- function of RTU, communication interface, protocol, discrete, analog, pulse and serial control, monitoring of analog, discrete, pulse and serial signals. **Master terminal units-** communications interface, configuring a picture of the process, some simple applications, data storage. **Application** of **SCADA-**monitoring and controlling of a gas lift system**.**

Module 4:

Distributed Control System: DCS - Architectures, Comparison, Local control unit, Process interfacing issues, Communication facilities. Distributed Control System Basics: DCS introduction, Various function Blocks, DCS components/block diagram, DCS Architecture of different makes, comparison of these architectures with automation pyramid, DCS specification, latest trend and developments, DCS support to Enterprise Resources Planning (ERP), performance criteria for DCS and other automation tools.

Module 5:

Interfaces In DCS: Operator interfaces, Low level and high-level operator interfaces, Operator displays, Engineering interfaces, Low level and high-level engineering interfaces, General purpose computers in DCS, DCS detail Engineering, configuration and programming, functions including database management, reporting, alarm management, diagnosis**.**

Text Books

1. W. Bolton, Programmable Logic Controllers, Fifth Edition – Newnes, 2009
2. Stuart A. Boyer, SCADA Supervisory Control and Data Acquisition, 3rd edition, ISA, 2004
3. Michael P. Lukas, 'Distributed Control Systems', Van Nostrand Reinhold Co.,Canada,1986

Reference Books

1. Béla G. Lipták, Instrument Engineers' Handbook -Process Control, ISA, 1995.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to the programmable logic controller (PLC) -**	
1.1	Hardware, internal architecture	2
1.2	PLC Systems, The IEC Standard	1
1.3	**I/O Processing**, Input/Output Units	1
1.4	Signal Conditioning, Remote Connections	1
1.5	Examples of Commercial Systems, Processing Inputs, I/O Addresses	1
2	**PLC programming timers and counters**	
2.1	**Ladder Diagrams**- Logic Functions, Latching, Multiple Outputs, and Entering Programs	2
2.2	**Function Blocks**- Logic gates, Boolean algebra, Programming examples	1
2.3	**Timers**- Types of Timers, On-Delay Timers, Off-Delay Timers, Pulse Timers, Retentive Timers, Programming Examples	2
2.4	**Counters**-Forms of Counter, Programming, Counter Application, Up-and Down-Counting, Timers with Counters, Sequencer	2
2.5	Data Handling, Arithmetic Functions, Closed Loop Control	1
3	**SCADA**	
3.1	Introduction to SCADA- applicable processes and elements of a SCADA system, a limited two-way system.	1
3.2	History of SCADA-development from telemetry, Dependence on communications and computers.	1
3.3	Real time systems- introduction to real time system, communication access and master slave.	2
3.4	Remote terminal units- function of RTU, communication interface, protocol, discrete, analog, pulse and serial control, monitoring of analog, discrete, pulse and serial signals	2
3.5	**Master terminal units-** communications interface, configuring a picture of the process, some simple applications, data storage.	1
3.6	**Application** of **SCADA-**monitoring and controlling of a gas lift system	1
4	**Distributed Control System**	
4.1	DCS - Architectures, Comparison, Local control unit, Process interfacing issues	1
4.2	Communication facilities. Distributed Control System Basics: DCS introduction, Various function Blocks	1

4.3	DCS components/block diagram, DCS Architecture of different makes, comparison of these architectures with automation pyramid	1
4.4	DCS specification, latest trend and developments, DCS support to Enterprise Resources Planning (ERP)	2
4.5	Performance criteria for DCS and other automation tools.	1
5	**Interfaces in DCS**	
5.1	Operator interfaces, Low level and high-level operator interfaces, Operator displays	2
5.2	Engineering interfaces, Low level and high-level engineering interfaces	1
5.3	General purpose computers in DCS, DCS detail Engineering,	2
5.4	configuration and programming, functions including database management,	1
5.5	Reporting, alarm management, diagnosis.	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation Engineering

Course Code: AET423

Course Name: SCADA and Distributed Control Systems

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 marks.

1.	What is IEC standard?	K1
2.	Explain I/O addressing used in PLC.	K2
3.	Explain the working of on-delay timer.	K1
4.	Draw ladder diagram to realize AND, OR and NOT gate.	K3
5.	List the various functions of RTU	K1
6.	What are real time systems? Explain.	K2
7.	Explain the basic elements in a DCS system.	K2
8.	What are the functions of LCU?	K1
9.	Explain alarm management in DCS.	K1
10.	What is meant by high level operator interface (HLOI)?	K1

PART – B

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

MODULE -1

11 a)	With neat diagram explain the architecture of PLC	7	CO1	K2
b)	Explain various signal conditioning methods applied before passing to input unit.	7	CO1	K2
	OR			
12 a)	How remote connection is made in PLC? Explain in detail	7	CO1	K2
b)	Explain some examples of systems used with installations involving PLCs	7	CO1	K2

MODULE -2

13 a)	Explain Functional block programming used in PLC with examples.	7	CO2	K2
b)	Devise ladder programs for systems that will carry out the following tasks: (a) Give an output after a photocell sensor has given 10 pulse input signals as a result of detecting 10 objects passing in front of it. (b) Give an output when the number of people in a store reaches 100, there continually being people entering and leaving the store.	7	CO2	K3
	OR			
14 a)	What is sequencer? Explain in Detail.	7	CO2	K2
b)	Explain forms of counter and its programming.	7	CO2	K2

MODULE -3

15 a)	Explain the monitoring and controlling of a gas lift system using SCADA	14	CO3	K3
	OR			
16 a)	The liquid level in a column gravity separator is observed to cycle with a two-minute period from one maximum level to the next. What would be the effect of sampling this level with the following: a. A two-minute scan rate? b. A thirty-second scan rate?	7	CO3	K3
b)	Describe one way that the scan rate for a single RTU could be increased beyond the scan rate for the other RTUs	7	CO3	K2

MODULE -4

17 a)	With neat sketches, explain different types of displays in DCS systems	10	CO4	K2
b)	How an automation pyramid helps in industrial automation?	4	CO4	K2
	OR			
18 a)	With a neat diagram, illustrate the architecture of a DCS.	10	CO4	K2
b)	Write notes on Local Control Unit	4	CO4	K2

MODULE -5

19 a)	Explain the various operator interface requirement in DCS?	7	CO5	K2
b)	What are the guidelines for human factor in operator interface design?	7	CO5	K2
	OR			
20 a)	What is meant by high level operator interface (HLOI)? How does it differ from a Low Level OI?	8	CO5	K2
b)	How do alarm management systems fit into process operating situations?	6	CO5	K2

AET433	Electromagnetic Interference and Compatibility	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to provide the principles of Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) and provide an insight into various techniques and procedures required for the design of electronic systems, which are in compliance with the EMC standards and guidelines.

Prerequisites: Nil

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

CO 1	Explain the fundamentals that are essential for electronics industry in the field of EMI / EMC
CO 2	Illustrate various types of EMI sources and coupling.
CO 3	Describe the different techniques for electromagnetic compatibility.
CO 4	Interpret various EMI standards and organizations.
CO 5	Model a given electromagnetic environment/system so as to comply with the standards.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12
CO 1	3					3						3
CO 2	3					3						3
CO 3	3					3						3
CO 4	3					3						3
CO 5	3	3	3	3	3	3						3

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	20
Understand	K2	30	30	60
Apply	K3	10	10	20
Analyse	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):
Explain the fundamentals that are essential for electronics industry in the field of EMI / EMC.

1. Explain the fundamentals of EMI and EMC.
2. Discuss various types of EMI emission
3. Explain radiation hazards.

Course Outcome 2 (CO2):

Illustrate various types of EMI sources and coupling.

1. Explain various types of electromagnetic sources.
2. Describe different kinds of coupling methods.
3. Discuss on cross talk.

Course Outcome 3 (CO3):
Describe the different techniques for electromagnetic compatibility.

1. Explain the principle of shielding.
2. Explain Murphy’s Law.
3. Describe gasketing and sealing
4. Explain various grounding methods.

Course Outcome 4 (CO4):

Interpret various EMI standards and organizations.

1. Explain general EMI standards for Industrial and residential environment.
2. Discuss about the national and international EMI Standardizing Organizations.
3. Describe electro magnetic emission and susceptibility standards and specifications.

Course Outcome 5 (CO5):

Model a given electromagnetic environment/system so as to comply with the standards.

1. Discuss on various EMI Shielding effectiveness tests.
2. Explain about EMI test receivers.
3. Describe on EMI test wave simulators.

SYLLABUS

Module 1:

Introduction to EMI/EMC:

Electromagnetic spectrum, basics of EMI and EMC, intra and inter system EMI, elements of interference, sources of EMI, conducted and radiated EMI emission and susceptibility, radiation hazards to humans and living cells, various issues of EMC, EMC testing categories.

Module 2:

Electromagnetic Sources and coupling:

Electromagnetic field sources, coupling paths, coupling via the supply network, common mode coupling, differential mode coupling, impedance coupling, inductive and capacitive coupling, radiative coupling, ground loop coupling. cross talk. ESD and EMP.

Module 3:

Electromagnetic Compatibility:

Principle of Shielding and Murphy's Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketing and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems, Surge protection devices, Transient protection.

Module 4:

EMI Standards and Organizations:

General Standards for Residential and Industrial environment, Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC. Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards.

Module 5:

EMI Shielding:

EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, shielded chamber, shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks.

Text Books

1. Clayton Paul, "Introduction to Electromagnetic Compatibility", Wiley Interscience, 2006.
2. Electromagnetic Compatibility Principles and Applications, Yang Zhao, Wei Yan, Jun Sun, Springer 2021
3. V Prasad Kodali, "Engineering Electromagnetic Compatibility", IEEE Press, Newyork, 2001, Printed in India by S. Chand & Co. Ltd., New Delhi, 2000

Reference Books

1. Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons Inc, New York, 2009: ISBN: 978-981-16-6452-6

2. Daryl Gerke and William Kimmel, “EDN’s Designer’s Guide to Electromagnetic Compatibility”, Elsevier Science & Technology Books, 2002
3. W Scott Bennett, “Control and Measurement of Unintentional Electromagnetic Radiation”, John Wiley & Sons Inc., (Wiley Interscience Series) 1997.
4. Dr Kenneth L Kaiser, “The Electromagnetic Compatibility Handbook”, CRC Press 2005.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to EMI/EMC:**	
1.1	Electromagnetic spectrum, basics of EMI and EMC	1
1.2	Intra and inter system EMI, elements of interference	2
1.3	Sources of EMI, conducted and radiated EMI emission and susceptibility	2
1.4	Radiation hazards to humans and living cells	1
1.5	Various issues of EMC, EMC testing categories	1
2	**Electromagnetic Sources and coupling:**	
2.1	Electromagnetic field sources	1
2.2	Coupling paths, coupling via the supply network	1
2.2	Common mode coupling, differential mode coupling	2
2.3	Impedance coupling, inductive and capacitive coupling	1
2.4	Radiative coupling, ground loop coupling, cross talk	2
2.5	ESD and EMP	1
3	**Electromagnetic Compatibility:**	
3.1	Principle of Shielding and Murphy’s Law, LF Magnetic shielding, Apertures and shielding effectiveness.	2
3.2	Choice of Materials for H, E, and free space fields	1
3.3	Gasketing and sealing, PCB Level shielding	1
3.3	Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems	2
3.4	Surge protection devices, Transient protection	1
4	**EMI Standards and Organizations:**	
4.1	General Standards for Residential and Industrial environment	1
4.2	Basic Standards	1
4.3	Product Standards,	1
4.5	National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC..	1
4.6	Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards	2
5	**EMI Shielding:**	
5.1	EMI Shielding effectiveness tests, Open field test	1
5.2	TEM cell for immunity test	1
5.3	shielded chamber, shielded anechoic chamber	1
5.4	EMI test receivers	1

5.5	Spectrum analyzer	1
5.6	EMI test wave simulators	1
5.7	EMI coupling networks	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Program: Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation Engineering

Course Code: AET433

Course Name: Electromagnetic Interference and Compatibility

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	Briefly explain the terms electromagnetic spectrum and radio spectrum.	CO1	K1
2	What is meant by electromagnetic compatibility?	CO1	K2
3	Define and explain transient Coupling.	CO1	K2
4	What is radiated Coupling?	CO1	K2
5	Sate and explain Murphys law.	CO2	K2
6	What is meant by shielding effectiveness?	CO2	K2
7	List out the EMI/EMC civilian standards.	CO4	K1
8	Give the reason why CISPR standards evolved.	CO4	K3
9	What is a TEM Cell?	CO5	K2
10	Illustrate the significance of narrow band testing.	CO5	K3

PART – B
Answer one question from each module; each question carries 14 marks.
Module – I

11.	What are the different types of electromagnetic interference? Explain in detail.	14	CO1	K2
	OR			
12.	Explain in detail the possible harm various electromagnetic frequencies can cause to human cells.	14	CO1	K2

Module – II

13	What is meant by cross talk? How cross talk affects signal to noise ratio in communication systems? What are the methods used to reduce cross talk? Explain in detail.	14	CO2	K2
	OR			

14	Define common mode coupling and differential mode coupling. Explain the practical methods to reduce common mode coupling and differential mode coupling.	14	CO2	K2

Module – III

15	Discuss the shielding mechanism and derive the expression for the attenuation due to single shield and multimedia laminated shield with neat diagrams and equations.	14	CO3	K2
	OR			
16	Explain in detail about the different types of system grounding for electromagnetic interference and compare their performance.	14	CO3	K2

Module – IV

17 a)	Discuss briefly of FCC regulations.	7	CO4	K2
b)	Discuss details about EMI specifications and its limits with respect to civilian and military standards.	7	CO4	K2
	OR			
18	What does the standard MIL 461E emphasize? What are the problems one may face by violating the regulations in it?	14	CO4	K2

Module – V

19 a)	Explain open area test site measurements. What are its limitations?	7	CO5	K2
b)	Write short notes on couplers.	7	CO5	K2
	OR			
20 a)	Explain briefly about the measurements using an anechoic chamber.	7	CO5	K2
b)	With a neat diagram explain the working of a spectrum analyser.	7	CO5	K2

AET443	FPGA Based System Design	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to develop the skill of FPGA based system design.

Prerequisite: ECT 203 LOGIC CIRCUIT DESIGN

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

CO 1	Design simple digital systems with programmable logic devices
CO 2	Analyze the architecture of FPGA
CO 3	Analyze the design considerations of FPGA
CO4	Design simple combinational and sequential circuits using FPGA

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyze	K4			
Evaluate				
Create				

Mark distribution

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

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test(2numbers) : 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 simple digital systems with programmable logic devices.

1. Design a decade counter using Verilog.
2. Implement a full adder using ROM

Course Outcome 2 (CO2): Analyze the architecture of FPGA

1. Compare coarse- and fine-grained FPGA.
2. Explain the architecture of logic block of FPGA

Course Outcome 3 (CO3): Analyze the design considerations of FPGA

1. What are the vendor specific issues in FPGA design.
2. Analyze Timing and Power dissipation in a typical FPGA.

Course Outcome 4 (CO4): Design simple combinational and sequential circuits using FPGA.

1. Implement a counter in Xilinx Virtex.
2. Explain how sequential circuit can be mapped into Xilinx Virtex LUT.

SYLLABUS

Module 1:

Introduction: Digital system design options and tradeoffs, Design methodology and technology overview, High Level System Architecture and Specification: Behavioral modelling and simulation, Hardware description languages (emphasis on Verilog), combinational and sequential design, state machine design, synthesis issues, test benches.

Module 2:

Programmable logic Devices: ROM, PLA, PAL, CPLD, FPGA Features, Limitations, Architectures and Programming. Implementation of MSI circuits using Programmable logic Devices.

Module 3:

FPGA architecture: FPGA Architectural options, granularity of function and wiring resources, coarse V/s fine grained, Logic block architecture: FPGA logic cells, timing models, I/O block architecture: Input and Output cell characteristics, clock input, Timing

Module 4:

Placement and Routing: Programmable interconnect - Partitioning and Placement, Routing resources, delays. Applications -Embedded system design using FPGAs, DSP using FPGAs

Module 5:

Commercial FPGAs: Xilinx (Different series description only), Case study Xilinx Virtex: implementation of simple combinational and sequential circuits.

Text Books

1. FPGA-Based System Design Wayne Wolf, Verlag: Prentice Hall
2. Modern VLSI Design: System-on-Chip Design (3rd Edition) Wayne Wolf, Verlag

Reference Books

1. Field Programmable Gate Array Technology - S. Trimberger, Edr, 1994, Kluwer Academic
2. Digital Design Using Field Programmable Gate Array, P.K. Chan & S. Mourad, 1994, Prentice Hall
3. Field programmable gate array, S. Brown, R.J. Francis, J. Rose, Z.G. Vranesic, 2007, BS

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction**	
1.1	Digital system design options and tradeoffs	1
1.2	Design methodology and technology overview	1
1.3	High Level System Architecture and Specification: Behavioral modelling and simulation	2
1.4	Hardware description languages, combinational and sequential design	2
1.5	State machine design, synthesis issues, test benches.	2
2	**Programmable logic Devices**	
2.1	ROM, PLA, PAL, CPLD	2
2.2	FPGA Features, Limitations, Architectures and Programming.	2
2.3	Implementation of MSI circuits using Programmable logic Devices.	3
3	**FPGA architecture**	
3.1	FPGA Architectural options	1
3.2	Granularity of function and wiring resources, coarse V/s fine grained	2
3.3	Logic block architecture: FPGA logic cells, timing models	2
3.4	I/O block architecture: Input and Output cell characteristics, clock input, Timing	2
4	**Placement and Routing**	
4.1	Programmable interconnect - Partitioning and Placement	1
4.2	Routing resources, delays	2
4.3	Applications -Embedded system design using FPGAs, DSP using FPGAs	3
5	**Commercial FPGAs**	
5.1	Xilinx (Different series description only)	1
5.2	Case study Xilinx Virtex	3
5.3	Implementation of simple combinational and sequential circuits	3

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B. TECH. DEGREE EXAMINATION,

(**Model Question Paper)**

Program: Applied Electronics & Instrumentation/Electronics & Instrumentation

Course Code: AET443

Course Name: FPGA Based System Design

Max. Marks: 100 Duration: 3Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	What are the synthesis issues in FPGA design.	K2
2	Describe FPGA design methodology.	K2
3	Differentiate PLA with PAL	K2
4	What are the limitations of FPGA.	K2
5	Compare coarse- and fine-grained FPGA architecture.	K2
6	What are the timing models in logic block architecture.	K2
7	List the applications of FPGA.	K2
8	Describe routing resources in FPGA routing.	K2
9	Describe how a combinational circuit can be mapped into Xilinx Virtex LUT.	K2
10	List different commercially available FPGAs.	K2

PART – B

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

Module – I

11. a)	Design a full adder using Verilog.	7	CO1	K3
b)	Explain behavioral modeling and simulation with an example.	7	CO1	K2

OR

12.a)	What is FSM? How it is used for FPGA.	7	CO1	K2
b)	Explain the purpose of test bench and how it is written in a HDL.	7	CO1	K2

Module – II

13 a)	Design the function F=XYZ’+Y’ Z+X Y’ using PLA	8	CO2	K3
b)	Compare CPLD with FPGA	6	CO2	K2

OR

14 a)	Implement the following Boolean function using PAL: F(w, x, y, z) = Σm (0, 2, 4, 10, 11, 12, 14, 15)	8	CO2	K3
b)	Draw the structure of PAL and explain it.	6	CO2	K2

Module – III

15 a)	Draw and explain I/O block architecture of FPGA.	7	CO2	K2
b)	Draw and explain coarse grained FPGA architecture.	7	CO2	K2
	OR			
16 a)	Explain timing in Logic block and I/O block.	7	CO2	K2
b)	Draw and explain fine grained FPGA architecture.	7	CO2	K2

Module – IV

17 a)	Explain partitioning and placement processes in FPGA	8	CO4	K2
b)	Explain embedded system design using FPGAs	6	CO4	K2
	OR			
18 a)	Explain the delays associated with placement and routing	7	CO4	K2
b)	Explain DSP design using FPGAs	7	CO4	K2

Module – V

19 a)	With neat diagram explain the architecture of Xilinx Virtex IOB.	7	CO3	K2
b)	Design a four bit up counter with parallel load feature using Xilinx Virtex.	7	CO3	K3
	OR			
20 a)	Explain the mapping of combinational and sequential circuits using LUTs.	5	CO3	K3
b)	Explain the architecture of Xilinx Virtex CLB	9	CO3	K2

AET453	PYTHON FOR SIGNAL AND IMAGE PROCESSING	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to be a bridge the fields of programming and signal processing

Prerequisite:
MAT 101 LINEAR ALGEBRA AND CALCULUS
ECL201 SCIENTIFIC COMPUTING LAB
AET302 DIGITAL SIGNAL PROCESSING

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

CO 1	Solve general scientific and engineering problems using python tool chain (K2)
CO 2	Make use of Python to explore topics in linear algebra and probability (K2)
CO 3	Make use of Python to explore topics in DSP (K3)
CO4	Make use of Python to explore topics in Image Processing (K3)

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyse	K4			
Evaluate				
Create				

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Solve general scientific and engineering problems using python tool chain (K2)

1. Write a Python program that utilizes a function to square each element of a list.
2. Write Python code to generate a random array of 10 numbers. Pick the number closest to 0.75.
3. Write Python code to create an array for variable x consisting of 100 values from 0 to 20. Compute y=sin(x) and plot y vs. x with a blue line. Next, using boolean indexing, replace all values of y that are larger than 0.5 by 0.5, and all values that are smaller than -0.75 by -0.75, and plot the modified y values vs. x using a red line on the same graph.

Course Outcome 2 (CO2): Make use Python to explore topics in linear algebra and probability (K2)

1. Explain the use of ordinary least squares to find an approximate solution to overdetermined systems
2. Explain SVD and the appropriate functions in scipy.linalg to accomplish SVD factorization
3. Generate 1000 realizations of X and Y where X and Y are independent zero mean Gaussian random variables with a common variance. Using histogram method, estimate the pdf of $Z = \sqrt{X^2 + Y^2}$

Course Outcome 3 (CO3): Make use Python to explore topics in DSP (K3)

1. Explain the different ways in which filter coefficients can be represented in Python and illustrate with an example transfer function
2. How can we use a Periodogram for spectral estimation? Give Python code example

Course Outcome 4 (CO4): Make use to Python to explore topics in Image Processing (K3)

1. Write Python code to generate a 5x4 RGB image which shows the letter H in red color in a green background

SYLLABUS

Module 1:

Introduction, How to Run Python Code, Basic Python Syntax, Python Semantics: Variables and Objects, Python Semantics: Operators, Built-In Scalar Types, Built-In Data Structures, Control Flow Statements, Defining and using Functions, Errors and Exceptions, Iterators, List Comprehensions, Generators and Generator Expressions, Modules and Packages, Strings and Regular Expressions

Module 2:

IPython: Beyond Normal Python, Introduction to NumPy: The Basics of NumPy Arrays , Computation on NumPy Arrays: Universal Functions, Aggregations: Min, Max, and Everything In Between, Computation on Arrays: Broadcasting, Comparisons, Masks, and Boolean Logic, Fancy Indexing, Sorting Arrays, Structured Data: NumPy's Structured Arrays-Functions in numpy.random-Numpy random generator-Simple random data, Perumutations, Distributions. Visualization with Matplotlib**:** Simple Line Plots, Simple Scatter Plots, Histograms, Binnings, and Density

Module 3:

Familiarization and usage of functions in scipy.linalg: Finding the inverse, Solving a linear system, Finding the determinant, Computing norms, Solving linear least-squares problems and pseudo-inverses, Generalized inverse, Decompositions- Eigenvalues and eigenvectors, Singular value decomposition, LU decomposition, Cholesky decomposition, QR decomposition, Schur decomposition, Matrix functions-Exponential and logarithm functions, Trigonometric functions, Hyperbolic trigonometric functions, Arbitrary function.

Module 4:

Familiarization and usage of functions in scipy.signal and scipy.fft –B-splines, Filtering-convolution, correlation, difference equation filtering, analysis of linear systems, Filter design-FIR filter design by windowing, IIR filter design, Filter Coefficients, Transfer function representation, Zeros and poles representation, Second-order sections representation, Spectral Analysis-Periodogram Measurements, Spectral Analysis using Welch's Method, Detrend, 1D DFT and 1D DCT

Module 5:

Familiarization and usage of functions in scikit-image: NumPy for images, Image data types, Input types, Output types, Working with OpenCV, Image processing pipeline, Rescaling intensity values, Image adjustment: transforming image content, Conversion between color models, Conversion between color and gray values, Image inversion, Painting images with labels, Contrast and exposure, Histogram Equalization, Geometrical transformations of images, Cropping, resizing and rescaling images, Projective transforms (homographies), Image Segmentation, Edge-based segmentation, Region-based segmentation

Text Books

1. A Whirlwind Tour of Python by Jake VanderPlas, 2016 (available freely at https://jakevdp.github.io/WhirlwindTourOfPython/
2. Python Data Science Handbook by Jake VanderPlas, 2017 (available freely at https://jakevdp.github.io/PythonDataScienceHandbook/)
3. Python for Data Analysis by Wes McKinney, O'Reilly

References

1 https://numpy.org/doc/stable/reference/random/generator.html

2 Scipy.linalg tutorial: https://docs.scipy.org/doc/scipy/tutorial/linalg.html

3 Scipy.signal tutorial: https://docs.scipy.org/doc/scipy/tutorial/signal.html

4. Scipy.fft tutorial: https://docs.scipy.org/doc/scipy/tutorial/fft.html
5. Scikit-image user guide: https://scikit-image.org/docs/stable/user_guide.html
6. Hands-on Signal Analysis with Python by Thomas Haslwanter, Wiley

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1.1	Introduction, How to Run Python Code, Basic Python Syntax, Python Semantics: Variables and Objects, Python Semantics:	**2**
1.2	Operators, Built-In Scalar Types, Built-In Data Structures, Control Flow Statements	**2**
1.3	Defining and using Functions, Errors and Exceptions, Iterators, List Comprehensions	**2**
1.4	Generators and Generator Expressions, Modules and Packages, Strings and Regular Expressions	**2**
2.1	IPython: Beyond Normal Python, Introduction to NumPy: The Basics of NumPy Arrays	**2**
2.2	Computation on NumPy Arrays: Universal Functions, Aggregations: Min, Max, and Everything In Between, Computation on Arrays: Broadcasting, Comparisons	**2**
2.3	Masks, and Boolean Logic, Fancy Indexing, Sorting Arrays, Structured Data: NumPy's Structured Arrays	**2**
2.4	Functions in numpy. random-Numpy random generator-Simple random data, Permutations, Distributions.	**1**
2.5	Visualization with Matplotlib**:** Simple Line Plots, Simple Scatter Plots, Histograms, Binnings, and Density	**1**
3.1	Familiarization and usage of functions in scipy.linalg: Finding the inverse, Solving a linear system	**2**
3.2	Finding the determinant, computing norms, solving linear least-squares problems and pseudo-inverses, Generalized inverse	**2**
3.3	Decompositions- Eigenvalues and eigenvectors, Singular value decomposition, LU decomposition, Cholesky decomposition, QR decomposition, Schur decomposition,	**2**
3.4	Matrix functions-Exponential and logarithm functions, Trigonometric functions, Hyperbolic trigonometric functions, Arbitrary function.	**1**
4.1	Familiarization and usage of functions in scipy.signal and scipy.fft –B-splines, Filtering- convolution, correlation, difference equation filtering, analysis of linear systems,	**1**
4.2	Filter design-FIR filter design by windowing, IIR filter design, Filter Coefficients	**2**
4.3	Transfer function representation, Zeros and poles representation, Second-order sections representation	**1**
4.4	Spectral Analysis- Periodogram Measurements, Spectral Analysis using Welch's Method, Detrend	**1**
4.5	1D DFT and 1D DCT	**1**
5.1	Familiarization and usage of functions in scikit-image: NumPy for images, Image data types, Input types, Output types,	**1**
5.2	Working with OpenCV, Image processing pipeline, Rescaling intensity values, Image adjustment: transforming image content, Conversion between color models, Conversion between color and gray values, Image inversion	**1**

5.3	Painting images with labels, Contrast and exposure, Histogram Equalization, Geometrical transformations of images, Cropping, resizing and rescaling images, Projective transforms (homographies)	**2**
5.4	Image Segmentation, Edge-based segmentation, Region-based segmentation	**2**

Assignment:

Two assignments based on theory or coding or combined.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Program: Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation Engineering

Course Code: AET453

Course Name: Python for Signal and Image Processing

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1. Everything in Python is an object. Justify this statement.
2. Write a function that returns the minimum of a list. Illustrate the function with a complete Python script.
3. Give a code example of Numpy broadcasting which allows us to do arithmetic on different sized arrays.
4. Write Python code to generate and plot a noisy sinewave.
5. Explain LU decomposition of an mxn matrix A.
6. What is the significance of generalized inverse of a matrix?
7. Explain with appropriate functions, how difference equation filtering can be done using Python
8. What are the advantages of DCT over DFT? Explain.
9. What conversion is needed when skimage uses an image created in OpenCV? Give code example.
10. What are the common datatypes used when working with images?

PART – B

Answer one question from each module; each question carries 14 marks-each sub-question carries 7 marks

Module – I

11.

a. The current flowing through a semiconductor diode is given by the equation $\boldsymbol{i} = \boldsymbol{I_0}\left(\boldsymbol{e^{\frac{qv}{kT}}} - \mathbf{1}\right)$ where
i= current through the diode, A
v=voltage across the diode, V
I_0=reverse saturation current, A
q=electronic charge=$1.602\text{x}10^{-19}$, C
k= Boltzmann's constant, $1.38\text{x}10^{-23}$ joule/K
T=temperature, K
The reverse saturation current of a diode is $\boldsymbol{1nA}$. Write a program to calculate the current flowing through this diode for all voltages from 0.3 V to 0.6 V, in 0.01 V steps. Repeat this process for the following temperatures: 290K and 310K, and 330K. Create a plot of the current as a function of applied voltage, with the curves for the three different temperatures appearing as different colors.

b. What is the difference between Python modules and packages?

OR

12.

a. A voltage source V=120V with an internal resistance Rs=50Ω supplies a load resistance RL . Plot the power supplied to the load resistance as a function of the load resistance RL. Also find the maximum power supplied to the load. Write the program using for loop and without using for loop.

b. Explain how errors can be handled in Python.

Module II

13.

a. Write a function that calculates the Taylor series approximation to a sine and a cosine, to second order. Write a script which plots the exact values, and superposes them with approximate values, in a range from –50 deg to +50 deg. Save the resulting image to a PNG-file.

b. What do you mean by fancy indexing in Numpy? Illustrate with an example.

OR

14.

a. Write code to generate 1000 realizations of $Y=X^2$ where X is standard normal. How will you estimate the pdf of Y using histogram method?

b. What do you mean by seeding a random number generator? Why is seeding often used in experimentation.

Module III

15.

a. What are the different norms available in scipy.linalg? Explain.

b. Explain LU decomposition and the corresponding functions in scipy.linalg.

OR

16.

a. What do you mean by eigenvalues and eigenvectors? How can they be computed using functions in scipy.linalg?

b. Explain QR decomposition and how to use functions in scipy.linalg to perform QR decomposition.

Module IV

17.

a. Write a Python program to design an FIR low pass filter with a length of 50 coefficients. Assume sampling frequency=16KHz and cut-off frequency = 1KHz. Plot its impulse response and magnitude response. Use Hamming window

b. What are the advantages of Welch method of periodogram computation? Illustrate with a code example.

OR

18.

a. Explain how B-splines can be used to construct an approximation to a continuous function. Give code example also.

b. Why is it better to represent a high order filter as a cascade of second order sections? Give code example to represent a transfer function as second order sections.

Module V

19.

a. Explain the different color models in scikit-image with code examples
b. What is homography? What are the different homographies in scikit-image? Explain using code examples.

OR

20.

a. Explain histogram equalization with code example
b. Explain different segmentation techniques in scikit-image using code examples.

AET463	COMPUTER NUMERICAL CONTROL	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble:
This course will help the student to understand the concept of numerical control and the peripheral requirements of the NC system. It familiarizes the different approaches of machining using numerical control and also to make the student familiar to the different programming methods of NC machines.
Prerequisite: Nil

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

CO 1	Explain the structure of numerical control and its applications
CO 2	Illustrate the features and control of CNC
CO 3	Develop numerical part program of simple machining
CO 4	Summarize the structure of computer assisted part programming features
CO 5	Identify constructional and automated features of numerical controlled machining

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	30	30	60
Apply	10	10	30
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1):
Explain the structure of numerical control and its applications (K2)
1. Describe the structure of NC system
2. Enumerate difference between ordinary and NC Machine tools.

Course Outcome 2 (CO2):
Illustrate the features and control of CNC (K2)
1. Differentiate open and closed loop control system
2. Enlist features of CNC and DNC system

Course Outcome 3 (CO3):
Develop numerical part program of simple machining (K3)
1. Define the structure of CNC part programme
2. Enlist the procedure of manual programming for simple parts

Course Outcome 4 (CO4): Summarize the structure of computer assisted part programming features (K2)
1. Enumerate the structure of computer assisted part programming.
2. Enlist the procedure of APT programming for simple parts.

Course Outcome 5 (CO5): Identify constructional and automated features of numerical controlled machining (K2)
1. Enumerate the constructional features of CNC machines.
2. Describe working principle of different sensors and feedback devices used in CNC machines

Syllabus

Module 1

Principles of Numerical Control Structure of NC systems, Applications of CNC machines in manufacturing, Advantages of CNC machines. Historical developments and future trends. Future of NC Machines, Difference between ordinary and NC Machine tools.

Module 2

Fundamentals of numerical control, advantages of NC systems, classification of NC systems, point to point and contouring systems. Incremental and absolute systems open loop and closed loop systems. Features of CNC Systems, Direct Numerical Control (DNC), Standard Controllers and General Programming features available in CNC Systems, Adaptive control systems.

Module 3

NC Part Programming: Axis identification and coordinate systems, Structure of CNC part program, Programming codes, Programming for 2 and 3 axis control systems, Part programming: Manual part programming, Preparatory and miscellaneous codes, Interpolation and canned cycle, Tool compensation, Simple programming exercises on turning, milling and drilling.

Module 4

Computer aided programming, concepts, APT programming, part programming examples. Geometric definitions, cutter motion definitions post processor statements, use of canned cycles, Generation of NC Programmes through CAD/CAM systems.

Module 5

Constructional Details of CNC Machines: Machine structure, Slide ways, ball screws and guideways, swarf removal and safety considerations, Automatic tool changers and multiple pallet systems, Sensors and feedback devices in CNC machines.

Text Books

1. Radhakrishnan, P., "Computer Numerical Control Machines", New Central Book Agencies
2. Mikell P. Groover., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall.

Reference Books

1. Yoram Koren, "Computer Control of Manufacturing Systems", Tata McGraw Hill Book Co.,2005.

2. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi,1998.

Course Contents and Lecture Schedule

No	Topic	No. of lectures
1	Module-1- **Principles of Numerical Control**	**6 Hours**
1.1	Structure of NC systems, Applications of CNC machines in manufacturing,	2 Hr
1.2	Advantages of CNC machines. Historical developments and future trends.	1 Hr
1.3	Future of NC Machines	1 Hr
1.4	Difference between ordinary and NC Machine tools.	2 Hr
2	**Module 2-Control of NC Systems:**	**7 Hours**
2.1	Classification of CNC control systems	1 Hr
2.2	Open and Closed loop systems	1 Hr
2.3	Features of CNC Systems,	1 Hr
2.4	Direct Numerical Control (DNC), Standard Controllers and General Programming features available in CNC Systems	2 Hr
2.5	Adaptive control systems.	2 Hr
3	**Module-3- NC Part Programming**	**9 Hours**
3.1	Axis identification and coordinate systems	1 Hr
3.2	Structure of CNC part program, Programming codes	2 Hr
3.3	Programming for 2 and 3 axis control systems	1 Hr
3.4	Preparatory and miscellaneous codes	1 Hr
3.5	Interpolation and canned cycle, Tool compensation	1 Hr
3.6	Simple programming exercises on turning, milling and drilling.	3 Hr
4	Module-4- **Computer aided part programming**;	**7 Hours**
4.1	Tools for computer aided part programming	2 Hr
4.2	Computer aided NC Programming in APT language	2 Hr
4.3	use of canned cycles	1 Hr
4.4	Generation of NC Programmes through CAD/CAM systems	2 Hr
5	**Module-5- Constructional Details of CNC Machines: Tooling of CNC Machines**	**6 Hours**
5.1	Machine structure, Slide –ways , ball screws and guideways	2 Hr
5.2	Swarf removal and safety considerations	1 Hr
5.3	Automatic tool changers and multiple pallet systems	1 Hr
5.4	Sensors and feedback devices in CNC machines	2 Hr

MODEL QUESTION PAPER
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SEVENTH SEMESTER B. TECH DEGREE EXAMINATION
Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation Engineering
Course Code: AET 463
Course Name: COMPUTER NUMERICAL CONTROL

Max. Marks: 100 Duration: 3 Hours

PART – A
(ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 3 MARKS)

1. How does the structure of NC/CNC machine tools differ from conventional machine tools?
2. Explain clearly the difference between NC and CNC machine.
3 Differentiate open loop and closed loop system in CNC machine.
4 Enumerate advantages and disadvantages of Direct numerical control
5 What is GO2 and GO3 in circular interpolation.
6 What is tool nose radius compensation and how to use it.
7 What is CAPP and discuss the benefits of CAPP
8 Discuss the code is used for canned cycle definition
9 Explain briefly swarf removal process in CNC machine.
10 What are the functions of guideways?

PART – B
(ANSWER ONE FULL QUESTION FROM EACH MODULE)

Module- 1

11 a) With schematic diagram explain the basic principal of numerical control. (8 Marks)
b) Explain the historical development of numerical controlled machining (6Marks)
12 a) Explain the applications of CNC machines in manufacturing (7 Marks)
b) Enlist and describe the advantages and disadvantages of CNC Machine (7 Marks)

Module-2

13 a) Describe the basic system of CNC machine tool (7Marks)
b) Explain the classification of NC system. (7Marks)
14 a) What is adaptive control system in CNC machining and what are its benefit (7Marks)
b) Describe the standard controllers of CNC machines . (7Marks)

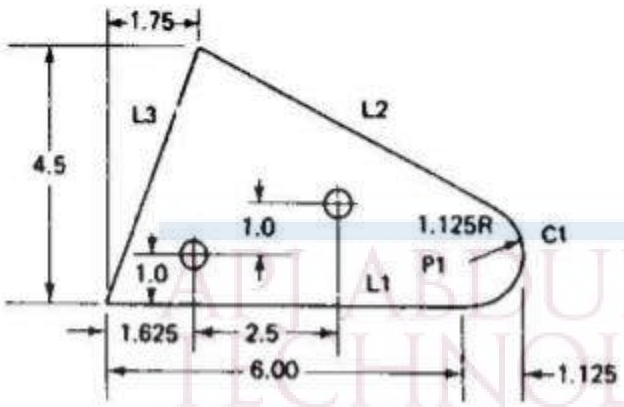
Module-3

15 a) Explain the structure of NC part program (7Marks)
b) Describe the various programing functions of NC machining (7Marks)

16 a) Explain the fundamental element for developing manual part programme. (7Marks)
b) Describe various G code and M codes of NC programming. (7Marks)

Module-4

17 Write the APT program of a given basic geometry element (14Marks)



18 a) Briefly explain the four types of statements in APT language. (8Marks)

b) Explain the generation of NC program through CAD/CAM system (6Marks)

Module-5

19 a) Explain Automatic tool changers and multiple pallet systems in CNC system.(7Marks)

b) Explain the working of an optical absolute encoder. How the number of tracks and sectors of absolute encoder is related to the resolution of the encoder? (7Marks)

20 a) Explain the working of recirculating ball screws with a neat sketch. (6Marks)

b) Explain briefly the following

i) Hydrostatic guideways ii) Aerostatic guideways. (8Marks)

AET 473	DATA STRUCTURES AND ALGORITHMS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course helps the student to have an idea of Data Structures and Algorithms. Students are introduced to the basic design consideration of algorithms. Discussion on various data structures, algorithms and their applications are also included as part of the course to get an overall idea on this topic.

Prerequisite: Nil

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

CO 1	Analyse various data structures and their applicability
CO 2	Use appropriate data structures like arrays, linked lists, stacks and queues to solve real world problems efficiently.
CO 3	Comprehend and implement various techniques for searching and sorting
CO 4	Represent and manipulate data using nonlinear data structures like trees and graphs to design algorithms for various applications.
CO 5	Identify the appropriate data structure to design efficient algorithm for the given application
CO 6	Illustrate various hashing techniques.

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	**3**	2										3
CO 2	3	2										3
CO 3	3	2										3
CO 4	**3**	3	3									3
CO 5	**3**	3	3									3
CO 6	**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
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. Differentiate between primitive and non-primitive data structures with the help of examples.
2. What do you mean by asymptotic notations?

Course Outcome 2 (CO2):

1. Differentiate between stacks and queues.

Course Outcome 3 (CO3):

1. Differentiate between linear search and binary search.
2. What are hash tables?

Course Outcome 4 (CO4):

1. What is breadth-first search?
2. What are the internal and external sorting algorithms?

Course Outcome 5 (CO5):

1. Characteristics of dynamic programming.
2. What is backtracking

Syllabus

Module I

Introduction to Data Structures: Basic Terminology, Elementary Data Structure Organization, Classification of Data Structures: Primitive and Non-primitive, Linear and Non-linear, Operations on Data structures, Asymptotic notations, Notion of recursive algorithms, Recurrence relations

Module II

Linear Data Structures: Introduction, variations, operations and applications of array, queue, stack and linked list

Array: Representation of arrays, Applications of arrays, sparse matrix and its representation.

Stack: Stack-Definitions & Concepts, Operations on Stacks, Applications of Stacks, Polish Expression, Reverse Polish Expression and Their Compilation, Recursion, Tower of Hanoi

Queue: Representation of Queue, Operations on Queue, Circular Queue, Priority Queue, Array representation of Priority Queue, Double Ended Queue, Applications of Queue

Linked lists: - singly linked list, doubly linked list, Circular linked list, operations on linked list, linked list with header nodes

Module III

Non-Linear Data Structures: Concepts and types of trees, tree traversal algorithms, search trees, Priority queue implementation and applications
Graph-Matrix Representation of Graphs, Elementary Graph operations, (Breadth First Search, Depth First Search, Spanning Trees, Shortest path, Minimal spanning tree).

Module IV

Indexing structure: Concepts and implementations of B-Tree, B+ tree, Hashing, Dictionary

Graph Algorithms: Depth-first search, strongly connected components, Breadth-first search, Dijkstra's algorithm

Searching and Sorting Algorithms: Linear search, Binary search, Hash tables, internal and external sorting algorithms, sorting without comparison.

Module V

Algorithm Design: Greedy algorithm, Divide and conquer, Dynamic programming, Backtracking, Branch and bound, Randomized algorithms

Algorithm Analysis: Asymptotic notations, Recurrences, NP complete problems

Text Books

1. Samanta D., Classic Data Structures, Prentice Hall India, 2/e, 2009.
2. Richard F. Gilberg, Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, 2/e, Cengage Learning, 2005.
3. Aho A. V., J. E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson Publication,1983.

Reference Books

1. Horwitz E., S. Sahni and S. Anderson, Fundamentals of Data Structures in C, University Press (India), 2008.
2. Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill, 1995.
3. Peter Brass, Advanced Data Structures, Cambridge University Press, 2008
4. Wirth N., Algorithms + Data Structures = Programs, Prentice Hall, 2004.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**MODULE 1**	
1.1	Introduction to Data Structures: Basic Terminology, Elementary Data Structure Organization	2
1.2	Classification of Data Structures: Primitive and Non-primitive, Linear and Non-linear	2
1.3	Operations on Data structures, Asymptotic notations, Notion of recursive algorithms, Recurrence relations	2
2	**MODULE 2**	
2.1	Introduction, variations, operations and applications of array, queue, stack and linked list, operations and applications of array, queue, stack and linked list	2
2.2	Array: Representation of arrays, Applications of arrays, sparse matrix and its representation.,	2
2.3	Stack: Stack-Definitions & Concepts, Operations On Stacks, Applications of Stacks, Polish Expression, Reverse Polish Expression And Their Compilation, Recursion, Tower of Hanoi	2
2.4	Queue: Representation Of Queue, Operations On Queue, Circular Queue, Priority Queue, Array representation of Priority Queue, Double Ended Queue, Applications of Queue	2
2.5	Linked lists:- singly linked list, doubly linked list, Circular linked list, operations on linked list, linked list with header nodes	2
3	**MODULE 3**	
3.1	Concepts and types of trees, tree traversal algorithms, search trees	2
3.2	Priority queue implementation and applications	2
3.3	Graph-Matrix Representation Of Graphs, Elementary Graph operations, (Breadth First Search, Depth First Search, Spanning Trees, Shortest path, Minimal spanning tree).	3
4	**MODULE 4**	
4.1	Indexing structure: Concepts and implementations of B-Tree, B+ tree, Hashing, Dictionary	2
4.2	Graph Algorithms: Depth-first search, strongly connected components,	2

	Breadth-first search, Dijkstra's algorithm	
4.3	Searching and Sorting Algorithms**:** Linear search, Binary search, Hash tables, internal and external sorting algorithms, sorting without comparison.	2
5	**MODULE 5**	
5.1	Algorithm Design: Greedy algorithm, Divide and conquer, Dynamic programming, Backtracking, Branch and bound, Randomized algorithms	4
5.2	Algorithm Analysis : Asymptotic notations, Recurrences, NP complete problems	4

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
Estd.
2014

MODEL QUESTION PAPER

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

Programme: Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation Engineering
Course Code: AET 473

Course Name: Data Structures and Algorithms

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries 3 marks. Marks

1	What do you mean by asymptotic notations? Explain briefly about the asymptotic notations that are commonly used to calculate the running time complexity of an algorithm?	(3)
2	Differentiate between primitive and non-primitive data structures with the help of examples	(3)
3	Write an algorithm/pseudocode to delete a given element k from an array A of n elements? Assume that the element k is always present in A.	(3)
4	How will you represent a polynomial 3x2 +2xy2 +5y3 +7yz using a singly linked list?	(3)
5	Draw the binary tree whose sequential representation is given below.	(3)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	B	C	D	—	E	F	—	G	—	—	H	—	—	I

6	Define (i) Tree (ii) Binary Tree.	(3)
7	Explain efficiency of (i) Quick sort (ii) Binary searching.	(3)
8	Write an algorithm to search for a substring in a given string.	(3)
9	Explain backtracking with an example.	(3)
10	What are the steps in dynamic programming?	(3)

PART B

Answer any one full question from each module, each carries14 marks.

MODULE I

11	a)	Explain in detail the substitution method for solving recurrence relations	(7)
	b)	Explain the operations on Data structures with examples.	(7)
12	a)	What is a recursive algorithm? Explain different types of recursive algorithms with examples.	(6)
	b)	Explain linear and nonlinear data structures.	(8)

MODULE II

13	a)	Assume that a stack is represented using a linked list. Write algorithms for the following operations: - (i) Push (ii) Pop	(7)
	b)	Explain the structure of Doubly Linked List (DLL). Differentiate the difference between DLL and Doubly Circular Linked List (DCLL). Explain the procedures to insert a node in DLL at the beginning and at the last.	(7)

14	a)	Write algorithms to perform the following operations on a doubly linked list. (i) Insert a node with data ‘y’ after a node whose data is ‘x’. (ii) Delete a node whose data is ‘s’ . (iii) Insert a node with data ‘a’ as the 1st node of the list.	(7)
	b)	Explain different types of queues and their applications.	(7)

MODULE III

15	a)	Which are the elementary graph operations? Explain in detail.	(7)
	b)	What is a priority queue? Implement using a linked list.	(7)
16	a)	Explain the various ways in which a graph can be represented bringing out the advantages and disadvantages of each representation.	(7)
	b)	Explain various tree traversal algorithms with examples.	(7)

MODULE IV

17	a)	Write an algorithm to perform selection sort in an array. Using the above selection sort algorithm, sort the input file [25, 7, 46, 11, 85].	(6)
	b)	With the help of an algorithm/pseudocode and suitable example, explain how you would perform binary search on an array of n elements. Find the time complexity of binary search algorithm.	(8)
18	a)	Explain in brief how the shortest path is calculated using Dijkstra’s algorithm.	(7)
	b)	Write an algorithm to perform binary search on a given set of ‘n’ numbers. Using the algorithm search for the element 23 in the set [12, 23, 34, 44, 48, 53, 87, 99]	(7)

MODULE V

19	a)	Explain divide-and-conquer approach in detail.	(7)
	b)	Explain greedy algorithm with example. Also explain its advantages and disadvantages.	(7)
20	a)	Explain dynamic programming in detail with example.	(7)
	b)	What is meant by NP-complete problems? Explain in detail with examples. What are the techniques that can be applied to solve computational problems in general?	(7)

****

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
AET415	INSTRUMENTATION SYSTEMS	OEC	2	1	0	3

Preamble: The syllabus is prepared with a view of giving the student a broad overview of the basic elements of an electronic measurements and instrumentation systems.

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	3											3
CO2	3	2										3
CO3	3				2							3
CO4	3				2							3
CO5	3											3

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 contains 5 questions with 4 questions (not exceeding 2 questions from each module). Part B contains 2 questions from each module out of which one to be answered. Each question carries 10 mark and can have 2 to 3 sub-divisions.

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): With suitable diagram explain the functioning of a strip chart recorder.

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.

Module 3
Transducers, principles and applications of basic transducers: LVDT, temperature sensors, thermocouples, RTD, LDR, displacement transducers, strain gauges, accelerometers, piezo electric transducers.

Module 4
DC bridges: introduction, sources and detectors for DC bridges. General equation for bridge at balance. Types of bridges –Wheatstone, Kelvin 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.

Text Books

1. David A Bell, Electronic Instrumentation and Measurements , 3rd 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**	**8**
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	3
2	**Indicating instruments**	**6**
2.1	Deflection type meters	3
2.2	Thermal, electrostatic and rectifier types of meters	3
3	**Transducers**	**7**
3.1	Introduction to transducers	2
3.2	LVDT, temperature sensors, thermocouples,	2
3.3	RTD, LDR, displacement transducers	1
3.4	strain gauges, accelerometers, piezoelectric transducers	2
4	**Bridges**	7
4.1	Introduction to bridges	1
4.2	General equation for bridge at balance.	2
4.3	DC bridges: Types of bridges –Wheatstone, Kelvin bridge	2
4.4	AC bridges: Maxwell's inductance and Maxwell's inductance - capacitance bridge, Anderson bridge, Shering bridge	2
5	**Oscilloscopes and Plotters**	6
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

Model Question paper
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET415

Course Name: Instrumentation Systems

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	What are the differences between terms accuracy and precision?	CO1	K2
2.	What are the reasons for the development of errors in measuring devices?	CO2	K2
3.	Explain rectifier type of deflection meters.	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 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 an X-Y plotter	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 of 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 piezoelectric transducer? Explain in detail.	7	CO4	K2
b)	What is the importance of load cells in measurements? Explain the factors on which the sensitivity of a load cell depends.	7	CO4	K2

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 suitable diagram explain the functioning of a strip chart recorder.	14	CO5	K2

AET425	BIOMEDICAL ENGINEERING	CATEGORY	L	T	P	CREDIT
		OEC	2	1	0	3

Preamble:

This course will introduce aspects of biomedical engineering to describe biological systems described using engineering principles and modern diagnosing equipment.

Prerequisite: NIL

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

CO1	Describe the basic idea about the biomedical engineering technology.
CO2	Explain the principle and working of different types of bio medical electronic equipment/device
CO3	Understand the electrical muscle activities and to measure it.
CO4	Analyze the brain wave activities and abnormalities.
CO5	Illustrate the principles of modern medical diagnosing machines.

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End semester examination
	I	II	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyze			
Evaluate			
Create			

Mark distribution

Total marks	CIE	ESC	ESC Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Syllabus

Module 1
Introduction to biomedical engineering, Sources of biomedical signals, General characteristics of biomedical signals, Examples of biomedical signals. Objective of biomedical signal analysis, Difficulties of biomedical signal analysis.
Bio signals acquisition: Acquisition of biomedical signals like ECG, EMG, EEG, and EGG (concept only)

Module 2
Basic medical instrumentation system, Intelligent medical instrumentation system. Biomedical Recorders: Electrocardiograph, VCG, PCG, EEG, EMG and other biomedical recorders.
Electrocardiogram: Generation of ECG, pacemakers – natural & ectopic, waveforms and their significance. Diagnostics value of ECG, ECG machine – Block diagram - Artifacts in ECG recording. Arrhythmias – rate abnormalities, AV conduction block, premature contractions, flutter, fibrillation.

Module 3
Electrical activity of muscles- EMG. Measurement of EMG - block diagram of EMG machine. Applications of EMG - myoelectric control system. Electrodes for measurement of bio potentials– ECG, EEG & EMG electrodes. Basics of other bio potentials – ENG, ERG, EOG, EGG.

Module 4
Electroencephalogram - brain waves, sleep stages, Abnormal EEGs – epilepsy. Measurement of EEG - 10-20 electrode system, block diagram of EEG machine. Applications of EEG.
Biomedical Telemetry system: Components of biotelemetry system, application of telemetry in medicine. Single channel telemetry system for ECG.

Module 5
Introduction to modern imaging systems: X-ray machines, Nuclear medical imaging, Magnetic resonance imaging, Ultrasonic imaging, Computed Tomography and thermal imaging systems.
Recording Systems: Basic recording systems, general condition for signal conditioners, sources of noise in law level measurement.

Text Books

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata Mc Graw Hill
2. Rangaraj M Rangayyan, Biomedical Signal analysis – a case study approah

References:

1. Arthur C. Guyton “Textbook of Medical Physiology”, Prism Books (Pvt) Ltd & W.B. Saunders Company.1991
2. John G. Webster: “Medical Instrumentation -Application and Design” ; Houghton Mifflin Co., Boston.1992
3. Geddes & Baker, “Principles of Applied Biomedical Instrumentation”, John Wiley 3 rd edition 1989
4. Webb, S. “The Physics of Medical Imaging”, Institute of Physics Publishing, Bristol, 1992.

Course Contents and Lecture Schedule

NO	TOPIC	NO. OF LECTURES
I	Introduction to biomedical engineering Sources of biomedical signals	1
	General characteristics of biomedical signals Examples of biomedical signals.	2
	Objective of biomedical signal analysis Difficulties of biomedical signal analysis.	2
	Acquisition of biomedical signals like ECG, EMG	1
	Acquisition of biomedical signals like EEG, and EGG	1
II	Basic medical instrumentation system Intelligent medical instrumentation system	2
	Biomedical Recorders: Electrocardiograph, VCG, PCG, EEG, EMG and other biomedical recorders.	2
	Electrocardiogram: Generation of ECG, pacemakers – natural & ectopic, waveforms and their significance.	1
	Diagnostics value of ECG, ECG machine – Block diagram Artifacts in ECG recording	1
	Arrhythmias – rate abnormalities, AV conduction block, premature contractions, flutter, fibrillation	2
III	Electrical activity of muscles- EMG. Measurement of EMG - block diagram of EMG machine	2
	Applications of EMG - myoelectric control system	1
	Electrodes for measurement of bio potentials– ECG, EEG & EMG electrodes	2
	Basics of other bio potentials – ENG, ERG, EOG, EGG	2
IV	Electroencephalogram - brain waves, sleep stages	1
	Abnormal EEGs – epilepsy Measurement of EEG - 10-20 electrode system	2
	Block diagram of EEG machine. Applications of EEG	1
	Biomedical Telemetry system: Components of biotelemetry system	1
	Application of telemetry in medicine. Single channel telemetry system for ECG	1
V	Introduction to modern imaging systems: X-ray machines, Nuclear medical imaging	2
	Magnetic resonance imaging, Ultrasonic imaging, Computed Tomography thermal imaging systems	3
	Recording Systems: Basic recording systems	1
	General condition for signal conditioners sources of noise in law level measurement.	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER
SEVENTH SEMESTER B. TECH. DEGREE EXAMINATION
(Applied Electronics & Instrumentation / Electronics & Instrumentation)
AET425 BIOMEDICAL ENGINEERING

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

PART A

(Answer all questions. Each question carries 3 marks)

1. How bio-potential is generated in cells? (3)
2. Which are signals acquired for analysis of EEG? (3)
3. What are the different type of amplifiers used with bio signal recorders in Medical instrumentation. (3)
4. What is a Defibrillator? (3)
5. Which are the types of electrodes used for ECG signal acquisition? (3)
6. Define EOG and ERG. (3)
7. List any three brain waves with their normal frequencies. (3)
8. What is a single channel radio telemetry system? (3)
9. Write any three advantages of NMR imaging technique. (3)
10. Mention any one application of thermal imaging system. (3)

PART B

(Answer one full question from each module)

MODULE 1

11. a) How does depolarization and repolarization occur in a cell? (7)
    b) What are difficulties occurring in biomedical signal analysis? (7)

OR

12. a) What are the general characteristics of biomedical signals? (7)
    b) With a neat diagram explain acquisition of EEG signals. (7)

MODULE 2

13. a) With neat diagrams explain natural and ectopic pacemakers. (7)
    b) What is fibrillation? How it can be treated? (7)

OR

14. a) Why intelligent medical instrumentation is preferred than conventional? (7)
    b) Draw the block diagram of ECG machine and describe each block. (7)

MODULE 3

15. a) What is EMG? Describe the measurement of EMG. (7)
    b) What are the applications of EMG signals? Explain any one application. (7)

OR

16. a) What is bio potential? Classify different bio potential electrodes. (10)
    b) Explain myoelectric control system. (4)

MODULE 4

17. a)With the block diagram explain single channel ECG telemetry transmitter. (7)
    b) How EEG is recorded? Which are signals to be analyzed for abnormalities identification? (7)

OR

18.a) Enumerate the advantages of telemetry in medicine. (6)
    b) With diagram explain 10-20 electrode method of EEG measurement. (8)

MODULE 5

19. a) List any four properties of X-ray. With a neat block diagram explain the working of an X-ray machine. (10)
    b) Compare CT scan and X-ray imaging technique. (4)

OR

20. a) What is the principle behind NMR imaging? What are the advantages of NMR imaging? (9)
    b) What are the basic elements of a bio signal recording system? (5)

*****

AET435	MEMS	CATEGORY	L	T	P	CREDITS
		OEC	2	1	0	3

Preamble: This course aims to impart knowledge in the design and fabrication of microsystems

Prerequisite: Nil

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

CO 1	Explain theLaws of scaling, multidisciplinary nature of MEMS and various Engineering disciplines in MEMS.
CO 2	Describe the various actuation mechanisms employed in MEMS devices and the geometry of typical sensors and actuators
CO 3	Discuss the various process steps in microfabrication
CO4	Explain the various micromachining techniques and packaging techniques employed in MEMS
CO5	List and explain the multi-disciplinary applications of MEMS

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	2							2
CO 2	3	3	3	3	2							2
CO 3	3	3	3	3	2							2
CO 4	3	3	3	3	2							2
CO5	3	3	3	3	3							

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyse	K4			
Evaluate				
Create				

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the Laws of scaling, multidisciplinary nature of MEMS and various Engineering disciplines in MEMS.

1. Explain the scaling laws that applies to MEMS
2. Discuss the multidisciplinary nature of MEMS
3. Discuss Microfluidics, MOEMS, Bio-MEMS and RF MEMS

Course Outcome 2 (CO2): Describe the various actuation mechanisms employed in MEMS devices and the geometry of typical sensors and actuators.

1. Explain the various actuation mechanisms employed MEMS sensors and actuators
2. Discuss parallel plate sensing employed in MEMS.

Course Outcome 3 (CO3): **Discuss the various process steps in microfabrication.**

1. Explain Czochralski crystal growth process of single crystal silicon
2. Compare low pressure CVD (LPCVD) and Plasma Enhanced CVD (PECVD)
3. Describe the various steps of photolithography

Course Outcome 4 (CO4): Explain the various micromachining techniques and packaging techniques employed in MEMS.

1. Compare bulk and surface micromachining technique.
2. Discuss MEMS packaging techniques, viz, die preparation, surface bonding, wire bonding
3. Explain LIGA process with an example

Course Outcome 5 (CO5): List and explain the multi-disciplinary applications of MEMS.

1. Describe MEMS medical pressure sensors.
2. Discuss the geometry and operation Digital Mirror Devices
3. Explain MEMS microphone

SYLLABUS

Module 1:

Introduction: Overview of microelectronics manufacture and Microsystem technology. Definition – MEMS materials. Laws of scaling. The multi-disciplinary nature of MEMS. Survey of materials central to micro engineering. Application of MEMS in various industries.

Module 2:

Microsensors and Actuators: Working Principle of Microsystems – various micro sensing and actuation techniques – parallel plate electrostatic sensing - micro sensors – various types – interdigitated finger capacitors or comb drive sensors - micro accelerometers.

Module 3:

Micro Fabrication: Substrates – Single crystal silicon wafer formation – Czochralski crystal growth process – Photolithography - Ion Implantation – Diffusion – Oxidation – Chemical Vapour Deposition – LPCVD – PECVD – Physical Vapour Deposition – Etching process – various types – Photo resists

Module 4:

Microsystem Manufacturing: MEMS Process – Bulk Micromachining – Surface Micromachining -Sacrificial etching process –LIGA Process – SLIGA – Die level – device level – System level – packaging techniques – die preparation - surface bonding – wire bonding – sealing

Module 5:

MEMS Applications: Bio-MEMS - Medical pressure sensors, Optical MEMS - Digital Mirror Devices (DMDs), Microfluidics – InkJet Print head technology, MEMS inertial sensors – Gyroscopes, RF MEMS – Switches, MEMS Microphones.

Text Books

1. Tai-Ran- Hsu,MEMS and Microsystems – Design and Manufacture, Tata McGraw-Hill Publishing Company Limited, 2010
2. Chang Liu, Foundation of MEMS, Pearson Education, 2012

Reference Books

1. Mohamed Gad –el -Hak, "MEMS Handbook", CRC Press, 2002
2. Rai- Choudhury P, "MEMS and MOEMS – Technology and Applications", PHI Learning Private Limited, 2009
3. M. H. Bao, "Micromechanical Transducers: Pressure sensors, accelerometers and gyroscopes", Elsevier Pvt. Ltd., NewYork, 1st Edition, 2000
4. Marc Madou, "Fundamentals of Microfabrication", CRC Press, 1st Ed., 1997
5. Edited by D.Uttamchandani, "Handbook of MEMS for wireless and mobile applications", Woodhead Publishing Limited, 2013
6. Stephen D. Senturia, "Microsystem Design", Kluwer Academic Publishers, 1st Ed. 2001

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**MEMS –Introduction**	
1.1	Overview of microelectronics manufacture and Microsystem technology	1
1.2	Quasi-fundamental scaling laws applicable to MEMS	2
1.3	Multi-disciplinary nature of MEMS and Microsystem	1
1.4	Application of MEMS in various industries	1
2	**Microsensors and Actuators**	
2.1	Overview of various micro sensing and actuation techniques	1
2.2	Parallel plate electrostatic sensing - analysis	2
2.3	Inter-digitated finger capacitors or comb drive sensors	2
2.4	Micro accelerometers - design	1
3	**Microfabrication**	
3.1	Single crystal silicon wafer formation – Czochralski crystal growth process	1
3.2	Photolithography	1
3.3	Ion Implantation – Diffusion – Oxidation	1
3.3	Chemical Vapour Deposition – LPCVD – PECVD – Physical Vapour Deposition – Sputtering process	3
3.4	Etching process – various types – Photo resists	2
4	**Microsystem Manufacturing**	
4.1	MEMS Process – Bulk Micromachining – Surface Micromachining	2
4.2	Sacrificial etching process – release of membranes	1

4.3	LIGA Process – process steps, example, SLIGA	2
4.4	MEMS packaging techniques – die preparation - surface bonding – wire bonding - sealing	2

5	**MEMS Applications**	
5.1	Bio-MEMS - Medical pressure sensors	2
5.2	Optical MEMS - Digital Mirror Devices (DMDs),	2
5.3	Microfluidics – InkJet Print head technology,	1
5.4	MEMS inertial sensors – Gyroscopes	2
5.5	MEMS microphones and RF MEMS switches	2

Assignment:

1. List the multidisciplinary applications of MEMS
2. Perform a study of Bio-MEMS, microfluidics, MOEMS, RFMEMS
3. Discuss various MEMS sensors and actuators

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET435

Course Name: MEMS

Max. Marks: 100 Duration: 3Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	List the applications of MEMS devices in industry	K2
2	Comment on the multi-disciplinary nature of MEMS.	K2
3	Discuss the principal components of Microsystem.	K2
4	Explain the various actuation mechanisms employed in MEMS devices	K2
5	Write a brief note on positive and negative photoresists	K2
6	Compare Low Pressure CVD and Plasma Enhanced CVD	K2
7	Discuss the principle of LIGA process of fabricating MEMS devices	K2
8	Explain the MEMS packaging techniques surface bonding and wire bonding.	K2
9	Explain the principle of RF MEMS switches.	K2
10	Distinguish between Bio-MEMS and MOEMS.	K2

PART – B

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

Module – I

11. a)	Describe the quasi-fundamental scaling laws that applies to MEMS	7	CO1	K3
11. b)	Perform a comparative study of microelectronics and microsystem	7	CO1	K2

OR

12.a)	Comment on the material properties central to microengineering	7	CO1	K3
12.b)	Explain the features of MEMS and list the critical factors that affect commercialization of MEMS devices	7	CO1	K3

Module – II

13. a)	Discuss the principle of parallel-plate electrostatic microsensors. Draw a coupled electro – mechanical model and derive an expression for the electrostatic force at equilibrium	8	CO2	K3
13. b)	With sketches, explain the geometry and principle of micro grippers and micro valves	6	CO2	K2

OR

14.a)	Explain the sensing principle of longitudinal and transverse comb drive sensing. Derive an expression for the magnitude of force in transverse comb drive	8	CO2	K3
14.b)	With appropriate diagrams, explain the principle of micromotors and micropumps	6	CO2	K2

Module – III

15. a)	Describe the Czochralski growth process of obtaining single crystal silicon	7	CO3	K2
15. b)	Explain the process of wet chemical etching. Draw the etching profiles of isotropic and anisotropic etching	7	CO3	K2

OR

16.a)	With appropriate figures, explain the steps of photolithography	8	CO3	K2
16.b)	Describe the sputtering process of deposition employed in microfabrication	6	CO3	K2

Module – IV

17. a)	Compare bulk and surface micromachining process of fabricating MEMS devices	6	CO4	K2
17. b)	With figures, list the various stages of micromachining a MEMS cantilever. Discuss the sacrificial etching process	8	CO4	K3

OR

18.a)	With an example, describe the LIGA process of MEMS manufacturing	8	CO4	K3
18.b)	Explain four important functions of microsystem package.	6	CO4	K2

Module – V

19. a)	Discuss Bio-MEMS. Explain the principle of MEMS medical pressure sensor	8	CO5	K2
19. b)	Describe the geometry and operation of MEMS microphone	6	CO5	K2

OR

20. a)	Comment on Optical MEMS. Explain the principle of Digital Mirror Devices (DMDs)	7	CO1	K2
20. b)	Discuss the geometry and principle of MEMS gyroscopes.	7	CO1	K2

AET445	ROBOTICS AND INDUSTRIAL AUTOMATION	CATEGORY	L	T	P	CREDITS
		OEC	2	1	0	3

Preamble: The purpose of this course is providing the knowledge of automation components, tools, systems and to give an overview on the classification and components of industrial robots.

Prerequisite: NIL

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

CO 1	Design and implement automated systems using pneumatics.
CO 2	Provide hydraulic solutions for designing automated systems.
CO 3	Devise Assembly automated systems using feeders, orienteers and escapement devices
CO 4	Perform selection of gripping mechanism for robotic application.
CO 5	Perform kinematic and dynamic analyses with simulation.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	30	30	80
Apply	K3	10	10	10
Analyze	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 and implement automated systems using pneumatics.

1. Mention the applications of hydraulic in engineering field.
2. Sketch and explain the basic hydraulic system.

Course Outcome 2 (CO2): Provide hydraulic solutions for designing automated systems.

1. What are the factors that influence the power input to the compressor?

Course Outcome 3 (CO3): Devise Assembly automated systems using feeders, orienteers and escapement devices.

1. Discuss about the need for robots
2. Explain about major parts of a robot with their functions.

Course Outcome 4 (CO4): Perform selection of gripping mechanism for robotic application.

1. What is repeatability of industrial robot?
2. Classify sensors for robot applications.
3. Discuss in detail about functions & need of industrial robots.

Course Outcome 5 (CO5): Perform kinematic and dynamic analyses with simulation.

1. What is g-factor? How grippers are classified based on g factor.
2. Give two applications where vacuum grippers are widely used in robots.

SYLLABUS

Module 1:

Hydraulic System Elements: Pumps, types, working, characteristics, applications: Types of conductors, and connectors, their selection: Seals and packing, types, materials, applications.

Hydraulic Actuators: Linear and Rotary, types, working, cushioning effect, mounting,

Control Elements: Pressure control Valves, direct acting type, pilot operated, sequence, counterbalancing, unloading, pressure reducing, construction and working: Direction control valves, types, construction and working.

Module 2:

Pneumatics: Air compressors, types, working, selection criteria; FRL unit, construction and working; Pneumatic cylinders and air motors, construction and working, Comparison of air, hydraulic and electric motor.

Pneumatic System Control Elements: Flow control valves, working of variable flow control, quick exhaust, time delay and shuttle valve

Module 3:

Robotics-Introduction-Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robot's classification with respect to geometrical configuration (Anatomy), Controlled system & chain type: Serial manipulator & Parallel Manipulator.

Module 4:

Components of Industrial robotics-precession of movement resolution, accuracy & repeatability-Dynamic characteristics- speed of motion, load carrying capacity & speed of response-Sensors-Internal sensors: Position sensors, & Velocity sensors, External sensors: Proximity sensors, Tactile Sensors, & Force or Torque sensors.

Module 5:

Grippers - Mechanical Gripper-Grasping force-Engel Berger-g-factors-mechanisms for actuation, Magnetic gripper, vacuum cup gripper-considerations in gripper selection & design, Industrial robots' specifications. Selection based on the Application

Text Books

1. Espositio A., "Fluid Power with Applications", Pearson, 2002.
2. Majumdar S. R., "Oil Hydraulic Systems", Tata McGraw Hill 2000

Reference Books

1. Majumdar S. R., "Pneumatic systems-principles and Maintenance", Tata Mc Graw Hill, 2000.
2. Janaki Raman P.A., "Robotics and image processing", Tata McGraw Hill, 1995.
3. Yoram Koren, "Robotics", McGraw Hill, 1992.
4. Groover M. P., "Industrial Robotics", Mc Graw Hill
5. John J. Craig, "Introduction to Robotics", Pearson

Course Contents and Lecture Schedule

Sl. No	Topic	No. of Lectures
1	**Hydraulic System Elements**	
1.1	Pumps, types, working, characteristics, applications	1
1.2	Types of conductors, and connectors, their selection	1
1.3	Seals and packing, types, materials, applications	1
	Hydraulic Actuators	
1.4	Linear and Rotary - types and working	1
1.5	Cushioning effect, mounting	1
	Control Elements	
1.6	Pressure control Valves, direct acting type, pilot operated, sequence, construction and working.	1
1.7	Counterbalancing, unloading, pressure reducing, construction and working.	1
1.8	Direction control valves, types, construction and working.	1
2	**Pneumatics**	
2.1	Air compressors, types, working, selection criteria	1
2.2	FRL unit, construction and working	1
2.3	Pneumatic cylinders and air motors, construction and working	1
2.4	Comparison of air, hydraulic and electric motor.	1
	Pneumatic System Control Elements	
2.5	Flow control valves, working of variable flow control	1
2.6	Quick exhaust, time delay and shuttle valve	2
3	**Robotics**	
3.1	Robotics-Introduction-Types of robots	1
3.2	Overview of robot subsystems, resolution, repeatability and accuracy	2
	Degrees of freedom of robot's classification with respect to geometrical configuration (Anatomy)	2
3.3	Controlled system & chain type	1
3.4	Serial manipulator & Parallel Manipulator.	1
4		
4.1	Components of Industrial robotics-precession of movement resolution, accuracy & repeatability	2
4.2	Dynamic characteristics- speed of motion, load carrying capacity & speed of response	2
4.3	Sensors-Internal sensors: Position sensors, & Velocity sensors	2
4.4	External sensors: Proximity sensors, Tactile Sensors, & Force or Torque sensors.	2
5	**Grippers**	
5.1	Mechanical Gripper-Grasping force-Engel Berger	1
5.2	G-factors-mechanisms for actuation	1
5.3	Magnetic gripper, vacuum cup gripper	1
5.4	Considerations in gripper selection & design	1
5.5	Industrial robots' specifications	1
5.6	Selection based on the Application	1

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET445

Course Name: Robotics & Industrial Automation

Max. Marks: 100 Duration: 3 Hours

PART A

Answer All Questions. Each Carries 3 mark.

1.	What are the types of hydraulic actuators?	CO1	K2
2	Compare hydraulic and pneumatic systems	CO1	K2
3	What is compression ratio?	CO2	K2
4	What are the different types of air compressor?	CO2	K2
5	What are the components of a robot?	CO3	K2
6	What are the laws of robotics?	CO3	K2
7	What do you mean by torque sensor?	CO4	K2
8	What is meant by accuracy of industrial robot?	CO4	K2
9	What is the principle of vacuum cup grippers?	CO5	K2
10	What is meant by grippers? What are the types of grippers	CO5	K2

PART – B

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

Module – I

11. a)	Describe the elements of hydraulic actuation system components in detail	9	CO1	K2
11. b)	explain external gear pump with neat sketch	5	CO1	K2

OR

12.a)	How are the control valve classified? Write the classification of the pressure control valve.	8	CO1	K2
12.b)	Define pump and state the purpose of the pump in hydraulic system and classify pumps	6	CO1	K2

Module – II

13 a)	What is the difference between rotary air compressor and reciprocating air compressor?	9	CO2	K2
13 b)	What are shuttle valve?	5	CO2	K2
	OR			
14 a)	What are the components of pneumatic system?	8	CO2	K2
14 b)	What is a quick exhaust valve? Mention it's application.	6	CO2	K2

Module – III

15 a)	Describe the classification of robots by control system.	9	CO3	K2
15 b)	What is the degree of freedom in the robotics? How can it be determined?	5	CO3	K2
	OR			
16 a)	Define a manipulator& also compare serial and parallel manipulator.	8	CO3	K2
16 b)	How to calculate the degree of freedom in serial manipulator.	6	CO3	K2

Module – IV

17 a)	Briefly explain the working principle of any two types of position sensors with neat sketch.	8	CO4	K2
17 b)	Write short notes on the following i). accuracy ii). precision iii). repeatability	6	CO4	K2
	OR			
18 a)	Describe the working principle of proximity sensor with neat sketch.	8	CO4	K2
18 b)	Briefly explain the dynamic characteristics of robot.	6	CO4	K2

Module – V

19 a)	Explain mechanical grippers & their linkage mechanism with neat sketches.	9	CO5	K2
19 b)	List out the important factors to be considered in the selection & design of grippers.	5	CO5	K2
	OR			
20 a)	Discuss about vacuum cup grippers along with their advantages & disadvantages.	9	CO5	K2
20 b)	Give the specification of industrial robot	5	CO5	K2

AEL411	PROCESS CONTROL LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble

This course aims students to achieve the following skills

- Ability to control basic physical processes using both simple and complex control schemes
- Experimentally verify a variety of process controls using computerized control
- Realization of process control schemes using various simulation software

Prerequisite

AET304 PROCESS DYNAMICS & CONTROL

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

CO 1	Analyze and study the responses of various combinations of P, I, D controls for controlling basic processes like level, temperature, etc.
CO 2	Tune controllers for processes using different methods
CO 3	Analyze the performance of complex controls- cascade, feed forward and ratio
CO4	Implement process controls using computerized control
CO5	Acquire familiarity with usage of simulation tools for mathematical computation, processing and virtual instrumentation for process control applications

Mapping of course outcomes with program outcomes

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2	2	3			2	3	2		3
CO 2	3	3	2	2	3			2	3	2		3
CO 3	3	3	2	2	3			2	3	2		3
CO 4	3	3	2	2	3			2	3	2		3
CO 5	3	3	2	2	3			2	3	2		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 equipment and troubleshooting)	: 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.

LIST OF EXPERIMENTS: (Minimum 10 experiments are to be done)

1. Design of ON- OFF controller with and without neutral zone- flow control, level control
2. Study of output response of P, PI, PD and PID controllers for flow control
3. Study of output response of P, PI, PD and PID controllers for level control
4. Study of output response of P, PI, PD and PID controllers for pressure control
5. Study of output response of P, PI, PD and PID controllers for temperature control
6. Study of characteristics of control valves
7. Controller tuning using Ziegler- Nichols method for various processes
8. Controller tuning using Cohen- Coon method for various processes
9. Simulation of controller tuning
10. Study of cascade, feed forward and ratio controls
11. Study of PLCs- Implementation of simple logic functions using ladder logic program
12. Control of processes like water level control & bottle filling system using PLC
13. PC based control of robotic actions
14. Study of virtual instrumentation and data logging
15. Interface of DCS with PLC/ SCADA using protocol/ fieldbus
16. Simulation of control schemes using Artificial Neural Networks & Fuzzy Logic
17. Simulation of heat exchanger temperature control

AEQ413	SEMINAR	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	2

Preamble: The course 'Seminar' is intended to enable a BTech graduate to read, understand, present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar guide. This course can help the learner to experience how a presentation can be made about a selected academic document and also empower her/him to prepare a technical report.

Course Objectives:

- To do literature survey in a selected area of study.
- To understand an academic document from the literate and to give a presentation about it.
- To prepare a technical report.

Course Outcomes [COs]: After successful completion of the course, the students will be able to:

CO1	Identify academic documents from the literature which are related to her/his areas of interest (Cognitive knowledge level: **Apply**).
CO2	Read and apprehend an academic document from the literature which is related to her/ his areas of interest (Cognitive knowledge level: **Analyze**).
CO3	Prepare a presentation about an academic document (Cognitive knowledge level: **Create**).
CO4	Give a presentation about an academic document (Cognitive knowledge level: **Apply**).
CO5	Prepare a technical report (Cognitive knowledge level: **Create**).

Mapping of course outcomes with program outcomes:

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

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

General Guidelines

- The Department shall form an Internal Evaluation Committee (IEC) for the seminar with academic coordinator for that program as the Chairperson/Chairman and seminar coordinator & seminar guide as members. During the seminar presentation of a student, all members of IEC shall be present.

- Formation of IEC and guide allotment shall be completed within a week after the University examination (or last working day) of the previous semester.

- Guide shall provide required input to their students regarding the selection of topic/ paper.

- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than a very specific research work. It's advisable to choose a topic for the Seminar to be closely linked to the final year project area. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.

- A topic/paper relevant to the discipline shall be selected by the student during the semester break.

- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IEC.

- The IEC shall approve the selected topic/paper by the second week of the semester.

- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

Evaluation pattern

Total marks: 100, only CIE, minimum required to pass 50

Seminar Guide: 20 marks (Background Knowledge – 10 (The guide shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).

Seminar Coordinator: 20 marks (Seminar Diary – 10 (Each student shall maintain a seminar diary and the guide shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

Presentation: 40 marks to be awarded by the IEC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

Report: 20 marks to be awarded by the IEC (check for technical content, overall quality, templates followed, adequacy of references etc.).

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

AED415	PROJECT PHASE I	CATEGORY	L	T	P	CREDIT
		PWS	0	0	6	2

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

- To apply engineering knowledge in practical problemsolving.
- To foster innovation in design of products, processes orsystems.
- To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs]: After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE I

Phase 1 Target

- Literature study/survey of published literature on the assigned topic
- Formulation of objectives
- Formulation of hypothesis/ design/ methodology
- Formulation of work plan and task allocation.
- Block level design documentation
- Seeking project funds from various agencies
- Preliminary Analysis/Modeling/Simulation/Experiment/Design/Feasibility study
- Preparation of Phase 1 report

Evaluation Guidelines & Rubrics

Total: 100 marks (Minimum required to pass: 50 marks).

- Project progress evaluation by guide: 30 Marks.
- Interim evaluation by the Evaluation Committee: 20 Marks.
- Final Evaluation by the Evaluation Committee: 30 Marks.
- Project Phase - I Report (By Evaluation Committee): 20 Marks.

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor).

Evaluation by the Guide

The guide/supervisor shall monitor the progress being carried out by the project groups on a regular basis. In case it is found that progress is unsatisfactory it shall be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Topic Selection: innovativeness, social relevance etc. (2)

Problem definition: Identification of the social, environmental and ethical issues of the project problem. (2)

Purpose and need of the project: Detailed and extensive explanation of the purpose and need of the project. (3)

Project Objectives: All objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are clearly specified. (2)

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (3)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day-to-day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (7)

EVALUATION RUBRICS for PROJECT Phase I: Interim Evaluation

No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-a	Topic identification, selection, formulation of objectives and/or literature survey. (Group assessment) [CO1]	10	The team has failed to come with a relevant topic in time. Needed full assistance to find a topic from the guide. They do not respond to suggestions from the evaluation committee and/or the guide. No literature review was conducted. The team tried to gather easy information without verifying the authenticity. No objectives formed yet.	The team has identified a topic. The originally selected topic lacks substance and needs to be revised. There were suggestions given to improve the relevance and quality of the project topic. Only a few relevant references were consulted/ studied and there is no clear evidence to show the team's understanding on the same. Some objectives identified, but not clear enough.	Good evidence of the group thinking and brainstorming on what they are going to build. The results of the brainstorming are documented and the selection of topic is relevant. The review of related references was good, but there is scope of improvement. Objectives formed with good clarity, however some objectives are not realistic enough.	The group has brainstormed in an excellent manner on what they were going to build. The topic selected is highly relevant, real world problem and is potentially innovative. The group shows extreme interest in the topic and has conducted extensive literature survey in connection with the topic. The team has come up with clear objectives which are feasible.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-b	Project Planning, Scheduling and Resource/ Tasks Identification and allocation. (Group assessment) [CO4]	10	No evidence of planning or scheduling of the project. The students did not plan what they were going to build or plan on what materials / resources to use in the project. The students do not have any idea on the budget required. The team has not yet decided on who does what. No project journal kept.	Some evidence of a primary plan. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no details. Some evidence on task allocation among the team members.	Good evidence of planning done. Materials were listed and thought out, but the plan wasn't quite complete. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is not complete in all respect / detailed. There is better task allocation and individual members understand about their tasks. There is room for improvement.	Excellent evidence of enterprising and extensive project planning. Gantt charts were used to depict detailed project scheduling. A project management/version control tool is used to track the project, which shows familiarity with modern tools. All materials / resources were identified and listed and anticipation of procuring time is done. Detailed budgeting is done. All tasks were identified and incorporated in the schedule. A well-kept project journal shows evidence for all the above, in addition to the interaction with the project guide. Each member knows well about their individual tasks.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

Phase 1 Interim Evaluation Total Marks: 20

EVALUATION RUBRICS for PROJECT Phase I: Final Evaluation

Sl. No.	Parameters	Marks	Poor	Fair	Very Good	Outstanding
1-c	Formulation of Design and/or Methodology and Progress. (Group assessment) [CO1]	5	None of the team members show any evidence of knowledge about the design and the methodology adopted till now/ to be adopted in the later stages. The team has not progressed from the previous stage of evaluation.	The students have some knowledge on the design procedure to be adopted, and the methodologies. However, the team has not made much progress in the design, and yet to catch up with the project plan.	The students are comfortable with design methods adopted, and they have made some progress as per the plan. The methodologies are understood to a large extent.	Shows clear evidence of having a well-defined design methodology and adherence to it. Excellent knowledge in design procedure and its adaptation. Adherence to project plan is commendable.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
1-d	Individual and Teamwork Leadership (Individual assessment) [CO3]	10	The student does not show any interest in the project activities, and is a passive member.	The student show some interest and participates in some of the activities. However, the activities are mostly easy and superficial in nature.	The student shows very good interest in project, and takes up tasks and attempts to complete them. Shows excellent responsibility and team skills. Supports the other members well.	The student takes a leadership position and supports the other team members and leads the project. Shows clear evidence of leadership.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
1-e	Preliminary Analysis/ Modeling / Simulation/ Experiment / Design/ Feasibility study [CO1]	10	The team has not done any preliminary work with respect to the analysis/modeling/ simulation/experiment/design/feasibility study/ algorithm development.	The team has started doing some preliminary work with respect to the project. The students however are not prepared enough for the work and they need to improve a lot.	There is some evidence to show that the team has done good amount of preliminary investigation and design/ analysis/ modeling etc. They can improve further.	Strong evidence for excellent progress in the project. The team has completed the required preliminary work already and are poised to finish the phase I in an excellent manner. They have shown results to prove their progress.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

1-f	Documentation and presentation. (Individual & group assessment). [CO6]	5	The team did not document the work at all. The project journal/diary is not presented. The presentation was shallow in content and dull in appearance. The individual student has no idea on the presentation of his/her part.	Some documentation is done, but not extensive. Interaction with the guide is minimal. Presentation includes some points of interest, but overall quality needs to be improved. Individual performance to be improved.	Most of the project details were documented well enough. There is scope for improvement. The presentation is satisfactory. Individual performance is good.	The project stages are extensively documented in the report. Professional documentation tools like LaTeX were used to document the progress of the project along with the project journal. The documentation structureis well- planned and can easily grow into the project report. The presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
Total		**30**	**Phase - I Final Evaluation Marks: 30**			

EVALUATION RUBRICS for PROJECT Phase I: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
1-g	Report [CO6]	20	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly Unacknowledged content. Lack of effort in preparation is evident.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report.	Project report shows evidence of systematic documentation. Report is following the standard format and there are only a few issues. Organization of the report is good. Most of references are cited properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows standard styles.
			(0 - 7 Marks)	(8 - 12 Marks)	(13 - 19 Marks)	(20 Marks)
Phase - I Project Report Marks: 20						

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

S7 MINOR

KTU
Estd.
2014

AED481	MINI PROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	4

Preamble: Mini Project Phase I: A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The object of Project Work I is to enable the student to take up investigative study in the broad field of Applied Electronics and Instrumentation, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on a group of three/four students, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

- Survey and study of published literature on the assigned topic;
- Preparing an Action Plan for conducting the investigation, including team work;
- Working out a preliminary Approach to the Problem relating to the assigned topic;
- Block level design documentation
- Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;
- Preparing a Written Report on the Study conducted for presentation to the Department;

CO1	Identify and synthesize problems and propose solutions to them.
CO2	Prepare work plan and liaison with the team in completing as per schedule.
CO3	Validate the above solutions by theoretical calculations and through experimental
CO4	Write technical reports and develop proper communication skills.
CO5	Present the data and defend ideas.

Mapping of course outcomes with program outcomes

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

*1-slight/low mapping, 2- moderate/medium mapping, 3-substantial/high mapping

Assessment Pattern

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through minimum of TWO reviews. At the time of the 1^{st} review, students are supposed to propose a new system/design/idea, after completing a thorough literature study of the existing systms under their chosen area. In the 2^{nd} review students are expected to highlight the implementation details of the proposed solution. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1^{st} and 2^{nd} review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brain storming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

Marks Distribution

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Marks awarded by Guide : 15 marks
Project Report : 10 marks
Evaluation by the Committee : 40 Marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.
(a) Demonstration : 50 Marks
(b) Project report : 10 Marks
(d) Viva voce : 15marks

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty-in-charge of miniproject/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews**.**

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

S7 HONOURS

KTU
Estd.
2014

AET495	ADVANCED CONTROL THEORY	CATEGORY	L	T	P	CREDITS
		VAC	4	0	0	4

Preamble: This course aims to study the basic concepts required for solving complex control problems

Prerequisite: AET 301 Control Systems.

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

CO 1	Apply different state space representation methods for solving complex control problems.
CO 2	Analyze the stability of nonlinear systems.
CO 3	Analyse the describing functions of various nonlinear systems.
CO 4	Design different systems and analyse its stability using Lyapunov stability analysis.
CO 5	Analyse the controllability and observability of different systems.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	15	15	30
Apply	K3	25	25	60
Analyse				
Evaluate				
Create				

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Apply different state space representation methods for solving complex control problems.

1. Define state, state variable, state space, state vector.
2. Formulate state equation from mathematical model.
3. Find the solution of state equations.

Course Outcome 2 (CO2): Analyze the stability of nonlinear systems.

1. Analysis of nonlinear system for finding solution to complex control systems.
2. Analyze the different responses in nonlinear control systems.

Course Outcome 3 (CO3): Analyze describing functions of various nonlinear systems.

1. Derive the describing functions of various systems.

Course Outcome 4 (CO4): Design different systems and analyse its stability using Lyapunov stability analysis.

1. Define Lyapunov stability theorems.
2. Study the stability of the systems using first and second method of Lyapunov.
3. Study the Lyapunov stability analysis for Linear Continuous time systems.

Course Outcome 5 (CO5): Analyse the controllability and observability of different systems.

1. Define controllability and observability.
2. Check whether the system is controllable or observable
3. Design optimal control systems.

SYLLABUS

Module 1:

State space representation of system: Concept, Solution of time invariant state equation- state transition matrix. Linear time varying system. Discrete system state space representation and solution.

Module 2:

Non-linear systems: Types of non-linearity, singular point, non-linear system stability analysis- phase plane technique, construction of phase trajectories, isocline method

Module 3:

Describing function analysis: Basic concepts, derivation of describing functions for common non-linearities Describing function analysis of non-linear systems – Conditions for stability – Stability of oscillations.

Module 4:

Lyapunov stability analysis: definition of stability, instability and asymptotic stability. Lyapunov stability theorems. Stability analysis of simple linear systems.

Module 5:

MIMO systems- Controllability- Observability: Definition- Effect of pole-zero cancellation, Practical examples-controllable and uncontrollable systems-observable and unobservable systems. Optimal control system-definition-design using state variable feedback and error squared performance indices.

Text Books/ Reference Book

1. C. D. Johnson, Process Control Instrumentation Technology, 7th ed., Prentice Hall of India, New Delhi, 2003.
2. K. Ogata “Discrete Time Control Systems”, 1996, PHI.
3. K. Ogata “Modern Control Engineering”, 1996, PHI.
4. R. C. Dorf and R. H. Bishop, Modern Control Systems, 8th ed., Pearson Education, Delhi, 2004.
5. M. Gopal, “Modern Control System Theory”, New Age International Publishers, 2nd edition,1996.
6. K.R.Varmah, “Modern Control Theory”, CBS Publishers & Distributors Pvt. Ltd, Ist edition, 2017.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**State space representation of system:**	
1.1	Concept of state space-state space representation of system	2
1.2	solution of time invariant state equation	2
1.3	state transition matrix.	2
1.4	Linear time varying system	1
1.5	Discrete system state space representation and solution	2
2	**Non-linear systems**	
2.1	Non-linear systems	1
2.2	types of non-linearity	1
2.3	singular point	1
2.4	non-linear system stability analysis	1
2.5	phase plane technique	2
2.6	construction of phase trajectories, isocline method	3
3	**Describing function analysis**	
3.1	Describing function analysis: Basic concepts	2
3.2	derivation of describing functions for common non-linearities	4
3.3	Describing function analysis of non-linear systems	1
3.4	Conditions for stability	1
3.5	Stability of oscillations	1
4	**Lyapunov stability analysis**	
4.1	definition of stability, instability and asymptotic stability.	3
4.2	Lyapunov stability theorems.	3
4.3	Stability analysis of simple linear systems.	3
5	**MIMO systems- Controllability- Observability**	
5.1	MIMO systems- Controllability- Observability-Definition	1
5.2	Effect of pole-zero cancellation,	1
5.3	Practical examples-controllable and uncontrollable systems	2
5.4	Practical examples- observable and unobservable systems	2
5.5	Optimal control system-definition	1
5.6	design using state variable feedback and error squared performance indices.	2

Assignment:

At least two assignments should be given.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B. TECH DEGREE (HONOURS) EXAMINATION (**Model Question Paper)**

Course Code: AET495

Program: Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation

Course Name: ADVANCED CONTROL THEORY

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 marks.

1.	Explain the terms state space, state, state variable and state vector	K2
2	List out any three Limitations of Transfer function approach.	K1
3	What is singular point?	K2
4	Explain atleast three nonlinearities with necessary characteristics.	K2
5	Explain the advantages and disadvantages of describing function method.	K2
6	Derive describing function of Ideal relay.	K3
7	Explain Sign definiteness in the sense of Lyapunov.	K2
8	Define Lyapunov stability theorem.	K1
9	Define Controllability and Observability.	K1
10	Define Optimal Control systems.	K1

PART – B

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

Module – I

11.a)	Obtain the state model of the system whose transfer function is given as $$\frac{Y(s)}{U(s)} = \frac{10}{s^3 + 4s^2 + 2s + 1}$$	6	CO1	K3
11.b)	Compute the state transition matrix for a system represented by the state equation by Laplace transform method. $$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$	8	CO1	K3

OR

12.a)	Obtain the state representation of the system represented by the differential equation $\frac{d^2y}{dt^2} + 6\frac{dy}{dt} + 8y(t) = r(t)$	6	CO1	K3
12.b)	Obtain the solution to non-homogeneous state equation using Laplace transform approach.	8	CO1	K3

Module – II

13 a)	Explain Singular Point, What is its significance. For the given system, determine the singular points. $\dot{x}_1 = x_2$, $\dot{x}_2 = -x_1 - x_2 - x_1^2$	7	CO2	K3
13 b)	Explain different types of non-linearity's	7	CO2	K2

OR

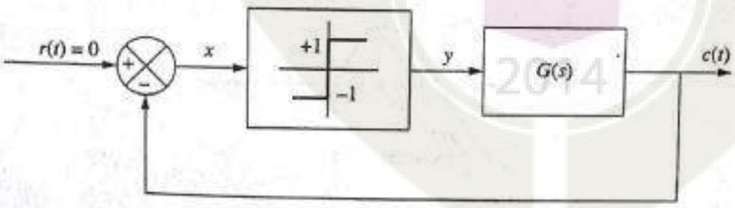
14 a)	Explain different types of singularities in phase plane analysis.	7	CO2	K2
14 b)	A second order system is represented by the differential equation ë + 2ζωnė +ωn 2 e = 0 where ζ= 0.15, ωn= 1 rad/sec, Find out the singularity associated with the system	7	CO2	K3

Module – III

15	Derive the describing function of a saturation non-linearity.	14	CO3	K3

OR

16	For the system shown in figure, an ideal relay is connected with a plant having G(s)=1/s(s+1)(s+3). Determine whether the limit cycles exists and if exists, determine the amplitude and frequency of it.	14	CO3	K3



Module – IV

17	Determine the stability of the system described by $\dot{X}$=AX where $A=\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$ by lyapunov theorem and determine a suitable lyapunov function	14	CO4	K3
	OR			
18	Using $V(x)=x_1^2+x_2^2$ study the stability of the origin of the system $\dot{x}_1 = -x_1 + 3x_1^2 x_2, \quad \dot{x}_2 = -x_2$	14	CO4	K3

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Module – V

19)	A linear system is represented by a state model $\dot{X}$ = AX + BU; y = CX, where $A=\begin{bmatrix} -1 & -1 & 0 \\ 0 & 0 & 1 \\ 0 & -3 & -4 \end{bmatrix}, B=\begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 2 \end{bmatrix}$ and $C=\begin{bmatrix} 1 & 3 & 1 \\ 1 & 2 & 0 \end{bmatrix}$ Check whether the system is completely observable by Kaman's Test.	14	CO5	K3
	OR			
20 a)	Explain the effect of Pole zero cancellation on Controllability and Observability with an example.	6	CO5	K3
20 b)	Check whether the system represented by the following state equation is completely controllable. $\dot{X}=\begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix}X+\begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix}U$	8	CO5	K3

KTU Estd. 2014

AET497	VLSI STRUCTURES FOR SIGNAL PROCESSING	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble:

This course aims to provide an insight to the realization of DSP architecture using different techniques in VLSI.

Prerequisite: A knowledge in fundamentals of Digital Signal Processing

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

CO1 K3	Identify iteration bound of a data flow graph.
CO2 K2	Explain pipelining and parallel processing in DSP systems to achieve high speed and low power.
CO3 K3	Apply retiming principles to reduce clock period and number of registers.
CO4 K3	Apply unfolding techniques to obtain parallel processing architectures.
CO5 K2	Explain how folding techniques can be used to reduce the number of functional units in DSP architecture.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment /Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	50
Apply	K3	20	20	40
Analyze				
Evaluate				
Create				

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

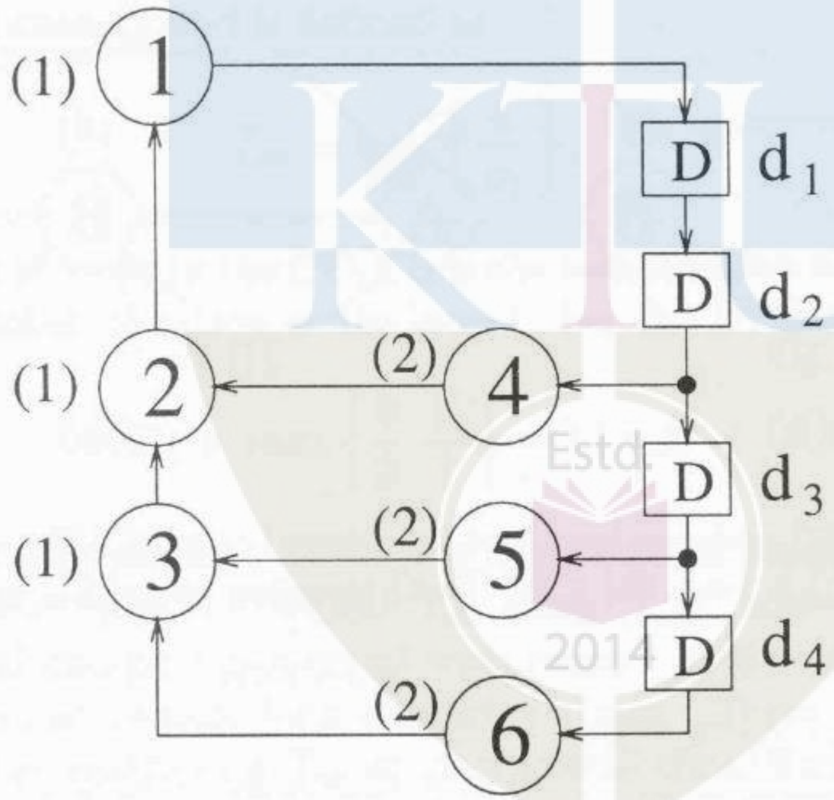
End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each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

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Course Level Assessment Questions

Course Outcome 1 (CO1): Identify iteration bound of a data flow graph. (K3)

1. Find loop bound and iteration bound of the DFG given below



2. Explain Minimum cycle mean algorithm for determination of iteration bound.

Course Outcome 2 (CO2): Explain pipelining and parallel processing in DSP systems to achieve high speed and low power. (K2)

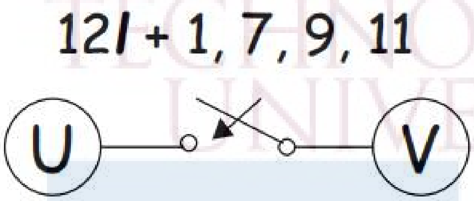
1. Obtain a parallel processing architecture for a 3 tap FIR filter with block size 3
2. What is fine grain pipelining?

Course Outcome 3 (CO3): Apply retiming principles to reduce clock period and number of registers. (K3)

1. Draw the structure of a 4 stage FIR lattice filter and obtain its 2-slow version.
2. Write down two properties of retiming.

Course Outcome 4 (CO4): Apply unfolding techniques to obtain parallel processing architectures. (K3)

1. Write algorithm for unfolding.
2. Unfold the given structure by a factor of 3.



Course Outcome 5 (CO5): Explain how folding techniques can be used to reduce the number of functional units in DSP architecture. (K2)

1. Explain folding of multirate systems.
2. Explain life time analysis for register minimization.

SYLLABUS

Module 1:

Review of DSP algorithms, Iteration Bound, Loop Bound, Iteration Bound Algorithms, Iteration Bound for multi rate data flow graphs

Module 2

Pipelining and Parallel Processing: Introduction, pipelining and parallel processing of FIR filters pipelining and parallel processing for low power

Module 3

Retiming-introduction, properties, system inequalities, retiming techniques- cutset retiming and pipelining, retiming for clock period minimization

Module 4

Unfolding: Introduction, unfolding algorithm, properties, critical path unfolding and retiming, applications- sample period reduction, parallel processing- 3-unfold and 3-parallel examples

Module 5

Folding: Introduction, Transformation, register minimization techniques- life time analysis, data allocation using forward-backward register allocation folding of multi rate systems

Text Book

1. Keshab K. Parhi, VLSI Digital signal processing Systems: Design and Implementation, John Wiley & Sons, 1999.

Reference Books

1. Digital Signal Processing for Multimedia Systems, Keshab K. Parhi and Takao Nishitani, Marcel Dekker.
2. Pipelined Lattice and Wave Digital Recursive Filters, J. G. Chung and Keshab K. Parhi, Kluwer.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
Estd. 2014

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Iteration Bound (9 hrs.)**	
1.1	Review of DSP algorithms	2
1.2	Representations of DSP algorithms	1
1.3	Loop Bound	1
1.4	Iteration Bound	2
1.5	Algorithms for computing Iteration Bound	2
1.6	Iteration Bound for multirate data flow graphs	1
2	**Pipelining and Parallel Processing (9 hrs.)**	
2.1	Introduction	1
2.2	pipelining of FIR filters	2
2.3	parallel processing of FIR filters	2
2.4	combining pipelining and parallel processing	2
2.5	pipelining and parallel processing for low power	2
3	**Retiming (9 hrs.)**	
3.1	introduction	1
3.2	properties	1
3.3	system inequalities	2
3.4	retiming techniques	2
3.5	cut set retiming and pipelining	2
3.6	retiming for clock period minimization	1
4	**Unfolding (9 hrs.)**	
4.1	Introduction	1
4.2	unfolding algorithm	1
4.3	properties of unfolding	1
4.4	critical path, unfolding and retiming	2
4.5	application- sample period reduction	2
4.6	application-parallel processing- 3-unfold and 3-parallel examples	2
5	**Folding (9 hrs.)**	
5.1	Folding Transformation	2
5.2	Register Minimization techniques – life time analysis	2
5.3	Data allocation using forward backward register allocation	2
5.4	Register minimization in folded architectures - examples	2
5.5	folding of multirate systems	1

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.T ECH (Honours) DEGREE EXAMINATION,

(**Model Question Paper)**

Program: Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation Engineering

Course Code: AET497

Course Name: VLSI Structures for Signal Processing

Max. Marks: 100 Duration: 3 Hours

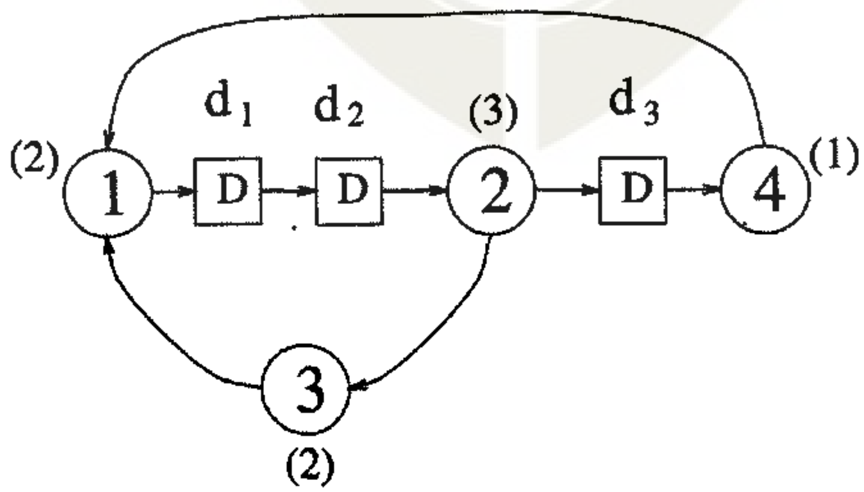
PART A

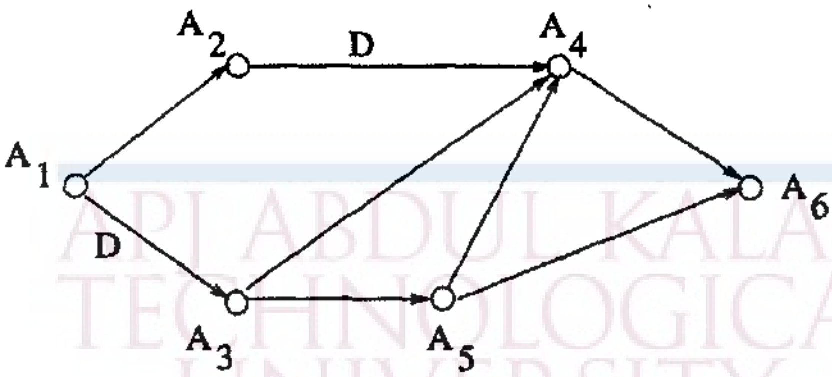
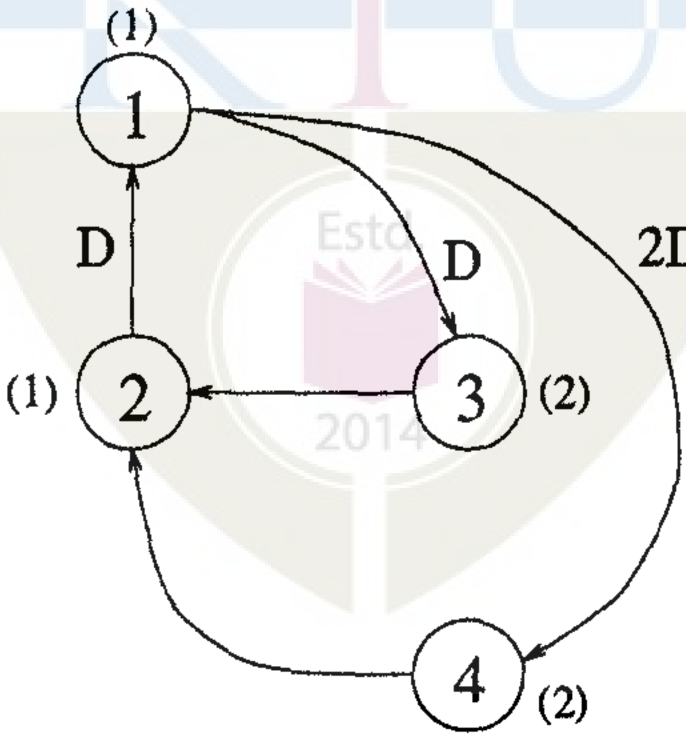
Answer ALL Questions. Each Carries 3 mark.

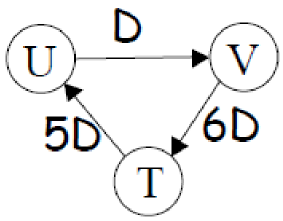
1	Draw block diagram and data flow graph representations of a 3 tap FIR filter		K2
2	Explain the terms loop bound and iteration bound.		K2
3	Draw a pipelined implementation of a 3-tap FIR filter y(n) =a x(n) +b x(n-1)+ c x (n-2)		K2
4	What is fine grain pipelining?		K2
5	Write any two properties of retiming.		K1
6	What are the applications of retiming?		K1
7	Write unfolding algorithm.		K1
8	Explain how critical path of original data flow graph (DFG) is related to J-unfolded DFG.		K2
9	Explain the concept of folding.		K2
10	Explain folding of multirate systems.		K2

PART – B

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

	Module – I			
11	Find iteration bound of the DFG given below using Longest Path Matrix Algorithm.  	14	CO1	K3

	OR			
12	Calculate the computation time of the critical path for the signal flow graph given below. 	14	CO1	K3
	Module – II			
13	Design a parallel processing architecture for a 3 tap FIR filter with block size 3	14	CO2	K2
	OR			
14	With suitable expressions explain pipelining and parallel processing for low power	14	CO2	K2
	Module – III			
15	Obtain the retimed DFG using cutest retiming for the DFG given below. 	14	CO3	K2
	OR			
16	With a suitable example show that pipelining is a special case of cutset retiming.	14	CO3	K2
	Module – IV			
17	Obtain 3 unfolded DFG for the DFG given below.	14	CO4	K3

				
	OR			
18	Show that sample period reduction can be achieved by using unfolding.	14	CO4	K3
	Module – V			
19	Explain life time analysis for register minimization.	14	CO5	K2
	OR			
20	Using IIR filter as an example, explain register minimization in folded architectures.	14	CO5	K2

AET499	Estimation and Detection	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble: This course introduces the concepts and trends of two major domains of statistical signal processing, estimation and detection, in statistical signal processing applications.

Prerequisites: MAT 101 Linear Algebra and Calculus
MAT 204 Probability, Random Process, and Numerical Methods
ECT 204 Signals and Systems

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

CO 1	Formulate and model various estimation and detection problems mathematically.
CO 2	Apply different types of signal detection techniques in statistical signal processing applications.
CO 3	Choose and apply suitable parameter estimation technique for a practical estimation problem.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12
CO 1	3	3			3							3
CO 2	3	3	3		3							3
CO 3	3	3	3		3							3

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1			
Understand	K2	20	20	40
Apply	K3	30	30	60
Analyse	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): Formulate and model various estimation and detection problems mathematically.

1. Differentiate estimation and detection techniques.
2. Differentiate classical approach and bayesian approch in detection theory (or estimation).
3. Enumerate different applications which are using estimation and detection techniques.
4. Give the mathematical formulation of estimation and detection methods.
5. Draw receiver operating characteristics with all details
6. Give the significance of Bayes risk
7. How multiple hypothesis testing is done.
8. Give the significance of linear models in estimation and detection theory.
9. Significance of Cramer-Rao Lower Bound in estimation.
10. Differentiate MAP and ML methods in estimation (or detection).

Course Outcome 2 (CO2): Apply different types of signal detection techniques in statistical signal processing applications.

1. Describe Neyman-Pearson theorem (or Bayes risk or minimization of probability of error) and apply it to any binary hypothesis (eg. Signal in white Gaussian noise)
2. Derive/Obtain the matched filters for the detection of deterministic signals
3. Derive/Obtain the estimator-correlator for the detection of random signals

Course Outcome 3 (CO3): Choose and apply suitable parameter estimation technique for a practical estimation problem.

1. Derive/Obtain the Minimum variance unbiased estimator (or best linear unbiased estimator) for any simple examples (eg. DC Signal in white Gaussian noise)
2. Derive/Obtain the Maximum likelihood estimator (or least squares estimator or minimum mean square error estimator) for any simple examples (eg. DC Signal in white Gaussian noise)
3. Using Bayesian approach, obtain an estimator for any simple examples.

SYLLABUS

Module 1:

Introduction to Detection and Estimation:

Review of joint and conditional probability concepts, Gaussian random variables and processes, Review of Linear Algebra.

Introduction to detection and estimation theory: Problem formulation and applications of signal detection and parameter estimation.

Module 2:

Statistical Detection Theory 1:

Binary hypothesis testing; Neyman-Pearson detector; Bayes Detector; Receiver operating characteristics; Multiple hypothesis testing.

Module 3:

Statistical Detection Theory 2:

Detection of Deterministic Signals: Matched filter, Estimator-Correlator.

Composite hypothesis testing with unknown signal and noise parameters: Uniformly most powerful test and Generalized likelihood ratio test.

Module 4:

Statistical Estimation Theory 1:

Minimum Variance Unbiased Estimators, Cramer-Rao Lower Bound (CRLB), Fisher information Matrix, Sufficient Statistics, Efficient estimators, Bias, Maximum Likelihood Estimator, Invariance property.

Module 5:

Statistical Estimation Theory 2:

Linear Models for estimation, Best Linear Unbiased Estimator, Least Square Estimator Bayesian Estimators – Minimum Mean Square Estimator (MMSE), Minimum Absolute Error, MAP Estimator.

Text Books

1. Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory, S.M. Kay, Prentice Hall 1993, ISBN-13: 978-0133457117.
2. Fundamentals of Statistical Signal Processing, Volume II: Detection Theory, S.M. Kay, Prentice 1993, ISBN-13: 978-0135041352.

Reference Books

1. An Introduction to Signal Detection and Estimation, H.V. Poor, Springer, 2nd edition, 1998, ISBN-13: 978-0387941738.
2. Statistical Signal Processing, L.L. Scharf, Pearson India, 2010, ISBN-13: 978-8131733615.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Detection and Estimation:**	
1.1	Review of joint and conditional probability concepts, Gaussian random variables and processes, Review of Linear Algebra.	2
1.2	Introduction to detection and estimation theory,	2
1.3	Problem Formulation of estimation	1
1.4	Problem Formulation of detection	1
1.5	Applications of detection and estimation	1
2	**Statistical Detection Theory 1:**	
2.1	Binary hypothesis testing	2
2.2	Neyman-Pearson detector	2
2.2	Bayes Detector	2
2.3	Receiver operating characteristics	1
2.4	Multiple hypothesis testing	2
3	**Statistical Detection Theory 2**	
3.1	Detection of Deterministic Signals: Matched filter,	2
3.2	Estimator-Correlator.	1
3.3	Composite hypothesis testing with unknown signal and noise parameters	2
3.3	Uniformly most powerful test	2
3.4	Generalized likelihood ratio test.	2
4	**Statistical Estimation Theory 1**	
4.1	Minimum Variance Unbiased Estimators	1
4.2	Cramer-Rao Lower Bound (CRLB)	2
4.3	Fisher information Matrix,	2
4.4	Sufficient Statistics	1
4.5	Efficient estimators, Bias	2
4.6	Maximum Likelihood Estimator, Invariance property	2
5	**Statistical Estimation Theory 1**	
5.1	Linear Models for estimation	1
5.2	Best Linear Unbiased Estimator	1
5.3	Least Square Estimator	2
5.4	Bayesian Estimators	1
5.5	Minimum Mean Square Estimator (MMSE),	2
5.6	Minimum Absolute Error	1
5.7	MAP Estimator	2

Simulation Assignments (using MATLAB or Python)

1. Generate and familiarize PDF and CDF of Normal distribution.
2. Generate DC level in White Gaussian Noise.
3. Simulate a Neyman-Pearson Detector.
4. Simulate a Maximum Likelihood Estimator.
5. Simulate a Best Linear Unbiased Estimator.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET499

Program: Applied Electronics and Instrumentation Engineering

Course Name: Estimation and Detection

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	Enumerate different applications which are using estimation and detection techniques.	CO2	K2
2	Differentiate estimation and detection techniques.	CO1	K3
3	Differentiate classical approach and bayesian approach in detection theory.	CO1	K3
4	Give the mathematical formulation of detection methods.	CO1	K3
5	Draw receiver operating characteristics with all details	CO2	K2
6	Give the significance of Bayes risk	CO2	K3
7	Give the significance of linear models in estimation theory.	CO3	K2
8	Significance of Cramer-Rao Lower Bound in estimation.	CO3	K3
9	What is Minimum Variance Unbiased Estimation?	CO3	K2
10	Differentiate MAP and ML methods in estimation.	CO3	K3

PART – B

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

Module – I

11.	Obtain the mathematical formulation of estimation method with an example.	14	CO1	K2
	OR			
12.	Using radar system as an example, differentiate estimation and detection techniques	14	CO1	K2

Module – II

13	Design Neyman-Pearson detector for the unknown level A in White Gaussian Noise with variance σ^2.	14	CO2	K2
	OR			
14	Describe the Bayesian approaches in the design of detectors.	14	CO2	K2

Module – III

15	Obtain Matched Filter detector for N -sample deterministic signal in noise, w[n] ~ N (0, σ^2) where w[n]'s are uncorrelated	14	CO2	K3
	OR			
16	Describe estimator-correlator in the detection of random signals.	14	CO2	K3

Module – IV

17	The data $x[n] = Ar^n + w[n]\ for\ \ n = 0,1,2\ are\ observed, where\ w[n]$ is WGN with variance σ^2 and r > 0 is known. Find the Cramer Rao lower bound for the unknown parameter, A?	14	CO3	K3
	OR			
18	If $x[n] = A + Bn + w[n]\ for\ \ n = 0,1,\ldots,N-1\ are\ observed,\ where\ w[n]$ is WGN with variance σ^2. Find the Fisher information and CRLB for estimating the unknown parameter B. Assume that the parameter A is known.	14	CO3	K3

Module – V

19	For the signal model: $$s[n] = \begin{cases} A, & 0 \le n \le M-1 \\ -A, & M \le n \le N-1 \end{cases}$$ a) Find the Least Square Estimator of A and minimum least square error. Assume $x[n] = s[n] + w[n], for\ n = 0, 1, 2, \ldots, N-1$ are observed. b) If w[n] is WGN with variance σ^2, find the pdf of LSE.	14	CO3	K3
	OR			
20	A data set x[n], n = 0, 1, ..., N-1 is modelled as: $$x[n] = a\cos(2\pi f_0 n) + b\sin(2\pi f_0 n) + w[n],$$ where w[n] is WGN with variance σ^2. Find MMSE estimate of $\theta = [a\ b]^T$, assuming appropriate prior PDF for a and b. Also assume that θ is independent of w[n].	14	CO3	K3

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

SEMESTER VIII

APPLIED ELECTRONICS AND INSTRUMENTATION

AET402	VLSI CIRCUIT DESIGN	CATEGORY	L	T	P	CREDITS
		PCC	2	1	0	3

Preamble: This course aims to develop the skill to design various VLSI circuits.

Pre-requisites: ECT201 SOLID STATE DEVICES & ECT203 LOGIC CIRCUIT DESIGN

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

CO 1	Design and analyze CMOS Inverters
CO 2	Explain CMOS fabrication process and prepare physical layout for various MOS Circuits
CO 3	Design and analyze various Combinational Logic Circuits
CO4	Design and analyze Sequential Logic Circuits and Datapath Subsystems
CO5	Design and analyze various types of Memories

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		3							3
CO 2	3	3			3							3
CO 3	3	3	2		3							3
CO 4	3	3	2		3							3
CO 5	3	3	2		3							3

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	50
Apply	K3	20	20	40
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 and analyze CMOS Inverters

1. Design a CMOS inverter with proper Transistor sizing.
2. Draw and explain the voltage transfer characteristics (VTC) of a CMOS Inverter and obtain its threshold voltage.
3. Describe the CMOS Inverter using SPICE code.
4. Analyze the static and dynamic behavior of CMOS Inverter.

Course Outcome 2 (CO2): Explain CMOS fabrication process and prepare physical layout for various MOS Circuits

1. Explain the concept and importance of stick diagrams in generating the physical layout of an integrated circuit.
2. Explain the lambda(λ) based layout rules in translating stick diagrams into actual geometry in silicon (the physical layout) and its dependency on the process technology.
3. Hand sketch basic MOS transistor layout employing the concept of stick diagrams.
4. Hand sketch the physical layout of a CMOS Inverter, NAND, NOR and XOR gates.
5. Generate the Layout of CMOS Inverter, NAND, NOR and XOR gates using MICROWIND.

Course Outcome 3 (CO3): Design and analyze various Combinational Logic Circuits

1. Design two-input NAND and NOR gates in static Complementary MOS style and analyze the respective VTCs and propagation delay.
2. Design Pseudo NMOS inverter and study the dependence of VTC on the W/L ratio.
3. Design a Pass Transistor and gate and obtain its VTC.
4. Explain the use of Transmission gates in the efficient implementation of complex gates.
5. Explain the basic principles of dynamic logic- Precharge and Evaluation.
6. Explain how the dynamic logic implementation of gates reduce Power dissipation and improve speed of operation.
7. Explain the adverse effects of charge leakage, charge sharing, capacitive coupling and clock feedthrough in the proper functioning of dynamic circuits.

Course Outcome 4 (CO4): Design and analyze Sequential Logic Circuits and Datapath Subsystems

1. Define and explain the three important timing parameters associated with a register.
2. Explain the implementation of latches and registers in the static style.
3. Explain the implementation of latches and registers in the dynamic style.
4. Explain the implementation of various Datapath subsystems.

Course Outcome 5 (CO5): Design and analyze various types of Memories

1. Design of the Memory Core-Read only Memories-Nonvolatile Read Write Memories-Read Write memories-SRAM and DRAM.
2. Explain the design of ROM arrays using NAND and NOR gates.
3. Explain the implementation of various types of Non-Volatile Read Write memories.
4. Explain the operations (read and write) of a six transistor CMOS SRAM cell.
5. Explain the operations (read and write) of a three transistor DRAM cell.

SYLLABUS
AET402 VLSI CIRCUIT DESIGN

Module 1:
Overview of CMOS device fundamentals (Pre-requisite). The CMOS inverter: - Voltage Transfer Characteristics, SPICE Description, Static Behavior - Switching Threshold - Noise Margins, Dynamic behavior - Device Capacitances - Propagation Delay - Power Consumption.

Module 2:
CMOS fabrication Processes: -N-Tub, P-Tub and Twin Tub. MOS Circuit Layout - Stick diagrams, Layout design rules, Transistor layout - PMOS and NMOS, Gate Layout - Inverter, NAND, NOR and XOR, Layout generation using MICROWIND tool (For Assignments/Projects only).

Module 3:
Combinational logic Circuits: - Static MOS - Complementary MOS - Ratioed logic - Pass Transistor logic - Differential Pass Transistor Logic - Transmission gate logic, Dynamic MOS - Basic Principles - Speed and power Dissipation - Signal Integrity issues.

Module 4:
Sequential Logic Circuits: -Timing Metrics for sequential circuits, Static Latches and Registers, Dynamic Latches and Registers. Datapath Subsystems: - Adder - Ripple carry Adder - Full adder - Carry chain Adder - Carry-Bypass Adder - Carry Select Adder - Carry Look Ahead Adder, Multiplier - Array Multiplier - Carry Save Multiplier, Shifter - Barrel Shifter - Logarithmic Shifter.

Module 5:
Design of the Memory Core - Read only Memories - Nonvolatile Read Write Memories - Read Write memories - SRAM and DRAM.

Text Books:

1. J.M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits- A Design Perspective, 2nd ed., PHI.
2. Douglas A. Pucknell & Kamran Eshraghian, Basic VLSI Design, PHI.
3. CMOS digital integrated circuits: Analysis and design, Sung-Mo Kang, Yusuf Lablebici, TATA McGraw-Hill

References:

1. CMOS Logic Circuit Design byJohn P. Uyemura, Springer India Pvt. Ltd. New Delhi.
2. Analysis &Design of Digital Integrated Circuits by David A. Hodges, Horace G. Jackson, R. Saleh, McGraw Hill.
3. CMOS VLSI Design, a Circuits and Systems Perspective, Neil H. E. Weste, David Money Harris, Addison-Wesley
4. VLSI Circuit Layout: theory and design, Edited by T.C Hu, Ernest S. Kuh, IEEE Press
5. Relevant IEEE Journals on VLSI Circuits and Systems.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**The CMOS inverter**	
1.1	The CMOS Inverter- Circuit and VTC	1
1.2	Brief Introduction to SPICE and description of a CMOS inverter in SPICE	1
1.3	The Evaluation of PMOS and NMOS W/L ratios and Inverter switching thresholds, Noise Margin.	2
1.4	MOS device capacitances and propagation delay	2
1.5	Dynamic power consumption	1
2	**MOS Circuit Layout**	
2.1	CMOS fabrication Processes: -N-Tub, P-Tub and Twin-Tub	2
2.2	Introduction to stick diagrams and layout design rules	1
2.3	Transistor layout-PMOS and NMOS	1
2.4	Gate Layout-Inverter, NAND, NOR and XOR.	1
2.5	Layout generation using MICROWIND tool	1
3	**Combinational logic Circuits**	
3.1	Static Complementary MOS	2
3.2	Ratioed logic, Pass Transistor logic	2
3.3	Transmission gate logic	1
3.4	Dynamic MOS- Basic Principles	1
3.5	Dynamic MOS -Speed and power Dissipation	1
3.6	Dynamic MOS -Signal Integrity issues.	2
4	**Sequential Logic Circuits**	
4.1	Timing Metrics for sequential circuits	1
4.2	Static Latches and Registers	2
4.3	Dynamic Latches and Registers	2
4.4	Datapath Subsystems- Adder- Ripple carry Adder-Full adder-Carry chain Adder-Carry-Bypass Adder-Carry Select Adder-Carry Look Ahead Adder.	2
4.5	Multiplier-Array Multiplier-Carry Save Multiplier.	1
4.6	Shifter-Barrel Shifter-Logarithmic Shifter.	1
5	**Design of the Memory Core**	
5.1	Read only Memories	1
5.2	Nonvolatile Read Write Memories	1
5.3	SRAM	1
5.4	DRAM.	1

Assignment:

At least one assignment should be a layout practice using MICROWIND and circuit simulation using SPICE.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B. TECH DEGREE EXAMINATION
Program: Applied Electronics and Instrumentation Engineering/ Electronics and Instrumentation
Course Code: AET402

Course Name: AET402 VLSI CIRCUITS DESIGN

Max. Marks: 100 Duration: 3 Hours

PART-A
Answer all Questions. Each carries 3 marks.

1.	Draw and explain the Voltage Transfer Characteristics of CMOS inverter.	CO1	K2
2.	What is Noise margin? Obtain its expression.	CO1	K3
3.	Explain the λ-based design rules for CMOS circuit layout.	CO2	K1
4.	Draw the stick diagram for a CMOS Inverter.	CO2	K3
5.	Explain the basic concept of complementary static CMOS design.	CO3	K1
6.	Differentiate between Ratioed and Non-ratioed styles of logic gate implementation.	CO3	K3
7.	Define the following timing parameters associated with a register i)Setup Time ii) Hold Time iii) Propagation Delay	CO4	K1
8.	With the help of truth table explain the implementation of Sum and Carry outputs of a binary full adder.	CO4	K2
9.	What is an EPROM? Explain.	CO5	K1
10.	Draw the circuit diagram and explain the operation of a one transistor DRAM cell.	CO5	K2

PART-B
Answer **ONE** question from each module. Each carries 14 marks.

	Module 1			
11.	Derive the Transistor sizing ratio for a CMOS Inverter so that its switching threshold is located at the mid value between supply rails	14	CO1	K3
	OR			
12.	Show that the values of t_{pHL} and t_{pLH} for a CMOS Inverter can be made identical by making the ON resistances of NMOS and PMOS transistors approximately equal.	14	CO1	K3
	Module 2			
13.	Explain the Twin-tub process of CMOS fabrication.	14	CO2	K2
	OR			
14.	Sketch the stick diagram of a CMOS XOR gate.	14	CO2	K2
	Module 3			
15 a).	Implement a two- input NAND gate in complementary static CMOS style.	9	CO3	K2
15 b)	Show that the VTC of a two-input NAND gate is data dependent.	5	CO3	K3
	OR			
16 a).	Explain the pass transistor implementation of an AND gate.	9	CO3	K2
16 b).	Show that the Transmission gate logic style is best suited to enable rial-to-rail switching.	5	CO3	K3
	Module 4			

17 a).	Explain the carry look ahead principle for the implementation of fast adders.	9	CO4	K2
17 b).	With the help of a transistor level circuit diagram explain the implementation of a 4-bit carry look ahead adder.	5	CO4	K2
	OR			
18.	With the help of a transistor level circuit diagram explain the working of a logarithmic shifter.	14	CO4	K2
	Module 5			
19.	Explain the Read/Write operation of a 6T CMOS SRAM cell.	14	CO5	K2
	OR			
20.	Explain the operation of a 3T DRAM cell	14	CO5	K2

AET 414	ANN AND DEEP LEARNING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble:

Artificial neural networks (ANNs), are computing systems inspired by the biological neural networks that constitute human brains. Deep learning is a powerful set of techniques for training neural networks. This course introduces the key concepts in neural networks, its architecture and learning paradigms, optimization techniques, basic concepts in deep learning, deep learning architectures such as Convolutional Neural Networks and Recurrent Neural Networks etc. The students will be able to provide best solutions to real world problems in domains such as pattern analysis and speech and audio processing.

Prerequisite:

A Sound knowledge in Computational fundamentals of machine learning

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

CO1	Explain the basic concepts of machine learning models, algorithms, and performance metrics. (K2)
CO2	Illustrate the basic concepts and architecture of artificial neural networks and its design issues. (K3)
CO3	Formulate methodologies for the standard regularization and optimization techniques, training and testing for deep neural networks. (K3)
CO4	Build CNN and RNN models for different use cases. (K3)
CO5	Explain the concepts of modern RNNs, LSTM, GRU and understand the usage for practical applications. (K2)

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3	3		2								2
CO 2	3	3			2							2
CO 3	2	2			2				3	3		2
CO 4					2				3	3		2
CO 5	2	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	50
Apply	K3	20	20	40
Analyze				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

End Semester Examination Pattern:

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the basic concepts of machine learning models, algorithms, and performance metrics.

1. Understand the basic terminologies in Machine learning- categorize different learning approaches.

2. Compare and contrast between different machine learning algorithms.

3. Understand basic principles of regression and classification.

4. Understand the principles definitions of different performance metrics for evaluating machine learning models.

Sample questions:

1. Calculate the two regression equations of X on Y and Y on X from the data given below, taking deviations from a actual means of X and Y. Estimate the likely demand when the price is Rs.20.

Price(Rs.)	10	12	13	12	16	15
Amount demanded	40	38	43	45	37	43

2. Consider a two-class classification problem of predicting whether a photograph contains a man or a woman. Suppose we have a test dataset of 10 records with expected outcomes and a set of predictions from our classification algorithm. Compute the confusion matrix, accuracy, precision, recall, sensitivity and specificity on the following data.

Sl.No.	Actual	Predicted
1	man	woman
2	man	man
3	woman	woman
4	man	man
5	man	woman
6	woman	woman
7	woman	man
8	man	man
9	man	woman
10	woman	woman

Course Outcome 2 (CO2): Illustrate the basic concepts and architecture of artificial neural networks and its design issues.

1. Understand the basic principles and terminologies in Artificial Neural Networks.
2. Explain the working principles of perceptron- understand the perceptron learning algorithm.
3. Understand the significance of different activation functions, usage and selection of its parameters.
4. Design of basic ANN for practical applications in classification and regression tasks.

Sample Questions:

1. Suppose you have a 3-dimensional input x = (x1, x2, x3) = (2, 2, 1) fully connected with weights (0.5, 0.3, 0.2) to one neuron which is in the hidden layer with sigmoid activation function. Calculate the output of the hidden layer neuron.

2. Consider the case of the XOR function in which the two points {(0, 0),(1, 1)} belong to one class, and the other two points {(1, 0),(0, 1)} belong to the other class. Design a multilayer perceptron for this binary classification problem.

Course Outcome 3 (CO3): Formulate methodologies for the standard regularization and optimization techniques, training and testing for deep neural networks.

1. Study the basic principles optimization and regularization techniques
2. Familiarize the concept and conventions used in training, validation and testing of deep learning models.
3. Understand the concepts of Early stopping, Dataset augmentation etc.

Sample questions:

1. Derive a mathematical expression to show L2 regularization as weight decay.
2. Explain how L2 regularization improves the performance of deep feed forward neural networks.
3. Explain how L1 regularization method leads to weight sparsity.

Course Outcome 4 (CO4): Build CNN and RNN models for different use cases.

1. Familiarization of deep leaning structures CNN and RNN and functionality of different layers.
2. Design and implementation of basic CNN for pattern analysis tasks.
3. Performance analysis of CNN models.

Sample questions:

1. Let us consider a Convolutional Neural Network having three different convolutional layers in its architecture as –

Layer-1: Filter Size – 3 X 3, Number of Filters – 10, Stride – 1, Padding – 0

Layer-2: Filter Size – 5 X 5, Number of Filters – 20, Stride – 2, Padding – 0

Layer-3: Filter Size – 5 X5 , Number of Filters – 40, Stride – 2, Padding – 0

If we give the input a 3-D image to the network of dimension 39 X 39, then determine the dimension of the vector after passing through a fully connected layer in the architecture.

2. Illustrate the workings of the RNN with an example of a single sequence defined on a vocabulary of four words.

Course Outcome 5 (CO5): Explain the concepts of modern RNNs, LSTM, GRU and understand the usage for practical applications.

1. Study the basic principles and properties of RNNs, LSTM and GRU.
2. Familiarize the concepts of deep recurrent networks, recursive neural networks
3. Build simple RNN for practical applications in speech processing domain.

Sample questions:

1. Draw and explain the architecture of LSTM.
2. List the differences between LSTM and GRU
3. Explain design steps of an RNN.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SYLLABUS

Module - 1 (Basics of Machine Learning)
Machine Learning basics - Learning algorithms - Supervised, Unsupervised, Reinforcement, Overfitting, Underfitting, Hyper parameters and Validation sets, Estimators -Bias and Variance. Challenges in machine learning. Simple Linear Regression, Logistic Regression, Classification. Performance metrics - Confusion matrix, Accuracy, Precision, Recall, Sensitivity, Specificity, Receiver Operating Characteristic curve (ROC), Area Under Curve (AUC).

Module -2 (Artificial Neural Networks)
Introduction to artificial neural networks -Single layer perceptrons, Multi-Layer Perceptrons (MLPs), Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax. Risk minimization, Loss function, Training MLPs with backpropagation, Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems, Difficulties in convergence, Local and spurious Optima, Computational Challenges. Applications of neural networks for classification and regression tasks.

Module 3 (Fundamentals of Deep learning)
Introduction to deep learning, Deep feed forward network, Training deep models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques - L1 and L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Parameter initialization.

Module -4 (Convolutional Neural Network)
Convolutional Neural Networks – Convolution operation, Motivation, Pooling, Convolution and Pooling as an infinitely strong prior, Variants of convolution functions, Structured outputs, Data types, Efficient convolution algorithms. Practical use cases for CNNs, Case study - Building CNN model AlexNet for simple pattern analysis tasks benchmark datasets.

Module- 5 (Recurrent Neural Network)
Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs. Case study – Build simple RNN for tasks in speech and audio processing and image processing domains.

Text Book

1. Symon O. Haykin, Neural Networks & Learning Machines, Pearson Education India; Third edition (1 April 2016)
2. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
3. Neural Networks and Deep Learning, Aggarwal, Charu C., Springer International Publishing AG, part of Springer Nature 2018
4. Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media, Inc.

Reference Books

1. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Michael Nielsen, Neural Networks and Deep Learning, 2018
4. Symon O. Haykin,Neural Network – A Comprehensive Foundation, Pearson Education (US) (7 August 1997).

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

Teaching Plan

Module 1: [Text book 1: Chapter 5, Textbook 2: Chapter 2]		(7 hours)
1.1	Introduction, Learning algorithms - Supervised, Unsupervised, Reinforcement, Overfitting, Underfitting, Hyperparameters	2 hours
1.2	Validation sets, Estimators -Bias and Variance. Challenges in machine learning.	1 hour
1.3	Simple Linear Regression, Illustration of Linear Regression	1 hour
1.4	Logistic Regression, Illustration of Logistic Regression	1 hour
1.5	Performance metrics - Confusion matrix, Accuracy, Precision, Recall, Sensitivity, Specificity, ROC, AUC.	1 hour
1.6	Illustrative Examples for performance metrics	1 hour
Module 2: Text book 2, Chapter 1		(6 hours)
2.1	Introduction to artificial neural networks -Single layer perceptrons	1 hour
2.2	Multi-Layer Perceptrons (MLPs), Representation Power of MLPs	1 hour
2.3	Activation functions - Sigmoid, Tanh, ReLU, Softmax. Risk minimization, Loss function	1 hour
2.4	Training MLPs with backpropagation algorithm, Illustration of back propagation algorithm	1 hour
2.5	Practical issues in artificial neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems	1 hour
2.6	Difficulties in convergence, Local and spurious Optima, Computational Challenges. Applications of artificial neural networks	1 hour
Module 3: Text book 1: Chapter 7, 8, Text book 2, Chapter 3, 4		(8 hours)
3.1	Introduction to deep learning, Deep feed forward network	1 hour
3.2	Training deep learning models - Introduction, setup and initialization issues	1 hour
3.4	Concepts of optimization, Gradient Descent (GD), GD with momentum.	1 hour
3.5	Nesterov accelerated GD, Stochastic GD.	1 hour
3.6	AdaGrad, RMSProp, Adam.	1 hour
3.7	Concepts of Regularization, L1 and L2 regularization, Early stopping, Dataset augmentation	2 hours
3.9	Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Parameter initialization.	1 hour
Module 4: Text book 1, Chapter 9, Text book 2: Chapter 8		(7 hours)
4.1	Convolutional Neural Networks, architecture	1 hour
4.2	Convolution and Pooling operation with example, Convolution and Pooling as an infinitely strong prior	1 hour
4.3	Variants of convolution functions, structured outputs, data types	1 hour
4.4	Efficient convolution algorithms.	1 hour

4.5	Practical use cases for CNNs	1 hour
4.6	Case study - Building CNN model AlexNet for simple pattern analysis tasks benchmark datasets.	2 hours
Module 5: Text book 1: Chapter 10, 11, Text book 2: Chapter 7		(7 hours)
5.1	Recurrent neural networks – Computational graphs, RNN design	1 hour
5.2	Encoder – decoder sequence to sequence architectures	1 hour
5.3	Deep recurrent networks- Architecture, Recursive neural networks	1 hour
5.4	Modern RNNs - LSTM, GRU	1 hour
5.5	Practical use cases for RNNs.	1 hour
5.6	Case study – Speech and Audio Processing.	1 hour
5.7	Case study - Image Processing.	1 hour

Assignment:

Assignment1: Implementation of ANN using Python / Neural Network Tool box- MATLAB
Assignment2: Implementation of simple CNN for pattern analysis tasks (Image Processing)

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Program: Applied Electronics and Instrumentation Engineering/ Electronics & Instrumentation Engineering

Course Code: AET414

Course Name: ANN and Deep Learning

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	List and compare the types of machine learning algorithms.	CO1	K3
2	Suppose 10000 patients get tested for flu; out of them, 9000 are actually healthy and 1000 are actually sick. For the sick people, a test was positive for 620 and negative for 380. For healthy people, the same test was positive for 180 and negative for 8820. Construct a confusion matrix for the data and compute the accuracy, precision and recall for the data.	CO1	K2
3	Illustrate the limitation of a single layer perceptron with an example.	CO2	K2
4	Specify the advantages of ReLU over sigmoid activation function.	CO2	K2
5	Derive weight updating rule in gradient descent when the error function is a) mean squared error b) cross entropy.	CO3	K3
6	List any three methods to prevent overfitting in neural networks.	CO3	K3
7	What happens if the stride of the convolutional layer increases? What can be the maximum stride? Justify your answer.	CO4	K2
8	Consider an activation volume of size 13×13×64 and a filter of size 3×3×64. Discuss whether it is possible to perform convolutions with strides 2, 3 and 5. Justify your answer in each case.	CO4	K3
9	How does a recursive neural network work?	CO5	K2
10	List down three differences between LSTM and RNN.	CO5	K2

PART – B

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

Module – I

11. a)	Prove that the decision boundary of binary logistic regression is linear	9	CO1	K3
11. b)	Given the following data, construct the ROC curve of the data. Compute the AUC.	5	CO2	K3

Threshold	TP	TN	FP	FN
1	0	25	0	29
2	7	25	0	22

<table>
<tr><td></td><td><table><tr><td>3</td><td>18</td><td>24</td><td>1</td><td>11</td></tr><tr><td>4</td><td>26</td><td>20</td><td>5</td><td>3</td></tr><tr><td>5</td><td>29</td><td>11</td><td>14</td><td>0</td></tr><tr><td>6</td><td>29</td><td>0</td><td>25</td><td>0</td></tr><tr><td>7</td><td>29</td><td>0</td><td>25</td><td>0</td></tr></table></td><td></td><td></td><td></td></tr>
<tr><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td>12.a)</td><td>With an example classification problem, explain the following terms: a) Hyper parameters b) Training set c) Validation sets d) Bias e) Variance</td><td>6</td><td>CO1</td><td>K3</td></tr>
<tr><td>12.b)</td><td>Determine the regression equation by finding the regression slope coefficient and the intercept value using the following data.<table><tr><td>x</td><td>55</td><td>60</td><td>65</td><td>70</td><td>80</td></tr><tr><td>y</td><td>52</td><td>54</td><td>56</td><td>58</td><td>62</td></tr></table></td><td>4</td><td>CO2</td><td>K3</td></tr>
<tr><td>12.c)</td><td>With illustrative examples, explain confusion matrix, accuracy, precision, recall, sensitivity, specificity of a classifier.</td><td>4</td><td>CO1</td><td>K3</td></tr>
</table>

Module – II

<table>
<tr><td>13 a)</td><td>Obtain the weight updation equations in a multi-layer perceptron (MLP) based on back propagation with one hidden layer. Suggest the complete architectural details for a MLP that may be used for classifying the spiral data as shown in Figure 1 above with two classes. Draw a neat diagram. The diagram must contain details of different layers, number of nodes, activation functions used in each layer/nodes and hyper parameters used.

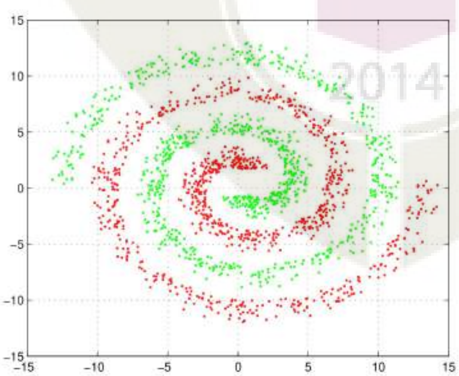



Figure 1</td><td>9</td><td>CO2</td><td>K2</td></tr>
<tr><td>13 b)</td><td>Briefly explain the significance of different activation functions used for neurons.</td><td>5</td><td>CO2</td><td>K2</td></tr>
<tr><td></td><td>OR</td><td></td><td></td><td></td></tr>
</table>

14 a)	An ANN as shown in Figure 2 is set up to classify 2D patterns belong to two classes as shown in the right side of Figure 1. Explain how do you select (1). Learning rate parameter (η) (2). initial weights (3). activation functions for different layers and (4) optimization algorithm.	9	CO2	K2

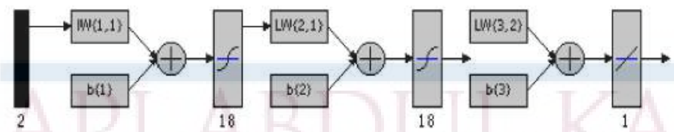


Figure 2

14 b)	Explain how the weights between output layer and hidden layer, hidden layer and input layer of an ANN are updated using stochastic gradient descent algorithm.	5	CO2	K2

Module – III

15 a)	Differentiate gradient descent with and without momentum. Give equations for weight updation in GD with and without momentum. Illustrate plateaus, saddle points and slowly varying gradients.	5	CO3	K3
15 b)	Discuss the differences between conventional learning and deep learning. Explain the functionalities of different layers in a deep learning structure.	9	CO3	K3
	OR			
16 a)	Suppose a supervised learning problem is given to model a deep feed forward neural network. Suggest solutions for the following a) small sized dataset for training b) dataset with both labelled and unlabeled data c) large data set but data from different distribution	9	CO3	K2
16 b)	Describe the effect in bias and variance when a neural network is modified with more number of hidden units followed with dropout regularization.	3	CO3	K2
16 c)	Explain the concept of dropout, parameter initialization associated with deep learning.	2	CO3	K3

Module – IV

17 a)	Draw and explain the architecture of Convolutional Neural Networks. Explain the functionalities of all layers.	9	CO3	K2
17 b)	Suppose that a CNN was trained to classify images into different categories. It performed well on a validation set that was taken from the same source as the training set but not on a testing set. What could be the problem with the training of such a CNN? How will you ascertain the problem? How can those problems be solved?	5	CO4	K3
	OR			
18 a)	Explain the following convolution functions a)tensors b) kernel flipping c) down sampling d) strides e) zero padding.	9	CO3	K2
18 b)	Explain the need for data augmentation in CNN. Also explain the selection of convolutional kernel.	5	CO3	K2

Module – V

19 a)	Describe how an LSTM takes care of the vanishing gradient problem. Use some hypothetical numbers for input and output signals to explain the concept.	8	CO4	K3
19 b)	Explain the architecture of Recurrent Neural Networks	6	CO4	K3
	OR			
20 a)	Explain LSTM based solution for anyone of the problems in the Natural Language Processing domain.	6	CO4	K3
20 b)	Discuss the architecture of GRU	4	CO4	K3
20 c)	Briefly explain the design steps involved in the design of an RNN for image restoration task.	4	CO2	K2

AET424	SOFT COMPUTING	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to introduce the concepts of Soft Computing that include Statistical learning models, Artificial Neural Networks, Support Vector Machines, Fuzzy logic-based systems, Genetic Algorithm-based systems and their hybrids.

Prerequisite: Nil

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

CO 1	Define and explain soft computing techniques and their applications, build statistical learning models.
CO 2	Analyze various neural network architectures and Support Vector Machine.
CO 3	Define the fuzzy systems. Understand the genetic algorithm concepts and their applications.
CO4	Identify and select a suitable Soft Computing technique to solve the real world problems; construct a solutions and implement a Soft Computing systems.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment /Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	40
Apply	K3	10	10	30
Analyze	K3	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): Define and explain soft computing techniques and their applications, build statistical learning models.

1. Understand the basic terminologies in soft computing- categorize different learning approaches.
2. Compare and contrast between human learning and machine learning.
3. Understand the principles of statistical learning methods

Course Outcome 2 (CO2): Analyze various neural network architectures and Support Vector Machine.

1. Understand the basic principles and terminologies in Artificial Neural Networks.
2. Explain the working principles of perceptron- understand the perceptron learning algorithm.
3. Understand the theory behind maximum margin-based classifiers. The concept of decision regions and hyperplanes. The principle of SVM.
4. Explain the use of SVM based classifiers for multi-class classifications

Course Outcome 3 (CO3): Define the fuzzy systems. Understand the Genetic Algorithm concepts and their applications.

1. Study the basic principles and properties of Fuzzy logic and fuzzy sets
2. Familiarize the operations on fuzzy relations, Fuzzy membership functions and fuzzification.
3. Understand the concepts of defuzzification methods, Truth values and Tables in Fuzzy Logic, Fuzzy propositions, Formation of fuzzy rules and Decomposition of rules.

Course Outcome 4 (CO4): Identify and select a suitable Soft Computing technique to solve the real-world problems; construct a solution and implement a Soft Computing system.

1. Familiarization and generation of synthetic and toy datasets such as linearly separable, non-linearly separable and overlapping datasets.
2. Design and implement Bayesian classifiers for different cases of covariance matrices
3. Implement ANNs and SVMs using suitable software tools.

SYLLABUS

Module 1:

Introduction to Soft Computing: Artificial neural networks - biological neurons, Basic models of artificial neural networks – McCulloch and Pitts Neuron, Perceptron networks Learning rule – Training and testing algorithm, Activation Functions – Multi-layer perceptrons, Back propagation Network – Architecture, Learning algorithm

Module 2:

Statistical Learning Models: Bayesian decision theory- Bayes classifier, Decision regions, significance of covariance matrix. Introduction to GMM. Support vector machines- introduction-concept of maximum margin- multi-class classifiers using SVM

Module 3:

Fuzzy Systems: Fuzzy logic - fuzzy sets - properties - operations on fuzzy sets, fuzzy relations - operations on fuzzy relations, Fuzzy membership functions, fuzzification, Methods of membership value assignments – intuition – inference – rank ordering, Lambda –cuts for fuzzy sets, Defuzzification methods- Truth values and Tables in Fuzzy Logic, Fuzzy propositions, Formation of fuzzy rules - Decomposition of rules –Aggregation of rules, Fuzzy Inference Systems – Mamdani and Sugeno types, Neuro-fuzzy hybrid systems –characteristics – classification

Module 4:

Genetic Algorithm: Introduction to genetic algorithm, operators in genetic algorithm - coding - selection - cross over – mutation, stopping condition for genetic algorithm flow, Genetic neuro hybrid systems, Genetic-Fuzzy rule-based system

Module 5:

Design and Implementation of Simple Soft Computing Systems: Study of synthetic datasets- linearly separable- non linearly separable -overlapping types. Implementation of perceptrons- Bayes classifiers- ANNs and SVMs using software tools.

Text Books

1. S. N. Sivanandam and S. N.Deepa, Principles of soft computing – John Wiley & Sons, 2007.
2. Timothy J. Ross, Fuzzy Logic with engineering applications, John Wiley & Sons, 2016.

Reference Books

1. N. K. Sinha and M. M. Gupta, Soft Computing & Intelligent Systems: Theory & Applications-Academic Press /Elsevier. 2009.
2. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc.
3. R. Eberhart and Y. Shi, Computational Intelligence: Concepts to Implementation, Morgan Kaufman/Elsevier, 2007.
4. Ross T.J, Fuzzy Logic with Engineering Applications- McGraw Hill.
5. Driankov D., Hellendoorn H. and Reinfrank M., An Introduction to Fuzzy Control-Narosa Pub.
6. Bart Kosko, Neural Network and Fuzzy Systems- Prentice Hall, Inc., Englewood Cliffs
7. Goldberg D.E., Genetic Algorithms in Search, Optimization, and Machine Learning-Addison Wesley.
8. B. Yegnanarayana, Artificial Neural Networks, Prentice Hall, Inc., 2004.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Soft Computing**	
1.1	Introduction to soft computing techniques	1
1.2	Artificial neural networks - biological neurons, Basic models of artificial neural networks – McCulloch and Pitts Neuron	2
1.3	Perceptron networks Learning rule – Training and testing algorithm, Activation Functions	2
	Multi-Layer Perceptrons	
1.4	Multi-layer perceptrons, Back propagation Network – Architecture, Learning algorithm	2
2	**Statistical Learning Models:**	
2.1	Bayesian decision theory- Bayes classifier, Decision regions, significance of covariance matrix.	2
	GMMs and Support vector machines	
2.2	Introduction to GMM. Support vector machines- introduction-concept of maximum margin- Multi-class classifiers using SVM	3
2.3	introduction-concept of maximum margin- Multi-class classifiers using SVM	3
3	**Fuzzy Systems**	
3.1	Fuzzy logic - fuzzy sets - properties - operations on fuzzy sets, fuzzy relations -	1
3.2	operations on fuzzy relations, Fuzzy membership functions, fuzzification, Methods of membership value assignments – intuition – inference – rank ordering, Lambda –cuts for fuzzy sets	2
	Defuzzification methods	
3.3	Defuzzification methods- Truth values and Tables in Fuzzy Logic, Fuzzy propositions, Formation of fuzzy rules -	2
3.4	Decomposition of rules –Aggregation of rules, Fuzzy Inference Systems – Mamdani and Sugeno types,	2
3.5	Neuro-fuzzy hybrid systems –characteristics - classification	1
4	**Genetic Algorithm**	

4.1	Introduction to genetic algorithm, operators in genetic algorithm - coding - selection - cross over – mutation.	2
4.2	Stopping condition for genetic algorithm flow, Genetic neuro hybrid systems,	2
4.3	Genetic-Fuzzy rule based system	1

5	**Design and Implementation of Simple Soft Computing Systems:**	
5.1	Study of synthetic datasets- linearly separable- non linearly separable - overlapping types.	1
5.2	Implementation of perceptrons- Bayes classifiers-	2
5.3	Implementation of ANNs using software tools.	2
5.4	Implementation of SVMss using software tools.	2

Assignment:

Assignment1: Implementation of Bayesian classifiers- Perceptrons.
Assignment2: Implementation of ANNs and SVMs

Model Question paper
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET424

Program: Minor in Applied Electronics and Instrumentation Engineering/ Electronics & Instrumentation Engineering

Course Name: SOFT COMPUTING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all Questions. Each question carry 3 marks.

1	With the help of a neat schematic, explain the operation of a perceptron. Also explain the significance of bias and activation function.	CO1	K2
2	Explain the significance of learning rate parameter associated with the perceptron learning.	CO1	K2
3	Explain Bayes decision theory. Discuss how a two-class classification problem can be solved using Bayes classifier.	CO2	K2
4	What do you mean be maximum margin? Derive an expression for the margin of SVM.	CO2	K2
5	Give a list of properties and operations on a fuzzy set.	CO3	K3
6	Briefly explain the characteristics of fuzzy inference systems.	CO3	K2
7	Discuss the importance of Genetic Algorithm in soft computing.	CO4	K2
8	Explain various operators used in Genetic Algorithm	CO4	K2
9	Discuss how do you generate synthetic datasets for different experiments associated with building classifiers.	CO5	K2
10	Briefly explain the procedure for generating training, testing and validation datasets for experiments.	CO5	K2

PART – B

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

Module – I

11. a)	Explain the learning rule for perceptron. Also explain how weights are updated in the perceptron learning process.	5	CO1	K2
11. b)	With neat waveforms and expressions explain the hard threshold logic and sigmoid activation functions. Discuss the significance of spread parameter associated with the sigmoid activation function.	9	CO2	K2
	OR			
12.a)	With the help of a neat diagram explain the architecture of a single hidden layer artificial Neural Network. Also discuss how different	5	CO1	K2

	parameters such as number of neurons in different layers, initial weights, activation functions etc., are selected.			
12.b)	Explain the back propagation algorithm associated with the ANN learning. Also explain hoe weights are updated and conditions for convergence.	5	CO2	K2
12.c)	Discuss the significance of momentum constant associated with the ANN.	4	CO1	K2

Module – II

13 a)	Give the expression for multivariate Gaussian distribution and explain each term. Explain the significance of covariance matrix.	9	CO2	K2
13 b)	Design Bayes classifier for a two class classification problem. Assume that the data is distributed as per multivariate Gaussian. Explain the decision logic.	5	CO2	K2
	OR			
14 a)	With the help of a neat schematic explain the basic principle of GMM.	9	CO2	K2
14 b)	With the help of a neat schematic explain the functionality of SVM. Also explain how do you determine the optimum decision surface if the underlying data is linearly separable ?	5	CO2	K2

Module – III

15 a)	Explain the concept of fuzzy membership functions. Also explain basic features of membership functions.	5	CO3	K2
15 b)	Discuss different methods for assigning membership values. Illustrate intuition and inference with relevant examples.	9	CO3	K3
	OR			
16 a)	Briefly explain the basic principles of defuzzification. Explain any two defuzzification methods.	7	CO3	K2
16 b)	Compare and contrast between conventional control and fuzzy control systems.	4	CO3	K2
16 c)	Explain the characteristics of a fuzzy inference system. Also with the help of sketches, explain Mamdani inference system	3	CO3	K3

Module – IV

17 a)	Briefly explain the concept of selection associated with the genetic algorithm. Distinguish between random selection and rank selection strategies.	9	CO3	K2
17 b)	What do you mean by cross over ? Explain single point and two point cross over with necessary illustrations. Also explain cross over probability.	5	CO4	K2
	OR			
18 a)	Explain various stopping conditions for genetic algorithm flow. Compare and contrast between best individual and worst individual conditions for stopping.	9	CO3	K2
18 b)	With the help of a neat schematic explain genetic neuro hybrid systems	5	CO3	K2

Module – V

19 a)	With neat illustrations, explain the characteristics of linearly, nonlinearly separable and overlapping type datasets.	6	CO4	K3
19 b)	Explain the experimental set up and procedures for conducting pattern analysis experiments using SVM	8	CO4	K2
	OR			
20 a)	Briefly comment on available software tools for implementing ANNs and SVMs.	4	CO4	K2
20 b)	Explain the experimental set up and procedures for conducting pattern analysis experiments using ANN using a suitable software tool	5	CO4	K3
20 c)	Explain how do you perform multi-class classification using SVM. What are the different approaches for multi-class classification using SVM ?	5	CO2	K2

AET434	BIOINFORMATICS	CATEGORY	L	T	P	Credit
		PEC	2	1	0	3

Preamble:

The course is designed for the engineering graduates to understand basic concepts of molecular biology bioinformatics and to introduce data processing and modelling of biological data. This will help the students to tap opportunities in the areas of computational biology, which is an emerging engineering discipline. The course will cover basics of molecular biology, biological data analysis and tools in bioinformatics.

Prerequisite: Basic background in higher secondary biology

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

CO 1	Describe the basic concept of Bioinformatics with emphasis on structure, function and generation of macromolecules and biological databases (K2)
CO 2	Explain the basic concept of genome analysis and gene mapping (K2).
CO 3	Make use of the similarity searching tools and align sequences to highlight the similarity (K3)
CO 4	Demonstrate the building of phylogenetic trees for multiple alignments (K3)
CO 5	Interpret basic aspects of Hidden Markov Model based machine learning with applications in bioinformatics (K2)

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks (%)
	Test 1 (%)	Test 2 (%)	
Remember	10	10	10
Understand	30	30	70
Apply	10	10	20
Analyze			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance **10 marks**

Continuous Assessment Tests (Average of SeriesTests1 & 2) **25 marks**

Continuous Assessment Assignment **15 marks**

End Semester Examination Pattern:

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Describe the basic concept of Bioinformatics with emphasis on structure, function and generation of macromolecules and biological databases.

1. Compare and contrast the DNA and RNA on the basis of structure and functions.
2. Demonstrate with the help of a flow diagram the generation of protein using the transcription and translation process.

Course Outcome 2 (CO2): Explain the basic concept of genome analysis and gene mapping.

1. Compare and contrast the gene structure of prokaryotic and eukaryotic genomes.
2. Summarize about physical maps.

Course Outcome 3 (CO3): Make use of the similarity searching tools and align sequences to highlight the similarity.

1. Apply Needleman-Wunsch Algorithm to perform sequence alignment for the following sequences: CGTGAATTCAT (sequence #1), GACTTAC (sequence #2)
2. Illustrate any one of the dynamic programming method for sequence alignment.

Course Outcome 4 (CO4): Demonstrate the building of phylogenetic trees for multiple alignments.

1. Differentiate between rooted and unrooted phylogenetic trees. How many rooted and unrooted trees are possible for n species?
2. Identify the advantages and disadvantages of parsimony methods.

Course Outcome 5 (CO5): Interpret basic aspects of Hidden Markov Model based machine learning with applications in bioinformatics.

1. Discuss the advantages and disadvantages of using HMMs.
2. Show how to construct a profile HMM·

SYLLABUS

Module-1 (Introduction to Bioinformatics and Biological Databases)
Introduction, Definition and Application of Bioinformatics, Central Dogma of Molecular Biology, the Genetic Material- DNA, Nucleotides, RNA, mRNA, rRNA, tRNA, RNA Interference-MiRNA, SiRNA, Biological Databases-Types of Databases, Biological Database Considerations, Data Mining of Biological Databases.

Module-2 (Genome Analysis and Gene Mapping)
Definitions, Genome Analysis- Prokaryotic Genomes, Prokaryotic Genome Structure, Eukaryotic Genomes, Structural Genes, Gene Family, Genome Mapping- Sequence Assembly Problem, Genetic Mapping and Linkage Analysis, Physical Maps, Genome Sequencing, Application of Genetic Maps, Sequence Assembly Tools, Human Genome Project

Module-3 (Sequence Alignment)
Pairwise Sequence Alignment, Sequence-homology, Similarity and Identity, Global and Local Alignment, Dot Matrix Method, Dynamic Programming Method- Gap Penalties, Scoring Matrices, Needleman–Wunsch Algorithm, Smith–Waterman Algorithm, Multiple Sequence Alignment.

Module-4 (Phylogenetics, Gene Expression and Microarray)
Introduction, Terminology, Tree Topologies, Gene Trees, Tree Visualization Tools. Phylogenetic Analysis- The Neighbour-Joining Method, UPGMA Method, Maximum Parsimony and Maximum Likelihood Methods (Brief on methods not in detail), Gene Expression- cDNAs and ESTs, SAGE, Microarray – Types, Gene Array Experiment.

Module-5 (Profiles and Hidden Markov Model)
Introduction, Definitions, Regular Expressions, Hidden Markov Model (HMM)- Markov Process, Markov Model for DNA Sequence, Components of HMM, Building HMM, HMM Scoring Algorithms, HMM Architecture, Applications of HMM, Modelling Protein Domains Using HMMs.

Text Books

1. S C Rastogi, N Mendiratta and P Rastogi, Bioinformatics: Methods and Applications, PHI Learning Private Limited, New Delhi, 2015.
2. Xiong, Jin. Essential bioinformatics. Cambridge University Press, 2006.
3. D E Krane and M L Raymer, Fundamental Concepts of Bioinformatics, Pearson Education, 2006.

References

1. Zvelebil, Marketa J., and Jeremy O. Baum. Understanding bioinformatics. Garland Science, 2007.
2. Andreas D.Baxevanis, B F Francis Ouellette, Bioinformatics - A Practical Guide to the Analysis of Genes and Proteins, Third Edition, John Wiley & Sons INC. , U.K. 2006
3. Neil C Jones and Pavel A Pevzner, An Introduction to Bioinformatics Algorithms, MIT press, 2004.
4. Klipp, E., Herwig, R., Kowald, A., Wierling, C., & Lehrach, H. Systems biology in practice: concepts, implementation and application. John Wiley & Sons. 2005.

Course Contents and Lecture schedule

No	Contents	No of Lecture Hrs.
	Module-1 (Introduction to Bioinformatics and Biological Databases) (6 hrs.)	
1.1	Introduction, Definition and Application of Bioinformatics	1
1.2	Central Dogma of Molecular Biology, the Genetic Material- DNA, Nucleotides, RNA	1
1.3	mRNA, rRNA, tRNA, RNA Interference-MiRNA, SiRNA	1
1.4	Biological Databases-Types of Databases	1
1.5	Biological Database Considerations	1
1.6	Data Mining of Biological Databases	1
	Module-2 (Genome analysis and Gene Mapping) (7 hrs)	
2.1	Definitions, Genome Analysis- Prokaryotic Genomes	1
2.2	Prokaryotic Genome Structure	1
2.3	Eukaryotic Genomes, Structural Genes, Gene Family	1
2.4	Genome Mapping- Sequence Assembly Problem, Genetic Mapping and Linkage Analysis	1
2.5	Physical Maps, Genome Sequencing	1
2.6	Application of Genetic Maps	1
2.7	Sequence Assembly Tools, Human Genome Project	1
	Module-3 (Sequence Alignment) (7 hrs)	
3.1	Pairwise Sequence Alignment	1
3.2	Sequence-Homology, Similarity and Identity	1
3.3	Global and Local Alignment, Dot Matrix Method	1
3.4	Dynamic Programming Method, Gap Penalties, Scoring Matrices	1
3.5	Needleman–Wunsch Algorithm	1
3.6	Smith–Waterman Algorithm	1
3.7	Multiple Sequence Alignment	1
	Module-4 (Phylogenetics, Gene Expression and Microarray) (8 hrs)	
4.1	Introduction, Terminology	1
4.2	Tree Topologies, Gene Trees	1
4.3	Tree Visualization Tools	1
4.4	Phylogenetic Analysis- The Neighbour -Joining Method	1
4.5	UPGMA Method	1
4.6	Maximum Parsimony and Maximum Likelihood Methods (Brief on methods not in detail)	1
4.7	Gene Expression- cDNAs and ESTs, SAGE, Microarray – Types	1
4.8	Gene Array Experiment	1

Module-5 (Profiles and Hidden Markov Model) (7 hrs)		
5.1	Introduction, Definitions, Eegular Expressions	1
5.2	Hidden Markov Model (HMM)- Markov Process	1
5.3	Markov Model for DNA Sequence	1
5.4	Components of HMM, Building HMM	1
5.5	HMM Scoring Algorithms, HMM Architecture	1
5.6	Applications of HMM	1
5.7	Modelling Protein Domains Using HMMs	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd.
2014

Model Question Paper

QP CODE:

Reg No: ______________

Name: ______________ **PAGES: 2**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B. TECH DEGREE EXAMINATION, MONTH & YEAR

Program: Applied Electronics and Instrumentation Engineering/ Electronics and Instrumentation

Course Code: AET 434

Course Name: Bioinformatics

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

PART A

Answer all Questions. Each question carries 3 Marks

1. Write a short note on nucleic acid sequence database.
2. What are the functions of mRNA, tRNA and rRNA?
3. Justify the reasons for the high Prokaryotic gene density compared to Eukaryotes.
4. Draw and explain Eukaryotic gene structure.
5. Write difference between local and global alignment.
6. Write short note on Gap penalties and its usage in comparing biological sequence
7. Summarize about the DNA microarray technology?
8. Differentiate between rooted and unrooted phylogenetic tees.
9. Explain the significance of Hidden Markov Model in bioinformatics.
10. How can you construct a profile in HMM?

(10 X 3 = 30 Marks)

PART B

(Answer any one Question from each Module. Each question carries 14 Marks)

11. A) Diagram the 'Central dogma' of molecular biology complete with labels that indicate the portions that correspond to transcription and translation and indicate what enzymes are responsible for those important steps. **7 marks**

B) With a neat diagram describe the structural and functional differences between DNA and RNA. **7 marks**

OR

12. Explain with the help of a neat diagram, the different steps in knowledge discovery. Also explain the different data mining tools for mining biological databases. **14 marks**

13. Explain Prokaryotic gene structure with neat diagrams. **14 marks**

OR

14. A) Write notes on any 4 DNA markers used for linkage analysis and studies. **8 marks**

B) What is genome mapping? Differentiate between genetic maps and physical maps. **6 marks**

15. Using Smith Waterman method construct the partial alignment scoring table and obtain the optimal local alignment of the following two sequences:

ACGTATCGCGTATA
GATGCTCTCGGAJAA **14 marks**

OR

16. A) Using Needleman and Wunsch dynamic programming method, construct the partial alignment score table for the following two sequences, using the following scoring parameters: match score: +5, mismatch score: -1, gap penalty: -2. GCATGCU and GATTACA Write down the optimal global alignment between these sequences along with optimal score. **10 marks**

B) Differentiate semi global alignment with Needleman and Wunsch algorithm. **4 marks**

17. A) What is a phylogenetic tree? Explain the steps of UPGMA method for phylogenetic tree construction with an example. **8 marks**

B) What are the problems confronted in phylogenetic analysis? Discuss the ways to test phylogenies. **6 marks**

OR

18. A) What are the major phylogenetic tools? Among various methods employed for phylogenetic tree analysis, maximum parsimony is considered better than maximum likelihood method. Comment on the statement. **8 marks**

B) How would you design a gene array experiment to study the expression of a particular species of mRNA? How would you take care of the troubleshooting? **6 marks**

19. What are the problems that are encountered in scoring the HMM? Discuss the main algorithms used in solving the alignment problems in HMMs. **14 marks**

OR

20. A) Discuss the advantages and limitations of using HMMs. Also define a profile and discuss about the important information that a profile has. **8 marks**

B) Structural protein domains with same or similar function always show significant similarity. Is it true or false? Discuss. **6 marks**

AET 444	SPEECH AND AUDIO PROCESSING	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: Nil

Prerequisite: AET302 Digital Signal processing

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

CO1	Explain basic concepts of speech production, speech analysis, speech coding and parametric representation of speech and apply it in practical applications (K2)
CO2	Develop systems for various applications of speech processing (K3)
CO3	Interpret Signal processing models of sound perception and application of perception models in audio signal processing (K2)
CO4	Implement audio compression algorithms and standards (K3)
CO5	Analyze various audio quality techniques (K3)

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										3
CO 2	3	3	3									3
CO 3	3	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	K1	10	10	20
Understand	K2	30	30	60
Apply	K3	10	10	20
Analyse				
Evaluate				
Create				

Mark distribution

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

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks. Mark patterns are as per the syllabus with 70 % for theory and 30% for logical/numerical problems, derivation and proof.

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain basic concepts of speech production, speech analysis, speech coding and parametric representation of speech and apply it in practical applications

1. Describe algorithm for computing LPC coefficients using autocorrelation method
2. Define short time energy and short time zero crossing rate

Course Outcome 2 (CO2): Develop systems for various applications of speech processing

1. Define mathematically the need of STFT & Spectrogram in speech signals
2. Describe the steps involved in obtaining MFCC coefficients of a speech signal

Course Outcome 3 (CO3): Interpret Signal processing models of sound perception and application of perception models in audio signal processing

1. Describe psycho-acoustic analysis of an audio signal
2. Explain MPEG psycho-acoustic model of audio perception
3. Differentiate between simultaneous masking and temporal masking

Course Outcome 4 (CO4): Implement audio compression algorithms and standards

1. Describe various audio compression methods
2. Explain mathematically the concept of MDCT and its properties

Course Outcome 5 (CO5): Analyze various audio quality techniques

1. Explain subjective analysis methods to measure the audio quality
2. Describe spatial audio standards

SYLLABUS

Module	Course contents	Hours
I	Speech Production: Acoustic theory of speech production. Speech Analysis: Short-Time Speech Analysis, Time domain analysis (Short time energy, short time zero crossing Rate, ACF). Parametric representation of speech: AR Model, ARMA model. LPC Analysis (LPC model, Auto correlation method).	6
II	Frequency domain analysis (Filter Banks, STFT, Spectrogram), Cepstral Analysis, MFCC. Fundamentals of Speech recognition. Speech coding, speech enhancement, Speaker Verification, Language Identification	8
III	Signal Processing Models of Audio Perception: Basic anatomy of hearing System. Auditory Filter Banks, Psycho-acoustic analysis: Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking, MPEG psycho-acoustic model.	7
IV	Audio compression methods: Sampling rate and bandwidth requirement for digital audio, Redundancy removal and perceptual irrelevancy removal, Transform coding of digital audio: MPEG2-AAC coding standard, MDCT and its properties, Pre-echo and pre-echo suppression, Loss less coding methods.	7
V	Spatial Audio Perception and rendering: The physical and psycho-acoustical basis of sound localization and space perception. Spatial audio standards. Audio quality analysis: Objective analysis methods-PEAQ, Subjective analysis methods - MOS score, MUSHRA score	7

Text Books:

1. Douglas O'Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2/e, 1999; ISBN: 0780334493.
2. Nelson Morgan and Ben Gold, Speech and Audio Signal Processing: Processing and Perception Speech and Music, July 1999, John Wiley & Sons, ISBN: 0471351547

References:

1. Donald G. Childers, Speech Processing and Synthesis Toolboxes, John Wiley & Sons, September 1999; ISBN: 0471349593
2. Rabiner and Juang, Fundamentals of Speech Recognition, Prentice Hall, 1994.
3. Rabiner and Schafer, Digital Processing of Speech Signals, Prentice Hall, 1978.
4. Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall; ISBN: 013242942X; 1/e

Course content and Lecture schedule

No	TOPIC	No of Lectures
	MODULE 1	
1.1	Acoustic theory of speech production	1
1.2	Time domain analysis (Short time energy, short time zero crossing Rate, ACF)	2
1.3	Parametric representation of speech: AR Model, ARMA model.	2
1.4	LPC Analysis	1
	MODULE II	
2.1	Frequency domain analysis (Filter Banks, STFT, Spectrogram)	2
2.2	Cepstral Analysis	1
2.3	MFCC. Fundamentals of Speech recognition	1
2.4	Speech coding	1
2.5	Speech Enhancement	1
2.6	Speaker Verification,	1
2.7	Language Identification	1
	MODULE III	
3.1	Signal Processing Models of Audio Perception	1
3.2	Basic anatomy of hearing System.	1
3.3	Auditory Filter Banks, Psycho-acoustic analysis.	2
3.4	Critical Band Structure, Absolute Threshold of Hearing.	1
3.5	Simultaneous Masking, Temporal Masking,	1
3.6	MPEG psycho-acoustic model	1
	MODULE IV	
4.1	Sampling rate and bandwidth requirement for digital audio,	1
4.2	Redundancy removal and perceptual irrelevancy removal,	1
4.3	Transform coding of digital audio:	1
4.4	MPEG2-AAC coding standard	1
4.5	MDCT and its properties,	1
4.6	Pre-echo and pre-echo suppression,	1
4.7	Lossless coding methods.	1
	MODULE V	
5.1	Spatial Audio Perception and rendering	2
5.2	The physical and psycho-acoustical basis of sound localization and space perception.	2
5.3	Spatial audio standards.	1
5.4	Audio quality analysis: Objective analysis methods- PEAQ	1
5.5	Subjective analysis methods - MOS score, MUSHRA score	1

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET 444

Course Name: SPEECH AND AUDIO PROCESSING

Max. Marks: 100 Duration: 3 Hours

	PART A **Answer all questions, each carries 3 marks**	
1.	Briefly explain the concept of ZCR	
2	Explain a method to compute the LPC coefficients	
3	Discuss the basic elements of a speech recognition system	
4	What is the need of Spectrogram in speech signals	
5	Differentiate between speaker identification and speaker verification	
6	List various steps involved in language identification	
7	Explain how MFCC coefficients are derived from speech signal	
8	Discuss the concept of temporal masking	
9	Discuss the significance of MOS score	
10	Discuss the need for pre-echo suppression	
	PART B **Answer any one full question from each module carries 14 marks.**	
	MODULE 1	
11	a) Write the algorithm for computing LPC coefficients using autocorrelation method.	7
	b) Define briefly the idea behind short time energy and short time zero crossing rate.	7
	OR	
12	Discuss the parametric representation of speech in detail	14
	MODULE II	
13	a) Define mathematically the need of STFT & Spectrogram in speech signals.	7
	b) Describe with the help of a block diagram the steps involved in obtaining MFCC coefficients of a speech signal.	7
	OR	
14	a) Define fundamentals of speech recognition	7
	b) Explain any one speech coding technique in details	7
	MODULE III	
15	a) Explain psycho-acoustic analysis of an audio signal	7
	b) With the help of neat diagram explain the anatomy of hearing system	

	OR	
16	a) Differentiate between simultaneous masking and temporal masking	6
	b) Explain the MPEG psycho-acoustic model of audio perception	8
	MODULE IV	
17	a) Explain mathematically the concept of MDCT and its properties.	7
	b) Briefly define the audio compression methods.	7
	OR	
18	a) Describe pre-echo suppression in audio signals	7
	b) Briefly explain lossless coding of audio signals	7
	MODULE V	
19	a) Explain any two subjective analysis methods to measure the audio quality.	7
	b) Explain any two spatial audio standards.	7
	OR	
20	a) Explain any one objective analysis method to analyze the audio quality.	9
	b) Mention the significance of MOS score and MUSHRA score	5

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

AET 454	WIRELESS SENSOR NETWORKS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble:
Wireless sensor networks (WSNs) refer to networks of spatially dispersed and dedicated sensors that monitor and record the physical conditions of the environment and forward the collected data to a central location. WSNs can measure environmental conditions such as temperature, sound, pollution levels, humidity and wind. The development of these networks was motivated by military applications such as battlefield surveillance. WSNs are used in industrial and consumer applications, such as industrial process monitoring and control and machine health monitoring. Students will be able to learn sensor network fundamentals, understand the different routing protocols, develop in-depth knowledge on sensor network architecture and design issues, and understand the transport layer and security issues in wireless sensor networks.

Prerequisite: A sound knowledge of the fundamentals and basics of data communication, computer networks, sensors.

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

CO1	Explain the fundamentals, concepts and terminologies of sensors and wireless sensor networks. (K2)
CO2	Illustrate the functionalities characteristics of the building blocks of WSN and understand software hardware requirements of WSN. (K3)
CO3	Discuss the routing protocols and different QoS issues of WSNs. (K2)
CO4	Analyze different security issues in WSN and evaluate defensive techniques. (K2, K4)
CO5	Evaluate critically, the domain specific applications of WSNs. (K2)

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		Continuous Assessment /Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	20	20	40
Apply	K3	20	20	50

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the fundamentals, concepts and terminologies of sensors and wireless sensor networks.

Sample questions:

1.Categorize different measurement errors associated with sensors.

2. Classify the sensors according to their domain of application.

3. Discuss the network architecture and protocol stack for WSNs

Course Outcome 2 (CO2): Illustrate the functionalities characteristics of the building blocks of WSN and understand software hardware requirements of WSN.

Sample Questions:

1. Critically investigate the mobility and power consumption issues of nodes in WSNs.

2. Discuss the suitability of homogeneous and heterogeneous nodes for WSNs

3. What are the hardware and software requirements for WSNs?

4. Compare and contrast between the following operating systems for WSN- TinyOS, and LiteOS.

5. What do you mean by localization in WSNs?

6. Comment on sensor data calibration. Discuss issues in sensor data calibration.

7. Explain steps in sensor node reprogramming.

Course Outcome 3 (CO3): Discuss the routing protocols and different QoS issues of WSNs.

Sample questions:

1. Explain different routing and data dissemination protocols for WSNs.

2. What do you mean by QoS. Discuss different QoS issues associated with WSNs.

3. Discuss LEACH protocol. Explain how LEACH organizes the cluster such that the energy is equally divided in all the sensor nodes in the network.

Course Outcome 4 (CO4): Analyze different security issues in WSN and evaluate defensive techniques.

Sample questions:

1. Discuss the security vulnerabilities of WSNs.

2. Discuss how DoS attacks are realized in WSNs? How WSNs can be protected from DoS attacks?

Course Outcome 5 (CO5): Evaluate critically, the domain specific applications of WSNs.

Sample questions:

1. Discuss the broad application domains for WSNs.
2. Discuss the suitability of WSNs in environmental/earth sensing such as air quality monitoring and Forest fire detection.
3. Explain Structural health monitoring using WSNs.

SYLLABUS

Module - 1 (Introduction Sensors and Wireless Sensor Networks)

Introduction to sensors- Sensor basics, Classification of measurement errors- Sensor deviations, Resolution. Types of sensors-Chemical sensor, Biosensor, Neuromorphic sensors, MOS sensors. Introduction to wireless sensor networks (WSN)- Network architecture and protocol stack, MAC access control – fundamental MAC protocols, MAC design for WSNs, MAC protocols for WSN (Contention based, Contention free, and Hybrid protocols), IEEE 802.15.4, Zigbee.

Module -2 (Characteristics of WSNs)

Characteristics of WSNs- Power consumption constraints for nodes, mobility of nodes, Heterogeneity and Homogeneity of nodes. Scalability, resilience. WSN platforms- Hardware, Wireless, Software. Operating systems for WSN- TinyOS, LiteOS, Contiki, RIOT. Online collaborative sensor data management platforms. Localization, Sensor Data Calibration and Fault Tolerance, Macroprogramming and reprogramming. Distributed sensor Networks.

Module 3 (Routing Protocols for WSNs)

Routing and data dissemination – Fundamentals and challenges, taxonomy of routing and data dissemination protocols, Overview of routing and data dissemination protocols – Sensor Protocol for Information via Negotiation (SPIN), geographic adaptive fidelity, LEACH, Sensor protocols for information via negotiation, joint mobility and routing protocol. Transport Protocols and Quality of Service – Transport protocol design for WSNs, Transport protocols for WSNs.

Module -4 (Security in WSNs)

Security requirements in WSNs, Security vulnerabilities in WSNs – DoS attacks, physical layer attacks, link layer, network layer, transport layer attacks, Attacks on secrecy and authentication, Security mechanisms for WSNs – cryptography in WSNs, Key management protocols, Defense against DoS attacks, Defense against routing attacks - TESLA, SPINS , Intrusion detection in WSNs.

Module- 5 (Application domains of WSNs)

Area/Habitat monitoring, Health care monitoring, Environmental/Earth sensing- Air quality monitoring, Forest fire detection, Landslide detection, Water quality monitoring, Natural disaster prevention. WSNs for Industrial monitoring- Machine health monitoring, Data logging, Water/waste water monitoring, Structural health monitoring. Advanced Topics in WSNs- Mobile WSNs, Wireless Adhoc networks, Virtual Sensor Networks.

Text Book

1. Jun Zheng, Abbas Jamalipour, “Wireless Sensor Networks: A Networking Perspective”, John Wiley, 2009
2. C.Siva Ram Murthy and B.S.Manoj, “Ad Hoc Wireless Networks – Architectures and 2 Protocols”, Pearson Education, 2006.
3. Sohraby, K., Minoli, D., Znati, T. (2007). Wireless sensor networks: technology, protocols, and applications. John Wiley and Sons. pp. 203–209. ISBN 978-0-471-74300-2.

Reference Books

1. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, Wiley, 2005
2. Guowang Miao; Jens Zander; Ki Won Sung; Ben Slimane (2016). Fundamentals of Mobile Data Networks. Cambridge University Press. ISBN 978-1107143210.
3. Ullo, Silvia Liberata; Sinha, G. R. (2020-05-31). "Advances in Smart Environment Monitoring Systems Using IoT and Sensors". Sensors (Basel, Switzerland). 20 (11): 3113. Bibcode:2020Senso..20.3113U. doi:10.3390/s20113113. ISSN 1424-8220. PMC 7309034. PMID 32486411.
4. Dargie, W. and Poellabauer, C. (2010). Fundamentals of wireless sensor networks: theory and practice. John Wiley and Sons. pp. 168–183, 191–192. ISBN.
5. Tiwari, Ankit; et al. (2007). "Energy-efficient wireless sensor network design and implementation for condition-based maintenance". ACM Transactions on Sensor Networks. 3: 1–es. CiteSeerX 10.1.1.188.8180. doi:10.1145/1210669.1210670. S2CID 7278286.
6. Silva, D.; Ghanem, M.; Guo, Y. (2012). "WikiSensing: An Online Collaborative Approach for Sensor Data Management". Sensors. 12 (10): 13295–332. Bibcode:2012Senso..1213295S. doi:10.3390/s121013295. PMC 3545568. PMID 23201997.
7. Mitchell, Robert; Chen, Ing-Ray (2014-04-01). "A survey of intrusion detection in wireless network applications". Computer Communications. 42: 1–23.

Teaching Plan (35 Hours)

Module 1: Introduction Sensors and Wireless Sensor Networks		(6 hours)
1.1	Introduction to sensors- Sensor basics.	1 hour
1.2	Classification of measurement errors- Sensor deviations, Resolution.	1 hour
1.3	Types of sensors-Chemical sensor, Biosensor, Neuromorphic sensors, MOS sensors.	1 hour
1.4	Introduction to wireless sensor networks (WSN)- Network architecture and protocol stack.	1 hour
1.5	MAC access control – fundamental MAC protocols, MAC design for WSNs.	1 hour
1.6	MAC protocols for WSN (Contention based, Contention free, and Hybrid protocols), IEEE 802.15.4, Zigbee.	1 hour
Module 2: Characteristics of WSNs		(7 hours)
2.1	Characteristics of WSNs- Power consumption constraints for nodes, mobility of nodes, Heterogeneity of nodes and Homogeneity of nodes.	2 hours
2.2	Scalability, resilience. WSN platforms- Hardware, Wireless, Software.	1 hour
2.3	Operating systems for WSN- TinyOS, LiteOS, Contiki, RIOT.	1 hour
2.4	Online collaborative sensor data management platforms.	1 hour
2.5	Localization, Sensor Data Calibration and Fault Tolerance.	1 hour
2.6	Macroprogramming and reprogramming. Distributed sensor Networks.	1 hour
Module 3: Routing Protocols for WSNs		(8 hours)
3.1	Routing and data dissemination – Fundamentals and challenges.	1 hour
3.2	Taxonomy of routing and data dissemination protocols.	1 hour
3.4	Overview of routing and data dissemination protocols, Sensor Protocol for Information via Negotiation (SPIN) – geographic adaptive fidelity, LEACH.	1 hour
3.5	Sensor protocols for information via negotiation.	1 hour
3.6	Joint mobility and routing protocol.	1 hour
3.7	Transport Protocols and Quality of Service – Transport protocol design for WSNs.	2 hour
3.9	Transport protocols for WSNs.	1 hour
Module 4: Security in WSNs		(7 hours)
4.1	Security requirements in WSNs, Security vulnerabilities in WSNs.	1 hour
4.2	DoS attacks, physical layer attacks, link layer, network layer.	1 hour
4.3	Transport layer attacks, Attacks on secrecy and authentication,	1 hour
4.4	Security mechanisms for WSNs – cryptography in WSNs, Key management protocols.	1 hour

4.5	Defense against DoS attacks, Defense against routing attacks.	1 hour
4.6	TESLA, SPINS , Intrusion detection in WSNs.	2 hours
Module 5 : Application domains of WSNs		(7 hours)
5.1	Area/Habitat monitoring, Health care monitoring.	1 hour
5.2	Environmental/Earth sensing- Air quality monitoring, Forest fire detection, Landslide detection.	1 hour
5.3	Water quality monitoring, Natural disaster prevention.	1 hour
5.4	WSNs for Industrial monitoring- Machine health monitoring, Data logging.	1 hour
5.5	Water/waste water monitoring, Structural health monitoring.	1 hour
5.6	Advanced Topics in WSNs- Mobile WSNs.	1 hour
5.7	Wireless Adhoc networks, Virtual Sensor Networks.	1 hour

Assignments:

Assignment 1: Opnet/NetSim/NS based simulation of a wireless sensor network.

Assignment 2: Case Study: WSN for Natural disaster prevention.

Assignment 3: Case Study: WSNs for Industrial monitoring

Model Question paper
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Program: Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation Engineering
Course Code: AET454

Course Name: WIRELESS SENSOR NETWORKS

Max. Marks: 100 Duration: 3 Hours

PART A
Answer ALL Questions. Each Carries 3 mark.

1	Explain the principle of operation of chemical sensors. Discuss some applications	CO1	K3
2	Compare and contrast between IEEE 802.15.4 and Zigbee protocols for wireless communication.	CO1	K2
3	Discuss the issues in power consumption constraints for sensor nodes.	CO2	K2
4	Briefly explain the requirements for operating systems suitable for WSN.	CO2	K2
5	List the challenges in routing and data dissemination in WSNs.	CO3	K3
6	Explain why Sensor Protocol for Information via Negotiation (SPIN) is called a data centric dissemination protocol?	CO3	K3
7	Explain how DoS attacks are realized in WSNs?		
8	Comment on the role of cryptography in WSNs.	CO4	K3
9	Discuss the use of WSNs in water quality monitoring and Natural disaster prevention.	CO5	K2
10	Briefly explain mobile WSNs.	CO5	K2

PART – B
Answer one question from each module; each question carries 14 marks.

Module – I

11. a)	Categorize sensors used in WSNs. Explain different measurement errors associated with sensors.	8	CO1	K3
11. b)	Compare and contrast between the functionalities of Biosensors and Neuromorphic sensors.	6	CO2	K3
	OR			
12.a)	Discuss MAC access control protocols used for WSNs. Also comment on issues considered in the MAC design for WSNs.	8	CO1	K3
12. b)	Explain features of contention based, contention free, and hybrid MAC protocols for WSNs.	6	CO2	K3

Module – II

13 a)	Discuss scalability issues of WSNs. Also comment on the suitability of homogeneous and heterogeneous nodes for WSNs.	8	CO2 K2
13 b)	Compare and contrast between the following operating systems for WSN- TinyOS, and LiteOS.	6	CO2 K2
	OR		
14 a)	What do you mean by localization in WSNs ? Also comment on sensor data calibration. Discuss issues in sensor data calibration.	9	CO2 K2
14 b)	What do ou mean by reprogramming of sensor nodes? Explain steps in sensor node reprogramming.	5	CO2 K2

Module – III

15 a)	Discuss LEACH protocol. Explain how LEACH organizes the cluster such that the energy is equally divided in all the sensor nodes in the network.	9	CO3 K3
15 b)	What do you mean by QoS. Discuss different QoS issues associated with WSNs.	5	CO3 K3
	OR		
16 a)	Explain how the Sensor Protocol for Information via Negotiation (SPIN) efficiently disseminates data among other nodes in the network?	6	CO3 K2
16 b)	Explain different routing and data dissemination protocols for WSNs.	4	CO3 K2
16 c)	Discuss the issues in transport protocol design for WSNs.	4	CO3 K3

Module – IV

17 a)	Explain steps in Intrusion detection in WSNs. Also discuss the vulnerability of WSN in different layers of its layered architecture.	9	CO3 K2
17 b)	Comment on attacks on secrecy and authentication in WSNs. Also explain defensive techniques.	5	CO4 K3
	OR		
18 a)	Discuss different security mechanisms for WSNs. Also explain use of cryptography in WSNs and explain different key management protocols.	9	CO3 K2
18 b)	Comment on routing attacks in WSNs. Also discuss defense against routing attacks.	5	CO3 K2

Module – V

19 a)	Discuss the suitability of WSNs in environmental/earth sensing such as air quality monitoring and Forest fire detection.	8	CO4 K3
19 b)	Illustrate the use of WSNs in industrial monitoring such as machine health monitoring.	6	CO4 K3
	OR		
20 a)	Illustrate network intrusion with example. Explain steps involved in investigating network intrusions.	6	CO4 K3
20 b)	With an illustrative example explain how WSNs are used in health care monitoring.	4	CO4 K3
20 c)	Briefly explain the principles of wireless adhoc networks	4	CO2 K2

AET464	Nano Electronics	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims at understanding the concepts of scaling of electronic devices to nano dimensions and novel electronic devices.

Prerequisite: ECT201 Solid State Devices

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

CO1 K2	Explain the challenges of scaling transistors to nano dimensions.
CO2 K2	Explain the methods to overcome the scaling challenges are nano scale.
CO3 K3	Apply Schrodingers equation and its solution in various devices.
CO4 K2	Describe the features of hetero junctions and devices based on heterojunctions.
CO5 K3	Analyse characteristics of different quantum devices.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3											3
CO2	3											3
CO3	3											3
CO4	3											3
CO5	3											3

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	25	25	60
Apply	K3	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): Explain the challenges of scaling transistors to nano dimensions. (K2)

1. Explain the principle of MOSFET operation and its characteristics.
2. Describe the challenges of scaling of transistor dimensions below 100nm.

Course Outcome 2 (CO2): Explain the methods to overcome the scaling challenges are nano scale. (K2)

1. Explain the advantages of Silicon on insulator devices over planar MOSFETs.
2. Explain how multi gate/strained devices are used to improve the short channel effects in nano devices.

Course Outcome 3 (CO3): Apply Schrodingers equation and its solution in various devices. (K3)

1. With the help of solutions of Schrodinger wave equation explain tunneling of electrons through a potential well.
2. What is spintronics and spin valve? Explain the operation of a spin transistor.

Course Outcome 4 (CO4): Describe the features of hetero junctions and devices based on heterojunctions. (K2)

1. What are the advantages of heterojunction over homojunction.?
2. Explain the principle of MODFET with the help of band diagrams.

Course Outcome 5 (CO5): Analyse characteristics of different quantum devices. (K3)

1. By solving Schrodingers wave equation show how sub bands are formed in a quantum wire.
2. What is coulomb blockade?

SYLLABUS

Module 1: Introduction to Nano electronics (8 Hrs.)

Review of MOSFETs—Band diagram, operation, Current equation, threshold voltage, short channel effects, DIBL.

Scaling of MOSFETs. Constant voltage, constant electric field and generalized scaling.

Challenges going to sub-100 nm MOSFETs: Oxide layer thickness, tunneling, power density, non-uniform dopant concentration, threshold voltage scaling, lithography, hot electron effects, subthreshold current, velocity saturation, interconnect issues.

Module 2: Novel Nano Electronic Devices (7 Hrs.)

High-K gate dielectrics, Effective oxide thickness, Effects of high-K gate dielectrics on MOSFET performance.

Novel MOS-based devices: Silicon-on nothing, Silicon-on-insulator devices, FD SOI, PD SOI, Multiple gate MOSFETs, Double gate MOSFETs, FinFETs, nanowires, strained Si devices.

Module 3: Applications of Quantum mechanics (8 Hrs.)

Tunneling and applications of quantum mechanics-Schrodinger Equation-solution of Schrodinger equation: Free space, Potential well, tunneling through a potential barrier. Potential energy profiles for material interfaces, Applications of tunneling.

Graphene and Carbon nanotubes--Carbon nanotube based devices: CNTFET, characteristics, Spin-based devices – spin valve, spin FET, characteristics

Module 4 : Hetero junction devices (6 Hrs.)

Hetero Junction: Hetero junctions, advantages, Types: Type I, II and III Hetero junction,

Hetero junction of elemental and compound semiconductors-Si-Ge hetero structure, Hetero structures of III-V and II-VI compounds

Hetero junction based devices-Hetero junction transistor, Resonant tunneling devices, MODFET/HEMT

Module 5: Quantum Devices (7 Hrs.)

Quantum structures: Quantum wells, quantum wires and quantum dots, Solution of Schrodinger equation, sub bands, density of states.

Single electron devices –Coulomb blockade in a nano capacitor, tunnel junctions, Double tunnel junction--Coulomb staircase, Single electron transistor.

Text Books

1. George W.Hanson, Fundamentals of nano electronics, Pearson Education.
2. Yuan Taur, Tak H Ning, Fundamentals of Modern VLSI Devices, Cambridge University Press, Second edition 2009
3. J M Martinez Duart, R J Martin Palma, F Agullo Rueda, Nanotechnology for microelectronics and naoelectronics, Elsevier, First Edition, 2006

Reference Books

1. Mircea Dragoman and Daniela Dragoman, Nanoelectronics – Principles & devices, Artech House Publishers, 2005.
2. Karl Goser, Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices, Springer 2005.
3. Mark Lundstrom and Jing Guo, Nanoscale Transistors: Device Physics, Modeling and Simulation, Springer, 2005.
4. J P Colinge FinFETs and Other Multi Gate Transistors, Springer 2009.
5. B L Sharma, R K Purohit, Semiconductor Heterojunctions, Pergamon Press, 1974.
6. H R Huff, D C Gilmer, High Dielectric Constant materials VLSI MOSFET Applications, Springer, 2004

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to Nano electronics**	
1.1	Review of MOSFETs Band diagram, operation, Current equation,	2
1.2	threshold voltage, short channel effects, DIBL.	1
1.3	Scaling of MOSFETs	2
1.4	Challenges going to sub-100 nm MOSFETs Oxide layer thickness, tunneling, power density,	1
1.5	non-uniform dopant concentration, threshold voltage scaling, lithography, hot electron effects,	1
1.6	subthreshold current, velocity saturation, interconnect issues.	1
2	**Novel Nano Electronic Devices**	
2.1	High-K gate dielectrics	2
2.2	Novel MOS-based devices	2
2.3	Multiple gate MOSFETs Multiple gate MOSFETs,	1
2.4	Double gate MOSFETs, FinFETs,	1
2.5	nanowires, strained Si devices.	1
3	**Applications of Quantum mechanics**	
3.1	Tunneling and applications of quantum mechanics Schrodinger Equation-solution of Schrodinger equation: Free space,	2
3.2	Potential well, tunneling through a potential barrier. Potential energy profiles for material interfaces,	2
3.3	Applications of tunneling.	1
3.4	Graphene	2
3.5	Carbon nanotubes	1
4	**Hetero junction devices**	
4.1	Hetero junction	2
4.2	Hetero junction of elemental and compound semiconductors	2
4.3	Hetero junction-based devices	2
5	**Quantum Devices**	
5.1	Quantum structures: Quantum wells	1
5.2	quantum wires and quantum dots	1
5.3	Solution of Schrodinger equation, sub bands, density of states	2
5.4	Single electron devices	3

Assignments: Two assignments can be given in the following areas. (a) Drawing of energy band diagrams of various hetero structures (Band gap, Electron affinity, Work function of materials can be given as input parameters) (b) Solution of Schrodinger equation in finite and infinite potential well, potential barrier, triangular well, parabolic well, Quantum well, Quantum wire, Quantum dot. (c) Derivation of density of states in Quantum well, Quantum wire, Quantum dot

Model Question paper
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B. TECH DEGREE EXAMINATION, (MODEL QUESTION PAPER)

Course Code: AET 464

Course Name: NANO ELECTRONICS

Programme: Applied Electronics & Instrumentation/ Electronics & Instrumentation

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Question Carries 3 marks.

1. Write the threshold voltage equation of a nmos MOSFET and explain the terms.
2. What is scaling of MOSFETs?
3. For an EOT of 1nm, what is the thickness of the High-K dielectric required if the dielectric constant of High-K is 25 and that of oxide is 4.
4. What is the effect of strain on nmos and pmos devices?
5. Write Schrodinger equation and explain the individual terms.
6. Explain the potential profile formed between metal and vacuum.
7. What are the advantages of heterojunction over homojunction.?
8. Explain the band structure of SiGe heterojunction.
9. Why a quantum dot is called an artificial molecule.
10. What is coulomb blockade?

PART – B

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

Module – I

11. (a) Explain the following challenges of scaling of transistors (i) velocity saturation (ii) power density (iii) Hot electron effects. 7

(b) What is constant voltage scaling and constant field scaling? Explain their differences 7

OR

12. (a) Write notes on oxide thickness scaling and threshold voltage scaling 7

(b) Derive the current equation of a nmos MOSFET. 7

Module – II

13. (a) Explain the need of High-K dielectrics and their impacts on MOSFET performance. 7

(b) What are multigate devices? Explain different types. 7

OR

14. (a) Compare between PDSOI and FDSOI MOSFET devices 7

(b) What is FinFET? Explain how introduction of multiple gates improve the performance of MOSFET devices. 7

Module – III

15. (a) With the help of solutions of Schrodinger wave equation explain tunneling of electrons through a potential well. 7

(b) Write a note on carbon nanotubes and CNT MOSFETs 7

OR

16. (a) Explain the wave propagation through a potential barrier of height Vo, when electron energy E<Vo using the solutions of Schrodinger wave equation. 7

(b) What is spintronics and spin valve? Explain the operation of a spin transistor 7

Module – IV

17. (a) What are the different types heterojunctions? Explain with the help of band diagrams. 7

(b) Explain the principle of MODFET with the help of band diagrams. 7

OR

18. (a) What is a heterojunction transistor. Explain its advantages over homo junction transistor 7

(b) Explain the characteristics of RTD with the help of band diagrams. 7

Module V

19. (a) By solving Schrodingers wave equation show how sub bands are formed in a quantum wire 7

(b) What are the conditions for coulomb blockade? 7

OR

20. (a) By solving Schrodingers wave equation show how discrete energy levels are formed in a quantum dot. 7

(b) Explain the formation of coulomb staircase in a double tunnel junction. 7

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY Estd. 2014

AET474	INTEGRATED OPTICS & PHOTONIC SYSTEMS	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to understand basic goals, principles and techniques of integrated optical devices and photonic systems.

Prerequisite: AET362 Optoelectronic Devices

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

CO 1	Discuss optical wave guide structures
CO 2	Explain optical wave guide fabrication techniques and polymer Waveguide Devices
CO 3	Explain Integrated lasers, Optical Amplifiers and Modulators.
CO4	Analyze different types of photo detectors and Micro-Optical-Electro-Mechanical Devices
CO5	Explain applications of Optical Integrated circuits and Nano photonics

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
CO 2	3	3										3
CO 3	3	3			2							3
CO 4	3	3	3		2							3
CO 5	3	3	3		2							3

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyze	K4			
Evaluate	K5			
Create	K6			

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): To discuss optical wave guide structures.

1. List the important types of waveguide structures used in integrated optics
2. Explain the existence of different modes in a planar waveguide.
3. If two dual-channel waveguide directional couplers of identical channel geometry and spacing are formed in the same substrate material, except that coupler A has an index of refraction n_A in the channels and coupler B has an index of refraction n_B in the channels, which coupler has the larger coupling coefficient k if $n_A > n_B$?

Course Outcome 2 (CO2): To explain optical wave guide fabrication techniques, Polymer Waveguide Devices.

1. Explain different steps involved in thin film deposition of waveguide fabrication.
2. Discuss the reasons for the Losses in Optical Waveguides
3. Explain the process for polyimide polymer channel waveguide fabrication.

Course Outcome 3 (CO3): Explain Integrated lasers, Optical Amplifiers and Modulators.

1. Explain the characteristics of a semiconductor laser
2. Explain the working principle of an Integrated Optical Amplifier
3. Discuss the principle of operation of different electro-optic modulators

Course Outcome 4 (CO4): Analyze different types of integrated photo detectors and Micro-Optical-Electro-Mechanical Devices.

1. Explain the construction and operation of integrated PIN diode and APD.
2. Discuss the term responsivity with respect to a photo detector.
3. Analyze the Mechanical Properties of Silicon and application in thin membrane devices

Course Outcome 5 (CO5): Explain applications of Optical Integrated circuits and Nano photonics

1. Explain the application OICs in sensors and other measuring instruments.
2. Discuss Opto-Electronic Integrated Transmitter Receiver system.
3. List out principle of line defect waveguide devices in Nano photonics.

SYLLABUS

Module 1:

Review of Electromagnetics- Maxwell's equations - Wave equation

Theory of optical waveguides - Planar waveguides, channel waveguides, graded index waveguides. Light Propagation in Waveguides: The Beam Propagation Method, Advantages of Integrated Optics -substrate materials for optical Integrated Circuits

Module 2:

Waveguide Fabrication Techniques, Epitaxially Grown Waveguides- Electro-Optic Waveguides, Types of Polymers, Polymer Waveguide Devices, Optical Fiber Waveguide Devices, Losses in Optical Waveguides, Fiber to Waveguide Couplers, Optical Fiber Couplers and Splitters.

Module 3:

Integrated Semiconductor Lasers and Modulators: Integrated Semiconductor Lasers, integrated semiconductor optical amplifier, Monolithically Integrated Direct Modulators, The Electro-Optic Effect, Mach-Zehnder Modulators, Acousto-Optic Modulators

Module 4 :

Integrated Optical Detectors – Depletion Layer Photodiodes, PIN, APD, Schottky barrier photodiode, Metal-Semiconductor-Metal Photodiodes. Factors Limiting Performance of Integrated Detector

Micro-Optical-Electro-Mechanical Devices: Thin Membrane Devices, Cantilever Beam Devices, Mechanical Properties of Silicon.

Module 5:

OIC and Nano Photonics: Applications of Optical Integrated Circuits (Temperature Sensors, High Voltage Sensors, Wavelength Meters and Spectrum Analysers etc.) Opto-Electronic Integrated Transmitter Receiver, Recent Trends in Optical Telecommunications

Nano-photonics: Photonic Crystals, Fabrication of Nanostructures, Nanophotonic Devices.

Text Books

1. Robert Hunsperger, Integrated optics :Theory and technology 6/e Springer, 2009.
2. Lifante, Integrated Photonics: Fundamentals, John Wiley 2003

Reference Books

1. H. Nishihara, M. Haruna, and T. Suhara, Optical Integrated Circuits, McGraw-Hill Professional, 1989.
2. Ff KeicoIizuka, Elements of photonics, John Wiley, 2002
3. Pappannareddy, Introduction to light wave systems, Artech House,1995

RELATED LINKS

Website of IEEE photonics society: www.ieee.org/photonics.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Review of Electromagnetics and Theory of optical waveguides**	
1.1	Maxwell's equations	1
1.2	Wave equation	1
1.3	Planar waveguides, channel waveguides, graded index waveguide	2
1.4	Light Propagation in Waveguides: The Beam Propagation Method	1
1.5	Integrated Optics - Advantages	1
1.6	Substrate materials for optical Integrated Circuits	1
2	**Waveguide Fabrication Techniques**	
2.1	Epitaxially Grown Waveguides- Electro-Optic Waveguides	2
2.2	Types of Polymers, Polymer Waveguide Devices	2
2.3	Optical Fiber Waveguide Devices	1
2.4	Losses in Optical Waveguides	1
2.5	Fiber to Waveguide Couplers	1
2.6	Optical Fiber Couplers and Splitters	1
3	**Integrated Semiconductor Lasers and Modulators**	
3.1	Integrated Semiconductor Lasers	2
3.2	Integrated semiconductor optical amplifier	1
3.3	Monolithically Integrated Direct Modulators	1
3.4	The Electro-Optic Effect	1
3.5	Mach-Zehnder Modulators	1
3.6	Acousto-Optic Modulators	1
4	**Integrated Optical Detectors, Micro-Optical-Electro-Mechanical Devices**	
4.1	Depletion Layer and waveguide Photodiodes.	2
4.2	Schottky barrier photodiode, Metal-Semiconductor-Metal Photodiodes	1
4.3	Factors Limiting Performance of Integrated Detectors	1
4.4	Thin Membrane Devices, Cantilever Beam Devices	1
4.5	Mechanical Properties of Silicon.	1

5	**Optoelectronic ICs and Nano Photonics**	
5.1	Optoelectronic ICs	1
5.2	Applications of Optical Integrated Circuits (Temperature Sensors, High Voltage Sensors, Wavelength Meters and Spectrum Analysers etc.)	2
5.3	Opto-Electronic Integrated Transmitter Receiver	1
5.4	Recent Trends in Optical Telecommunications	1
5.5	Photonic Crystals, Fabrication of Nanostructures,	1
5.6	Nano photonic Devices	1

Assignment: At least one assignment should be simulation of wave propagation through integrated optical components or devices on MATLAB or any optical simulation software.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Program: Applied Electronics & Instrumentation Engineering / Electronics & Instrumentation Engineering

Course Code: AET474

Course Name: INTEGRATED OPTICS & PHOTONIC SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	What are the different substrate material used for fabrication of monolithic optical ICs.	K3
2	Briefly explain Beam Propagation Method.	K2
3	Outline the epitaxial growing process of GaAlAs Waveguides.	K2
4	List out any three polymers that are used in optical waveguides.	K2
5	In order to produce a semiconductor laser, what two conditions basic to the gain mechanism must be satisfied?	K3
6	Explain the Electro-Optic effect experienced in certain materials.	K2
7	Explain the term responsivity of a photo detector.	K3
8	What are the three major categories of MOEM devices?	K3
9	List out some features of Optical ICs.	K2
10	How line defect can make use in construction of nanophotonic waveguides?	K2

PART – B

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

Module – I

11. a)	Write down Maxwell's equations for light propagating in free space and explain each term.	7	CO1	K3
11. b)	Describe the structure of a three-layer waveguide and explain the modes in a planar wave guide.	7	CO1	K3
	OR			
12.a)	Describe the Absorption in Quantum wells and the Quantum Confined Stark effect.	5	CO1	K3
12.b)	Consider a PN junction Semiconductor sample. At equilibrium the acceptor concentration at P type region is $N_A=10^{16}cm^{-3}$ and that of in N region the donor concentration $N_D=5x10^{15}cm^{-3}$. At a particular temperature the hole concentration in P region is determined to be	9	CO2	K3

	$1.1 \times 10^{16} cm^{-3}$. Find the intrinsic concentration n_i for the semiconductor at this temperature. Find the equilibrium electron concentration n in the N region at this temperature.			
	Module – II			
13.a)	Explain different steps involved in thin film deposition of waveguide fabrication.	8	CO2	K2
13.b)	Explain the reason for different types of losses in optical waveguides.	6	CO2	K3
	OR			
14.a)	Describe the important characteristics of $LiNbO_3$.	7	CO2	K2
b)	Explain the Processing of Polystyrene for waveguide fabrication.	7	CO2	K2
	Module – III			
15.a)	A semiconductor laser formed in a direct bandgap material is found to have an emission wavelength of 1.2 μm. The external quantum efficiency is 15%. What is the approximate bandgap energy of the material? If the output power is 20 mW, give an approximate estimate of the input current.	8	CO3	K2
15.b)	Explain the structure of InGaAsP Integrated optical Amplifier.	6	CO3	K3
	OR			
16.a)	Explain the operation of Raman-Nath-Type Modulator.	6	CO3	K2
16.b)	With suitable diagrams explain the structure of a Mach-Zhender modulator. Also describe how an applied electric field affects the optical signal.	8	CO3	K2
	Module – IV			
17.a)	Draw the layer diagram and explain the operation of a wave guide photo diode.	6	CO4	K2
b)	Explain the principle of Schottky-barrier photodiode and discuss the construction of MSM photodiode	8	CO4	K3
	OR			
18.a)	With a diagram explain a cantilever beam MOEM optical switch	9	CO5	K2
b)	Explain the construction of thin membrane-based pressure sensor	5	CO5	K2
	Module – V			
19.a)	Explain the advantages of optical integrated circuits.	4	CO5	K3
b)	Describe the working of Optical Integrated Temperature Sensors and High Voltage Sensor	10	CO5	K3
	OR			
20.a)	With necessary figures explain integrated optical transmitter and receiver.	8	CO5	K2
20.b)	Write short notes on Nanophotonic waveguides and couplers	6	CO5	K2

AET416	INDUSTRIAL DRIVES AND CONTROL	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble:

To familiarize the concept of electrical machines and drives in industries for driving the equipment.

Prerequisite:

Basics of Electrical and Electronics and their control circuitry.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain the fundamental operations of transformer and alternator.
CO 2	Discuss single phase and three phase induction motor.
CO 3	Explain the basics of power electronics and chopper circuits.
CO 4	Explain the concepts of AC drives and induction motor drives.
CO 5	Discuss about the special electrical machines.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember		15	15
Understand	50	35	85
Apply			
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

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

Course Level Assessment Questions

Course Outcome 1 (CO1):
1. Explain the working principle of transformer.
2. Write the emf equation of transformer and alternator.
3. Explain the working principle of alternator and write the concept of parallel operation of alternators.

Course Outcome 2 (CO2):
1. Mention different types of rotor construction in three phase induction motor.
2. What are the different starting methods of single-phase induction motor?
3. What is the speed control or braking methods in three phase induction motor?

Course Outcome 3 (CO3):
1. Explain the working of MOSFET.
2. Explain the working of IGBT.
3. Highlight the importance of step-up and step-down chopper.

Course Outcome 4 (CO4):
1. What are electric drives? List the advantages of electric drives.
2. Explain the working of various VSI fed induction moor drives.
3. Explain stator voltage and frequency control of induction motor.

Course Outcome 5 (CO5):
1. Explain any one mode of working of variable reluctance stepper motor.
2. Explain the working of permanent magnet stepper motor.
3. Explain the working of AC servomotor.

Syllabus
INDUSTRIAL DRIVES AND CONTROL

Module 1 (7 Hours)
Introduction to machines
Transformers-principle of operation-EMF equation-types-losses-KVA rating-all day efficiency-autotransformer-current transformer-potential transformer.
Alternators-principle of operation-emf equation-regulation of emf and mmf methods-parallel operation.

Module 2 (7 Hours)
Induction Motor
Three phase induction motor-principle of working-advantages-types of induction motor based on construction-effect of slip-synchronous watts-speed control using braking methods-losses.
Single phase induction motor-principle of operation-starting methods.

Module 3 (7 Hours)
Power Semiconductor Devices
Power diode and power MOSFET-(construction and working only)-Thyristors and IGBT-(construction, working and characteristics)-Chopper-basic operating principle-step up and step down chopper-Quadrant chopper.

Module 4 (7 Hours)
AC Drives
AC electric drives-basic block diagram-advantages and applications-VSI fed induction motor drive-speed control of induction motor-stator voltage control-frequency control-rotor resistance control.

Module 5 (7 Hours)
Special Electrical Machines
Stepper motor-basic operating principle-advantages and applications-rotor and stator construction-types-variable reluctance and permanent magnet stepper motor-Hybrid stepper motor-AC servomotor-DC and AC tachogenerator.

Text Books

1. B L Theraja & AK Theraja, “Electrical Technology”, S Chand, 23/e.
2. P.S Bhimbra, “Power Electronics”, Khanna Publications, 5/e.

Reference Books

1. Dubey G K, “Fundamentals Of Electric Drives”, Narosa, 2/e.
2. J.B Gupta, “Electrical Machines (AC and DC Machines)”, S K Kataria and Sons.
3. Krishnan, Electric Motor Drives: Modeling, Analysis and Control, Pearson, 2015

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to machines (7 Hours)**	
1.1	Transformer-principle of operation-EMF equation-losses-KVA rating-All day efficiency.	2 Hours
1.2	Types of transformer: step up and step-down transformer, distribution transformer, power transformer- autotransformer-instrument transformer: current transformer-potential transformer.	2 Hours
1.3	Alternator-principle of operation-EMF equation-regulation of emf and mmf method- parallel operation.	3 Hours
2	**Induction Motor (7 Hours)**	
2.1	Three phase induction motor-principle of working-advantages-types of induction motor based on construction (slip ring and squirrel cage induction motor).	2 Hours
2.2	Effect of slip on induction motor-basic torque equation-synchronous watts-losses-speed control using braking methods (regenerative braking-plugging-dynamic braking).	3 Hours
2.3	Single phase induction motor-principle of operation-starting methods (capacitor, split-phase, capacitor start capacitor run, shaded pole, permanent magnet).	2 Hours
3	**Power semiconductor devices (7 Hours)**	
3.1	Power diode (construction-working)-types of power diode (general purpose, Schottky, fast recovery)-Thyristors (reverse blocking mode, forward blocking mode, forward conduction mode-characteristics).	2 Hours
3.2	MOSFET- (construction and working only)-IGBT- (construction, working, characteristics).	2 Hours
3.3	Chopper-basic operating principle-step up and step-down chopper-Quadrant chopper (Type A-Type B-Type C-Type D-Type E).	3 Hours
4	**AC Drives (7 Hours)**	
4.1	AC electric drives- basic block diagram-advantages-applications.	1 Hour
4.2	VSI fed induction motor drives-using PWM inverter-Chopper-controlled rectifier-dual controlled rectifier.	3 Hours
4.3	Speed control of induction motor-stator voltage, frequency controlled, rotor resistance controlled.	3 Hours
5	**Special Electrical Machines (7 Hours)**	
5.1	Stepper motor-basic operating principle-advantages and applications - rotor and stator construction-AC servomotor - AC and DC tachogenerator.	4 Hours
5.2	Variable reluctance steeper motor-permanent magnet stepper motor - Hybrid stepper motor.	3 Hours

Model Question paper

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

Course Code: AET416
Program: Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation
Course Name: INDUSTRIAL DRIVES AND CONTROL

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

PART A
Answer all Questions. Each question carries 3 Marks

1. Derive the EMF equation of transformer.
2. Briefly explain parallel operation of alternators.
3. Define synchronous watts.
4. Explain the braking methods of three phase induction motor.
5. Explain the working of a power diode.
6. What are the different types of choppers?
7. List any three drive circuits for an induction motor.
8. Explain rotor resistance speed control of induction motor.
9. List the advantages and applications of stepper motor.
10. Explain the working of AC servomotor.

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

Module 1

11. (a) Explain the mmf method of finding voltage regulation of alternator. (10)
    (b) Highlight the variation of losses of a given transformer when the load is halved. (4)
12. (a) Derive the emf equation of alternator. (7)
    (b) Explain the working principle of transformer. (7)

Module 2

13. (a) Explain the starting methods of single-phase induction motor? (10)
    (b) Explain the losses in three phase induction motor. (4)
14. (a) Explain the working principle of single-phase induction motor. (10)
    (b) Explain the effect of slip in induction motor. (4)

Module 3

15. (a) Explain the construction and working of power MOSFET. (10)
    (b) Explain the principle of operation of chopper. (4)
16. (a) Describe the construction and working of IGBT. (7)
    (b) What are the types of power diode? (7)

Module 4

17. (a) Explain the frequency control of induction motor. (7)
    (b) Explain the block diagram of electric drive and its advantages. (7)

18. (a) Explain any four VSI methods of induction motor. (8)

(b) Explain the speed control methods of induction motor. (6)

Module 5

19. (a) Explain the modes of operation in permanent magnet stepper motor. (10)

(b) List the advantages of stepper motor. (4)

20. (a) Explain the working of ac and dc tachogenerator. (7)

(b) Explain the working of variable reluctance stepper motor. (7)

AET 426	CONTROL OF POWER CONVERTERS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course helps the students to learn about various types of power electronic drives and their control

Prerequisite: AET306 Power Electronics

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

CO 1 K2	Explain DC motor drives and their modelling
CO 2 K2	Describe the control of DC motor in different quadrants
CO 3 K3	Explain the modelling of induction motor and their speed control
CO 4 K3	Discuss the principle of synchronous motors and its control
CO 5 K2	Explain the different PWM techniques for power converters

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember K1	10	10	10
Understand K2	30	30	60
Apply K3	10	10	30
Analyse			
Evaluate			
Create			

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the components of a power electronic drive
2. List and explain the main classification of power converters
3. Discuss the effect of the base drive wave shape on the switching power dissipation.

Course Outcome 2 (CO2):

1. Explain the advantages of closed loop control of Dc drives
2. Explain the principle of DC motor speed control
3. What do you mean by vector control

Course Outcome 3 (CO3):

1. Explain the features of VSI driven induction motor
2. Explain the torque speed characteristics of an induction motor
3. Derive the transfer function of an induction motor

Course Outcome 4 (CO4):

1. Explain the constructional details of a synchronous motor
2. Explain why the speed of a 3 Phase synchronous motor remains constant at various loads when fed from a constant frequency
3. List the advantages of synchronous motor drives

Course Outcome 5 (CO5):

1. Explain the principle of third harmonic injection in sinusoidal PWM
2. Explain the principle of over modulation in sinusoidal and space vector PWM
3. Compare and contrast between sinusoidal PWM and space vector PWM

SYLLABUS

Module 1:

Introduction to Motor Drives: Components of Power Electronic Drives, Criteria for selection of Drive components. DC Motor Drives: Equivalent circuit of DC Motor, Block diagram and transfer function.

Module 2:

Principle of DC Motor control, two quadrant three phase converter-controlled DC Motor drives, Four-quadrant converter circuit.

Module 3:

Induction Motor Drives: Induction Motor equivalent circuit, Block diagram and transfer function, Speed control by varying stator frequency and voltage. Principle of vector control, Comparison of vector control and scalar control, Voltage source inverter driven induction motor.

Module 4:

Synchronous Motor Drives: Basic principles of synchronous motor operation and its equivalent circuit, Methods of control.

Module 5:

Application of PWM in control of DC-DC and DC-AC converters, Classification of PWM, Quasi square wave PWM, Frequency spectrum of PWM signals, Sinusoidal PWM, Space vector PWM, Comparison of SPWM and SVPWM, Selective harmonic elimination PWM.

Text Books

1. R. Krishnan, Electric Motor drives – Modeling, Analysis and Control, PHI, 2008.
2. Umanand L., Power Electronics Essentials and Applications, Wiley India, 2009.
3. Ned Mohan et. al, Power Electronics: Converters, Applications and Design, 2/e, John Wiley.

Reference

1. Theodore Wildi, Electrical Machines, Drives and Power Systems, 6/e, Pearson Education.
2. Shepherd W. and L N Hulley, Power Electronics & Control of Motor, CambridgeUniversity Press.
3. 6. Bubey, Power Electronics Drives, Wiley Eastern.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Introduction to Motor Drives:	1
1.2	Components of Power Electronic Drives	1
1.3	Criteria for selection of Drive components	1
1.4	DC Motor Drives: Equivalent circuit of DC Motor	2
1.5	Block diagram and transfer function.	2
2	**Module 2**	
2.1	Principle of DC Motor control	2
2.2	two quadrant three phase converter-controlled DC Motor drives	3
2.3	Four-quadrant converter circuit.	2
3	**Module 3**	
3.1	Induction Motor Drives	1
3.2	Induction Motor equivalent circuit	2
3.3	Block diagram and transfer function	2
3.4	Speed control by varying stator frequency and voltage	2
3.5	Principle of vector control	1
3.6	Comparison of vector control and scalar control	1
4	**Module 4**	
4.1	Voltage source inverter driven induction motor	2
4.2	Synchronous Motor Drives	1
4.3	Basic principles of synchronous motor operation and its equivalent circuit	1
4.4	synchronous motor control	1
5	**Module 5**	
5.1	Application of PWM in control of DC-DC and DC-AC converters, Classification of PWM	1
5.2	Quasi square wave PWM	1
5.3	Frequency spectrum of PWM signals	1
5.4	Sinusoidal PWM, Space vector PWM, comparison	2
5.5	Selective harmonic elimination PWM.	2

Assignment:

At least one assignment should be simulation of power electronic circuits using any software package.

Model Question paper
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Program: Applied Electronics and Instrumentation/ Electronics & Instrumentation

Course Code: AET426

Control of Power Converters

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	Draw the equivalent circuit of a DC motor and derive expression for electromagnetic torque	CO1	K2
2	List and explain the main classification of power converters	CO1	K2
3	What are the important factors to be considered while selecting a drive component	CO2	K1
4	Distinguish between field control and armature control methods of varying speed of a DC motor	CO2	K2
5	Draw the equivalent circuit model of an induction motor and find the expression for rotor speed	CO3	K1
6	Compare and contrast between scalar control and vector control methods of induction motor	CO3	K2
7	Explain why the speed of a 3-phase synchronous motor remains constant at various load when fed from a constant frequency	CO4	K2
8	With schematic explain the principle of sinusoidal pulse width modulation	CO5	K2
9	Explain the principle of quasi square wave PWM	CO5	K1
10	Compare sinusoidal PWM and space vector PWM	CO5	K2

PART – B

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

	Module – I			
11(a)	With a schematic diagram explain an adjustable speed drive?	9	CO 1	K3
11(b)	Explain the coupling mechanisms used in motor drives	5	CO 1	K3
	OR			
12(a)	Explain a servo drive with neat schematic diagram	9	CO 1	K3
12(b)	Explain how tripping can be prevented in drives under sudden changes	5	CO 1	K2
	Module – II			
13(a)	With circuit diagram and waveform explain the operation of a four-quadrant converter circuit	9	CO 2	K2
13(b)	Explain the torque speed characteristics of DC motor drive	5	CO 2	K2

	OR			
14(a)	A separately excited DC motor has the following parameters, Ra=.5ohm, La=.003H and Ka=.8V/rad/sec. The motor has a load of J=.0167 kg-m2,B1=.01 Nm/rad/sec with a load torque of 100 Nm. Its armature is connected to a dc supply voltage of 220 V and is given the rated field current. Find the speed of the motor	8	CO 2	K3
14(b)	Explain the open loop speed control of DC drive	8	CO 2	K2
	Module – III			
15(a)	Explain the principle of speed control of induction motor by varying stator frequency	8	CO 3	K2
15(b)	Explain the generation mode and braking mode operation of Induction motor drives	6	CO 3	K2
	OR			
16(a)	With circuit schematics and waveforms describe the operation of a voltage source driven induction motor	8	CO 3	K2
16(b)	Explain the torque speed characteristics of wound rotor induction motor drive	6	CO 3	K2
	Module – IV			
17(a)	With block diagram explain a vector controlled permanent magnet synchronous motor drive	8	CO 4	K2
17(b)	With waveforms explain the operation of trapezoidal waveform synchronous motor drive	6	CO 4	K2
	OR			
18(a)	Derive expression for power developed in a salient pole synchronous motor in terms of excitation voltage, load angle. Neglect the armature resistance	10	CO 4	K2
18(b)	Explain the operation of load commutated synchronous motor drive	4	CO 4	K2
	Module – V			
19(a)	Explain the application of PWM in control of DC-AC converters	7	CO 5	K2
19(b)	Write short note on the following I)Unipolar Sinusoidal PWM ii)Bipolar Sinusoidal PWM	7	CO 5	K2
	OR			
20 (a)	With the help of diagrams explain the principle of space vector PWM	9	CO 5	K2
20(b)	Explain selective harmonic elimination PWM technique	5	CO 5	K3

AET436	Aviation Electronics	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to develop a strong understanding of the basic principles of aviation electronics

Prerequisite: Nil

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

CO 1	Explain the features of an instrument system.
CO 2	Summarize the principles of air data instruments.
CO 3	Illustrate the measurements of various parameters using power plant instruments
CO4	Identify various blocks of radar.
CO5	Explain the principle of radio navigation systems.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12
CO 1	3											2
CO 2	3	3										2
CO 3	3	3										2
CO 4	3	3										2
CO5	3	3										2

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	20
Understand	K2	30	30	60
Apply	K3	10	10	20
Analyse	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): Explain the features of an instrument system.

1. Differentiate between static and dynamic characteristics of an instrument.
2. Explain the structure and functioning of a measurement system.

Course Outcome 2 (CO2): Summarize the principles of air data instruments.

1. Explain different techniques used to measure the speed of an air craft.
2. Differentiate between vertical and horizontal velocities of an aircraft.

Course Outcome 3 (CO3): Illustrate the measurements of various parameters using power plant instruments

1. What are the various parameters to be monitored for the safe operation of an aircraft engine?
2. How will you measure fuel flow of an aircraft?

Course Outcome 4 (CO4): Identify various blocks of radar.

1. Explain the principle of a pulse radar.
2. Explain principle of coherent MTI radar.

Course Outcome 5 (CO5): Explain the principle of radio navigation systems.

1. Explain the principle of Instrument Landing System.
2. Explain LORAN

SYLLABUS

MODULE I

MEASUREMENT

Concept of Measurement-Errors and error estimation- Functional elements of an instrument System-System representation- Static and dynamic characteristics- calibration- Estimate of system performance-classification of aircraft Instruments-Instrument displays panels and cockpit layout.

MODULE II

AIR DATA INSTRUMENTS

Air data instruments-airspeed, altitude, Vertical speed indicators. Static Air temperature, Angle of attack measurement. Synchronous data transmission system. Hydraulic control, Fly by wire control.

MODULE III

POWER PLANT INSTRUMENTS

Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments-measurement of RPM, manifold pressure, torque, exhaust gas temperature, fuel flow, engine vibration monitoring. Introduction-signal conditioners-Instrumentation amplifiers-filters. Data conversion -multiplexers-A/D-D/A conversion.

MODULE IV

RADAR PRINCIPLES

The Radar Equation, Detection and False alarm probabilities - Pulse integration, block diagram of a simple pulse radar and description of the various blocks - transmitter, antenna, duplexer, mixer and detector, receiver front end, displays.

MODULE V

TYPES OF RADARS AND RADIO NAVIGATION

CW and FM CW Radars-Tracking radars-MTI radars block diagram and principles of coherent MTI radars, Synthetic Aperture radar. Different types of radio navigation- ADF, VOR/DME- Doppler -LORAN and Omega, Satellite Navigation systems. Instrument Landing Systems.

Text Books

1. Pallet, E.H.J. 'Aircraft Instruments & Integrated systems', Longman Scientific and Technical, McGraw-Hill, 1992.
2. Murthy, D.V.S., 'Transducers and Measurements', McGraw-Hill, 1995
3. Doeblin.E. O, 'Measurement Systems Application and Design', McGraw-Hill, New York, 1986.

Reference books

1. HarryL.Stilz, 'Aerospace Telemetry', Vol I to IV.
2 Nagaraja, N.S. "Elements of Electronic Navigation", Tata McGraw-Hill Pub. Co., New Delhi, 1975.
3. Slater, J.M. Donnel, C.F.O and others, "Inertial Navigation Analysis and Design" , McGraw-Hill Book Company, New York, 1964.
4. Sen, A.K. & Bhattacharya, A.B. "Radar System and Radar Aids to Navigation", Khanna Publishers, 1988.
5. M.I. Skolnik, Radar Hand book (Second Edition) McGraw Hill, 1990.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Measurement**	
1.1	Concept of Measurement-Errors and error estimation-	1
1.2	Functional elements of an instrument System-System representation-	2
1.3	Static and dynamic characteristics- calibration	1
1.4	Estimate of system performance	1
1.5	classification of aircraft Instrument displays panels and cockpit layout	2
2	**Air data instruments**	
2.1	airspeed, altitude, vertical speed indicators	2
2.2	Static Air temperature	1
2.3	Angle of attack measurement	1
2.4	Synchronous data transmission system	2
2.5	Hydraulic control, Fly by wire control	2
3	**Power plant Instruments**	
3.1	Pressure measurement, temperature measurement,	1
3.2	fuel quantity measurement,	1
3.3	engine power and control instruments	1
3.4	measurement of RPM, manifold pressure, torque, exhaust gas temperature, fuel flow, engine vibration monitoring	2
3.5	signal conditioners-Instrumentation amplifiers-filters	1
3.6	Data conversion - multiplexers-A/D-D/A conversion	1
4	**Radar Principles**	
4.1	The Radar Equation	1
4.2	Detection and False alarm probabilities, Pulse integration	1
4.3	The block diagram of a simple pulse radar and description of the various blocks	1

4.4	transmitter, antenna, duplexer	2
4.5	mixer and detector, receiver front end, displays	2
5	**Types of radars and radio navigation**	
5.1	CW and FM CW Radars	2
5.2	Tracking radars-MTI radars block diagram and principles of coherent MTI radars	1
5.3	Synthetic Aperture radar	1
5.4	Different types of radio navigation- ADF, VOR/DME	1
5.5	Doppler -LORAN and Omega	1
5.6	Satellite Navigation systems. Instrument Landing Systems	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY EIGHTH SEMESTER B. TECH DEGREE EXAMINATION			
Program: Applied Electronics and Instrumentation Engineering/ Electronics & Instrumentation Engineering			
Course Code: AET436			
Course Name: AVIATION ELECTRONICS			
Max. Marks: 100			Duration: 3 Hours
PART A			
		(Answer all questions; each question carries 3 marks)	Marks
1		Differentiate between static and dynamic characteristics of an instrument.	3
2		What is meant by calibration errors? How can they be minimised.	3
3		Differentiate between vertical and horizontal velocities of an aircraft.	3
4		Define and explain the term ''angle of attack'.	3
5		What method can be used to measure the temperature of hot gases at more than 1000K	3
6		Explain two strategies to measure high values of pressure.	3
7		What are the factors on which the range of a radar depends on?	3
8		What are the advantages of using higher frequencies in a radar system? Explain.	3
9		Explain the principle of LORAN.	3
10		What is Doppler effect? How is it used in radars	3
PART B			
(Answer any two complete questions from each module)			
Module -1			
11		With a block diagram explain the structure and functioning of a measurement system.	14
		OR	
12		What are the different types of display technology used in air crafts? give detailed comparison	14
Module -2			
13		What are the various techniques which can be used to measure the speed of an air craft? Explain in detail	14
		OR	
14		With suitable diagrams explain the principle of fly by wire control.	14
Module -3			

15		What are the various parameters to be monitored for the safe operation of an aircraft engine? Explain in detail.	14
		OR	
16		With circuit diagrams explain the principles of A/D conversion and D/A conversion.	14
		Module -4	
17	a)	Derive Radar range equation.	7
	b)	With a block diagram explain the principle of a pulse radar.	7
		OR	
18	a)	What is meant by radar cross section? Explain.	7
	b)	What are the factors which determine radar cross section?	7
		Module -5	
19	a)	With a block diagram explain the working of a CW radar.	7
	b)	Explain the principle of a Synthetic Aperture radar.	7
		OR	
20	a)	What are the principles of satellite navigation systems?	7
	b)	Explain the principle of ILS system.	7

AET446	DIGITAL CONTROL SYSTEM	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to analyze and design of digital control systems.

Prerequisite: AET301: **CONTROL SYSTEMS**

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

CO 1	Understand the basic elements, their functions and Interconnections in a digital control system.
CO 2	Develop the pulse transfer function and steady state error analysis of digital control systems
CO 3	Understand frequency domain analysis and analyse stability of linear digital control systems.
CO 4	Develop state space representation of discrete time systems and find solution of state equation.
CO 5	Understand the concept of controllability and observability and design discrete data control systems with state variable feedback.

Mapping of course outcomes with program outcomes

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2										
CO 2	3	2										
CO 3	2	3										
CO 4	2	3	2									
CO 5	3	2										

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	20		20
Understand	K2		20	20
Apply	K3	10	10	20
Analyze	K4	10	10	20
Evaluate	K5	10	10	20
Create				

Mark distribution

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

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the basic elements, their functions and Interconnections in a digital control system.

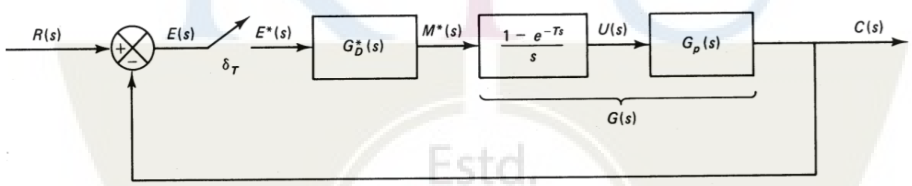
1. To control fluid intake, a fluid level control system consists of a tank, a level sensor, a fluid supply, and an actuator. Obtain an analog fluid control system's block diagram. Make changes to the block diagram to indicate how the fluid level can be managed digitally.

2. Explain how to model the sampling process mathematically. Also, with and without aliasing, plot the amplitude spectrum of the sampler output.

3. With suitable diagrams explain how data reconstruction is done in zero order hold and first order hold. Derive transfer functions for each

CO 2 Develop the pulse transfer function and steady state error analysis of digital control systems

1. Determine the pulse transfer function of the closed loop system given below



2. Derive the expression for acceleration error constant and velocity error constant of a Type 1 digital system

3. Describe the mapping of the following locus from s-plane to z-plane
   i. Constant damping loci
   ii. Constant frequency loci
   iii. Constant damping ratio loci

CO 3 Understand frequency domain analysis and analyse stability of linear digital control systems.

1. Sketch the root locus plot for the given system

$$G(z) = \frac{0.3935kz}{(z-1)(z-0.6065)}$$

2. Test the stability of the polynomial using Jury's stability test

$$\boldsymbol{F(z) = z^5 + 2.6z^4 - 0.56z^3 - 2.05z^2 + 0.0775z + 0.35 = 0}$$

3. Explain in detail about gain margin and phase margin

CO 4 Develop state space representation of discrete time systems and find solution of state equation.

1. Obtain the state transition Matrix of the given state space representation

$$x(k+1) = Ax(k) + Bu(k)$$
$$y(k) = Cx(k) + Du(k)$$

Where

$$A = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}; B = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \text{ and } C = \begin{bmatrix} 1 & 0 \end{bmatrix}$$

2. Obtain the state space representation of the following transfer function in observable canonical form and controllable canonical form.

$$\frac{Y(z)}{U(z)} = \frac{0.368z^{-1} + 0.264z^{-2}}{1 - 1.368z^{-1} + 0.368z^{-2}}$$

3. Evaluate the state equation for the following state space representation with $x(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$

$$A = \begin{bmatrix} 0 & 1 \\ -0.21 & 1 \end{bmatrix}; B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \text{ and } C = \begin{bmatrix} 1 & 0 \end{bmatrix}$$

CO 5 Understand the concept of controllability and observability and design discrete data control systems with state variable feedback.

1. Consider the system $x(k+1) = Ax(k) + Bu(k)$, $y(k) = Cx(k) + Du(k)$ where

$$A = \begin{bmatrix} -2 & 1 \\ 1 & -2 \end{bmatrix}; B = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \text{ and } C = \begin{bmatrix} 0 & 1 \end{bmatrix}$$

Check whether the system is controllable or not.

2. Explain the concept of pole placement by state feedback.
3. Find out the state feedback gain matrix K for the following system by converting the system into controllable canonical form such that the closed loop poles are located at 0.5 and 0.6

$$x(k+1) = \begin{bmatrix} -1 & -1 \\ 0 & -2 \end{bmatrix} x(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

SYLLABUS

Module 1:

Introduction:

Basic Elements of discrete data control systems, advantages of discrete data control systems, examples. Signal conversion & processing: Digital signals & coding, data conversion & quantization, sample and hold devices. Mathematical modelling of the sampling process, Design of maximum sampling frequency of digital systems in terms of the sensor delay; Data reconstruction and filtering of sampled signals: Zero order hold & first order Hold.

Module 2:

Discrete time control systems:

Pulse transfer function, Z transform analysis of closed loop and open loop systems- Modified z-transfer function- Steady state error analysis of digital systems- Examples on static error coefficients. Bilinear transformation- mapping from s-plane to z-plane.

Module 3:

Analysis of digital control systems:

Stability analysis of linear digital control systems - Routh Hurwitz criteria, Jury's test. Root loci of digital control systems – rules for construction of root locus. Frequency domain analysis - Bode plots-Gain margin and Phase margin.

Module 4:

State Space Techniques:

State space representation of discrete time systems- Transfer function from state space model-various canonical forms, discrete time state transition matrix- conversion of transfer function model to state space model-characteristics equation- solution of discrete state equations.

Module 5:

Pole placement:

Controllability and Observability - Response between sampling instants using state variable approach-Pole placement using state feedback. Dynamic output feedback- closed loop pole placement.

Text Books

1. M. Gopal, Digital Control and State variable methods, 4th edition- Tata McGraw Hill
2. B. C. Kuo, Digital control systems, 2nd Edition, Oxford University Press, 2007
3. M. Sami Fadali & Antonio Visioli, Digital Control Engineering- Analysis & Design, 2nd edition, ELSIEVER.
4. Katsuhiko Ogata,Discrete-Time Control Systems,2nd Edition, Prentice Hall of India,2005.

Reference Books

1. John Dorsey, Continuous & Discrete Control Systems, 2001, Tata McGraw Hill
2. Richard C Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2001.

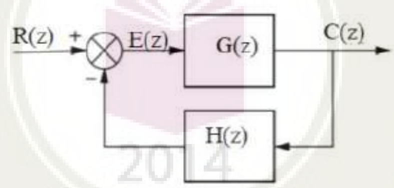
Course Contents and Lecture Schedule

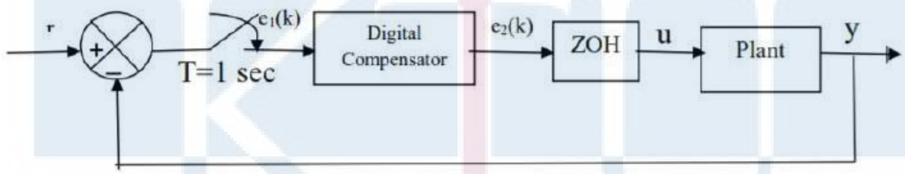
No	Topic	No. of Lectures
1	**Introduction:**	
1.1	Basic Elements of discrete data control systems, advantages of discrete data control systems, examples.	1
1.2	Signal conversion & processing: Digital signals & coding, data conversion & quantization, sample and hold devices.	2
1.3	Mathematical modelling of the sampling process	1
1.4	Design of maximum sampling frequency of digital systems in terms of the sensor delay.	1
1.5	Data reconstruction and filtering of sampled signals: Zero order hold & first order Hold.	2
2	**Discrete time control systems:**	
2.1	Pulse transfer function, Z transform analysis of closed loop and open loop systems	2
2.2	Modified z- transfer function	1
2.3	Steady state error analysis of digital systems- Examples on static error coefficients	2
2.4	Bilinear transformation- mapping from s-plane to z-plane.	1
3	**Analysis of digital control systems:**	
3.1	Stability analysis of linear digital control systems - Routh Hurwitz criteria	1
3.2	Jury’s test	1
3.3	Root loci of digital control systems – rules for construction of root locus.	2
3.4	Frequency domain analysis - Bode plots	2
3.5	Gain margin and Phase margin	2
4	**State Space Techniques:**	
4.1	State space representation of discrete time systems- Transfer function from state space model	2
4.2	various canonical forms, discrete time state transition matrix	3

4.3	conversion of transfer function model to state space model	2
4.4	characteristics equation- solution of discrete state equations.	1
5	**Pole placement:**	
5.1	Controllability and Observability	2
5.2	Response between sampling instants using state variable approach	1
5.3	Pole placement using state feedback	1
5.4	Dynamic output feedback- closed loop pole placement	2

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY EIGHTH SEMESTER B. TECH DEGREE EXAMINATION			
Program: Applied Electronics and Instrumentation/ Electronics & Instrumentation			
Course Code: AET446			
Course Name: DIGITAL CONTROL SYSTEM			
Max. Marks: 100			Duration: 3 Hours
PART A			
		Answer all questions, each carries 3 marks.	Marks
1		State Shannon's sampling theorem. What is the need for sampling?	(3)
2		Derive the transfer function of Zero Order Hold from its impulse response.	(3)
3		What do you mean by frequency warping? Using bilinear transformation, obtain the discrete time function $H_d(z)$ for the continuous time function given below: $$H_a(s) = \frac{1}{1+RCs}$$	(3)
4		Map the following s- plane poles onto the z- plane using conformal mapping: $(i)\ \ s = \pm 2\pi j \qquad (ii)\ s = -4 \pm 5j$	(3)
5		Write the necessary and sufficient conditions for Jury stability test for the characteristic equation $$F(z) = a_n z^n + a_{n-1} z^{n-1} + \cdots + a_0 = 0$$	(3)
6		Define Gain margin and Phase margin. Also write the equations for the same.	(3)
7		Derive the expression for Transfer function from the state space model given by $$x(k+1) = Ax(k) + Bu(k)$$ $$y(k) = Cx(k) + Du(k)$$	(3)
8		Find the characteristic equation and also the eigen values of the system having the state equation given below: $$x(k+1) = \begin{bmatrix} -1 & 1 \\ 0 & -1 \end{bmatrix} x(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$	(3)
9		What do you mean by controllability and observability of discrete time control systems? Also write the equations for the controllability and observability matrix.	(3)
10			(3)

		Derive the equation for the state feedback control law in pole placement using state feedback	
		Answer any two full questions, each carries 14 marks.	
11	a)	Write any 4 advantages of digital control over analogue control systems.	(4)
	b)	With the help of a neat block diagram, explain the basic elements of a digital control system. Mention any 1 example and explain each block.	(10)
		OR	
12		Consider the following second order transfer function. Select a suitable range of sampling period for the system, if the system has a sensor delay of 0.02 seconds. $$T.F = \frac{100}{s^2 + 14s + 100}$$	(14)
13	a)	Map the following s- plane poles onto the z- plane using conformal mapping: $(i)\ s = \pm \pi j$ $\quad (ii)\ s = -5 \pm 4j$	(4)
	b)	A DSP system is described by the following difference equation: $$y(k+2) - 1.5\,y(k+1) + 0.5\,y(k) = u(k)\,;$$ with initial conditions $y(0) = 1\ ;\ y(1) = \frac{5}{2}$ Determine the system response $y(k)$, if $u(k)$ is a unit step function.	(10)
		OR	
14		For the non-unity feedback system shown below, derive the equations for the static position error constant Kp , static velocity error constant Kv and static acceleration error constant Ka. 	(14)
15	a)	Briefly explain the concept of stability of a system in z-plane.	(4)
	b)	After forming the Jury table, predict the stability of the digital system represented by the characteristic equation given below. (Use Jury stability criterion) $$z^5 + 0.2z^4 + z^2 + 0.3z - 0.1 = 0$$	(10)
		OR	
16		Draw the bode plot and determine the phase margin and gain margin for the following system with open loop transfer function *G(z)* (sampling period T=1sec)	(14)

		$$G(z) = \frac{0.2838z+0.1485}{(z-1)(z-0.1353)}$$	
17		Obtain the controllable canonical state space model for the transfer function given below. Also draw the block diagram of the state model with unit delay blocks. $$G(z) = \frac{4z^3-12z^2+13z-7}{(z-1)^2(z-2)}$$ **OR**	(14)
18		Derive the following relationship between A and F; B and g, starting from the analog state equation: $\dot{x} = Ax + bu$ $$F = e^{AT} \ and\ g = \left(\int_0^T e^{At} dt\right) B$$	(14)
19		A closed loop computer control system is shown in figure. The digital controller is described by the difference equation $$e_2(k+1) + 2e_2(k) = e_1(k)$$  The state variable model of the plant is given below: $$\dot{x} = Ax + bu$$ $$y = cx$$ $$A = \begin{bmatrix} 0 & 1 \\ -5 & -6 \end{bmatrix}; b = \begin{bmatrix} 0 \\ 1 \end{bmatrix}; c = [1 \ \ 0]$$ Obtain the discrete time state space model for the above closed loop system. **OR**	(14)
20		Consider the system $$\mathbf{x}(k+1) = \mathbf{F}\mathbf{x}(k) + \mathbf{g}u(k)$$ $$y(k) = \mathbf{c}\mathbf{x}(k)$$ where $$\mathbf{F} = \begin{bmatrix} 0.16 & 2.16 \\ -0.16 & -1.16 \end{bmatrix}; \mathbf{g} = \begin{bmatrix} -1 \\ 1 \end{bmatrix}; \mathbf{c} = [1 \ \ 1]$$ **(a) Design a state-feedback control algorithm which gives closed-loop characteristic roots at $0.6 \pm j0.4$.** (b) Design a state feedback control for deadbeat response	(8) (6)

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY Estd. 2014

AET456	POWER PLANT INSTRUMENTATION	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble:

The course is designed to learn about the working of different types of power plants. The major objectives of the course are to study about boilers, various measurements techniques and various control techniques used in power plants.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Explain the basic concepts about different types of power plants.
CO 2	Describe the working of boilers in power plants.
CO 3	Discuss the measurement and control in boiler accessories.
CO 4	Explain the measurements of electrical and non-electrical parameters in power plants.
CO 5	Describe about turbine monitoring and controls in power plants.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember			
Understand	50	50	100
Apply			
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern:

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss the differences in power generation methods in thermal and wind power plants.
2. What are the major reliability aspects to be considered in nuclear power plants?
3. Explain about power generation method in hydroelectric power plants.
4. Discuss about control and safety instrumentation in nuclear power plants.

Course Outcome 2 (CO2):

1. Explain the importance of air to fuel ratio in power plants.
2. Discuss why feed water conditioning is required in power plants?
3. Describe the working of boilers in power plants.
4. Explain why treatment of flue gas is needed in power plants?

Course Outcome 3 (CO3):

1. Explain the need of pressure measurement in boiler.
2. Describe about feedwater control.
3. Discuss the importance of drum level measurement in boiler.
4. Explain the importance of Automatic Turbine Runs up Systems.

Course Outcome 4 (CO4):

1. Describe a method for the measurement of current.
2. Discuss about the significance of interlocks in boiler operation.
3. Explain a method for the measurement for voltage.
4. Discuss about the role of Distributed Control System in power plants.

Course Outcome 5 (CO5):

1. Why dust monitoring is important in power plants?
2. Describe the importance of pedestal vibration.
3. Discuss the importance of flame monitoring.
4. Explain a method for the measurement of eccentricity.

Model Question paper

Course Code: AET456

Course Name: POWER PLANT INSTRUMENTATION

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. Discuss the differences in power generation methods in thermal and wind power plants.
2. What are the major reliability aspects to be considered in nuclear power plants?
3. Explain the importance of air to fuel ratio in power plants.
4. Discuss why feed water conditioning is required in power plants?
5. Explain the need of pressure measurement in boiler.
6. Describe about feedwater control.
7. Describe a method for the measurement of current.
8. Discuss about the significance of interlocks in boiler operation.
9. Why dust monitoring is important in power plants?
10. Describe the importance of pedestal vibration.

PART B

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

Module 1

11. Explain about power generation method in hydroelectric power plants.
12. Discuss about control and safety instrumentation in nuclear power plants.

Module 2

13. Describe the working of boilers in power plants.
14. Explain why treatment of flue gas is needed in power plants?

Module 3

15. Discuss the importance of drum level measurement in boiler.
16. Explain the importance of Automatic Turbine Runs up Systems.

Module 4

17. Explain a method for the measurement for voltage.
18. Discuss about the role of Distributed Control System in power plants.

Module 5

19. Discuss the importance of flame monitoring.
20. Explain a method for the measurement of eccentricity.

Syllabus

Course Code: AET456
Course Name: POWER PLANT INSTRUMENTATION

Module 1 (7 Hours)

Introduction to power plants

Brief survey of methods of power generation - Hydro, Thermal, Nuclear, Solar and Wind power, Power generation and distribution, Introduction to thermal power plant processes.

Importance of instrumentation in power generation, Nuclear power plant instrumentation, Piping and instrumentation diagram of different types in nuclear power plant. Nuclear reactor control loops, Control and safety instrumentation.

Module 2 (7 Hours)

Boiler systems

Boiler – types, Details of boiler processes - turbine units and its range systems, feed water systems, steam circuits, air preheating, air to fuel ratio, burner tilting and bypass damper.

Soot blowing operation - Soot blower types, combustion process, products of combustion, fuel systems, treatment of flue gases, steam turbine, alternator, feed water conditioning, turbine bypass valves.

Module 3 (7 Hours)

Measurement and control in boiler accessories

Drum level measurement, Radiation detector, Steam pressure and temperature measurement.

Controls in boiler: Boiler drum level control method, feed water control, steam temperature control, Cooling system, Automatic Turbine Runs up Systems.

Module 4 (7 Hours)

Measurements of electrical and non-electrical parameters

Measurements of Electrical measurements – Current, voltage, power, frequency and power factor.

Measurements of non-electrical parameters in power plants – fuel, air and steam – Distributed Control System in power plants, Interlocks in boiler operation.

Module 5 (7 Hours)

Turbine monitoring & Control

Measurement in boiler and turbine: Smoke and dust monitor, flame monitoring, Smoke density measurement – dust monitor.

Introduction to turbine supervising system, pedestal vibration, shaft vibration, eccentricity measurement, Installation of non-contracting transducers for speed measurement.

Text Books

1. Gill A.B, “Power Plant Performance”, Butterworth, London, 1984.
2. P.C Martin, I.W Hannah, “Modern Power Station Practice”, Pergamon, 3/e.
3. Sam. G.Dukelow, “The Control of Boilers”, 2nd Edition, ISA Press, New York, 1991.

Reference Books

1. David Lindsley, “Boiler Control Systems”, McGraw Hill, New York, 1991.
2. Jervis M.J, “Power Station Instrumentation”, Butterworth Heinemann, Oxford, 1993.
3. Modern Power Station Practice, Vol.6, “Instrumentation, Controls and Testing”, Pergamon Press, Oxford, 1971.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to power plants (7 hours)**	
1.1	Brief survey of methods of power generation - Hydro, Thermal, Nuclear, Solar and Wind power, Power generation and distribution, Introduction to thermal power plant processes.	3 hrs
1.2	Importance of instrumentation in power generation, Nuclear power plant instrumentation, Piping and instrumentation diagram of different types in nuclear power plant. Nuclear reactor control loops, Control and safety instrumentation.	4 hrs
2	**Boiler systems (7 hours)**	
2.1	Boiler – types, Details of boiler processes - turbine units and its range systems, feed water systems, steam circuits, air preheating, air to fuel ratio, burner tilting and bypass damper.	3 hrs
2.2	Soot blowing operation - Soot blower types, combustion process, products of combustion, fuel systems, treatment of flue gases, steam turbine, alternator, feed water conditioning, turbine bypass valves.	4 hrs
3	**Measurement and control in boiler accessories (7 hours)**	
3.1	Drum level measurement, Radiation detector, Steam pressure and temperature measurement.	3 hrs
3.2	Controls in boiler: Boiler drum level control method, feed water control, steam temperature control, Cooling system, Automatic Turbine Runs up Systems.	4 hrs
4	**Measurements of electrical and non-electrical parameters (7 hours)**	
4.1	Measurements of Electrical measurements – Current, voltage, power, frequency and power factor.	3 hrs
4.2	Measurements of non-electrical parameters in power plants – fuel, air and steam – Distributed Control System in power plants, Interlocks in boiler operation.	4 hrs
5	**Turbine monitoring & Control (7 hours)**	
5.1	Measurement in boiler and turbine: Smoke and dust monitor, flame monitoring, Smoke density measurement – dust monitor.	3 hrs

5.2	Introduction to turbine supervising system, pedestal vibration, shaft vibration, eccentricity measurement, Installation of non-contracting transducers for speed measurement.	4 hrs

Assignment:
At least two assignments should be given.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

AET466	MEMS	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to impart knowledge in the design and fabrication of microsystems

Prerequisite: Nil

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

CO 1	Explain theLaws of scaling, multidisciplinary nature of MEMS and various Engineering disciplines in MEMS.
CO 2	Describe the various actuation mechanisms employed in MEMS devices and the geometry of typical sensors and actuators
CO 3	Discuss the various process steps in microfabrication
CO4	Explain the various micromachining techniques and packaging techniques employed in MEMS
CO5	List and explain the multi-disciplinary applications of MEMS

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	2							2
CO 2	3	3	3	3	2							2
CO 3	3	3	3	3	2							2
CO 4	3	3	3	3	2							2
CO5	3	3	3	3	3							

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyse	K4			
Evaluate				
Create				

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the Laws of scaling, multidisciplinary nature of MEMS and various Engineering disciplines in MEMS.

1. Explain the scaling laws that applies to MEMS
2. Discuss the multidisciplinary nature of MEMS
3. Discuss Microfluidics, MOEMS, Bio-MEMS and RF MEMS

Course Outcome 2 (CO2): Describe the various actuation mechanisms employed in MEMS devices and the geometry of typical sensors and actuators.

1. Explain the various actuation mechanisms employed MEMS sensors and actuators
2. Discuss parallel plate sensing employed in MEMS.
3. Describe the principle various types micro sensors, like inter-digitated finger capacitors or comb drive sensors

Course Outcome 3 (CO3): **Discuss the various process steps in microfabrication.**

1. Explain Czochralski crystal growth process of single crystal silicon
2. Compare low pressure CVD (LPCVD) and Plasma Enhanced CVD (PECVD)
3. Describe the various steps of photolithography

Course Outcome 4 (CO4): Explain the various micromachining techniques and packaging techniques employed in MEMS.

1. Compare bulk and surface micromachining technique.
2. Discuss MEMS packaging techniques, viz, die preparation, surface bonding, wire bonding
3. Explain LIGA process with an example

Course Outcome 5 (CO5): List and explain the multi-disciplinary applications of MEMS.

1. Describe MEMS medical pressure sensors.
2. Discuss the geometry and operation Digital Mirror Devices
3. Explain MEMS microphone

SYLLABUS

Module 1:

Introduction: Overview of microelectronics manufacture and Microsystem technology. Definition – MEMS materials. Laws of scaling. The multi-disciplinary nature of MEMS. Survey of materials central to micro engineering. Application of MEMS in various industries.

Module 2:

Microsensors and Actuators: Working Principle of Microsystems – various micro sensing and actuation techniques – parallel plate electrostatic sensing - micro sensors – various types – interdigitated finger capacitors or comb drive sensors - micro accelerometers.

Module 3:

Micro Fabrication: Substrates – Single crystal silicon wafer formation – Czochralski crystal growth process – Photolithography - Ion Implantation – Diffusion – Oxidation – Chemical Vapour Deposition – LPCVD – PECVD – Physical Vapour Deposition – Etching process – various types – Photo resists

Module 4:

Microsystem Manufacturing: MEMS Process – Bulk Micromachining – Surface Micromachining -Sacrificial etching process –LIGA Process – SLIGA – Die level – device level – System level – packaging techniques – die preparation - surface bonding – wire bonding – sealing

Module 5:

MEMS Applications: Bio-MEMS - Medical pressure sensors, Optical MEMS - Digital Mirror Devices (DMDs), Microfluidics – InkJet Print head technology, MEMS inertial sensors – Gyroscopes, RF MEMS – Switches, MEMS Microphones.

Text Books

1. Tai-Ran- Hsu,MEMS and Microsystems – Design and Manufacture, Tata McGraw-Hill Publishing Company Limited, 2010
2. Chang Liu, Foundation of MEMS, Pearson Education, 2012

Reference Books

1. Mohamed Gad –el -Hak, “MEMS Handbook”, CRC Press, 2002
2. Rai- Choudhury P, “MEMS and MOEMS – Technology and Applications”, PHI Learning Private Limited, 2009
3. M. H. Bao, “Micromechanical Transducers: Pressure sensors, accelerometers and gyroscopes”, Elsevier Pvt. Ltd., NewYork, 1st Edition, 2000
4. Marc Madou, “Fundamentals of Microfabrication”, CRC Press, 1st Ed., 1997
5. Edited by D. Uttamchandani, “Handbook of MEMS for wireless and mobile applications”, Woodhead Publishing Limited, 2013
6. Stephen D. Senturia, “Microsystem Design”, Kluwer Academic Publishers, 1st Ed. 2001

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**MEMS –Introduction**	
1.1	Overview of microelectronics manufacture and Microsystem technology	1
1.2	Quasi-fundamental scaling laws applicable to MEMS	2
1.3	Multi-disciplinary nature of MEMS and Microsystem	1
1.4	Application of MEMS in various industries	1
2	**Microsensors and Actuators**	
2.1	Overview of various micro sensing and actuation techniques	1
2.2	Parallel plate electrostatic sensing - analysis	2
2.3	Inter-digitated finger capacitors or comb drive sensors	2
2.4	Micro accelerometers - design	1
3	**Microfabrication**	
3.1	Single crystal silicon wafer formation – Czochralski crystal growth process	1
3.2	Photolithography	1
3.3	Ion Implantation – Diffusion – Oxidation	1
3.3	Chemical Vapour Deposition – LPCVD – PECVD – Physical Vapour Deposition – Sputtering process	3
3.4	Etching process – various types – Photo resists	2
4	**Microsystem Manufacturing**	
4.1	MEMS Process – Bulk Micromachining – Surface Micromachining	2
4.2	Sacrificial etching process – release of membranes	1
4.3	LIGA Process – process steps , example , SLIGA	2
4.4	MEMS packaging techniques – die preparation - surface bonding – wire bonding - sealing	2
5	**MEMS Applications**	
5.1	Bio-MEMS - Medical pressure sensors	2
5.2	Optical MEMS - Digital Mirror Devices (DMDs),	2
5.3	Microfluidics – InkJet Print head technology,	1
5.4	MEMS inertial sensors – Gyroscopes	2
5.5	MEMS microphones and RF MEMS switches	2

Assignment:

1. List the multidisciplinary applications of MEMS
2. Perform a study of Bio-MEMS, microfluidics, MOEMS, RFMEMS
3. Discuss various MEMS sensors and actuators

Model Question paper
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Program: Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation Engineering

Course Code: AET466

Course Name: MEMS

Max. Marks: 100 Duration: 3Hours

PART A
Answer ALL Questions. Each Carries 3 mark.

1.	List the applications of MEMS devices in industry	K2	
2	Comment on the multi-disciplinary nature of MEMS.	K2	
3	Discuss the principal components of Microsystem.	K2	
4	Explain the various actuation mechanisms employed in MEMS devices	K2	
5	Write a brief note on positive and negative photoresists	K2	
6	Compare Low Pressure CVD and Plasma Enhanced CVD	K2	
7	Discuss the principle of LIGA process of fabricating MEMS devices	K2	
8	Explain the MEMS packaging techniques surface bonding and wire bonding.	K2	
9	Explain the principle of RF MEMS switches.	K2	
10	Distinguish between Bio-MEMS and MOEMS.	K2	

PART – B
Answer one question from each module; each question carries 14 marks.
Module – I

11. a)	Describe the quasi-fundamental scaling laws that applies to MEMS	7	CO1	K3
11. b)	Perform a comparative study of microelectronics and microsystem	7	CO1	K2
	OR			
12.a)	Comment on the material properties central to microengineering	7	CO1	K3
12.b)	Explain the features of MEMS and list the critical factors that affect commercialization of MEMS devices	7	CO1	K3

Module – II

13. a)	Discuss the principle of parallel-plate electrostatic microsensors. Draw a coupled electro – mechanical model and derive an expression for the electrostatic force at equilibrium	8	CO2	K3
13. b)	With sketches, explain the geometry and principle of micro grippers and micro valves	6	CO2	K2
	OR			

14.a)	Explain the sensing principle of longitudinal and transverse comb drive sensing. Derive an expression for the magnitude of force in transverse comb drive	8	CO2	K3
14.b)	With appropriate diagrams, explain the principle of micromotors and micropumps	6	CO2	K2

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Module – III

15. a)	Describe the Czochralski growth process of obtaining single crystal silicon	7	CO3	K2
15. b)	Explain the process of wet chemical etching. Draw the etching profiles of isotropic and anisotropic etching	7	CO3	K2
	OR			
16.a)	With appropriate figures, explain the steps of photolithography	8	CO3	K2
16.b)	Describe the sputtering process of deposition employed in microfabrication	6	CO3	K2

Module – IV

17. a)	Compare bulk and surface micromachining process of fabricating MEMS devices	6	CO4	K2
17. b)	With figures, list the various stages of micromachining a MEMS cantilever. Discuss the sacrificial etching process	8	CO4	K3
	OR			
18.a)	With an example, describe the LIGA process of MEMS manufacturing	8	CO4	K3
18.b)	Explain four important functions of microsystem package.	6	CO4	K2

Module – V

19. a)	Discuss Bio-MEMS. Explain the principle of MEMS medical pressure sensor	8	CO5	K2
19. b)	Describe the geometry and operation of MEMS microphone	6	CO5	K2
	OR			
20. a)	Comment on Optical MEMS. Explain the principle of Digital Mirror Devices (DMDs)	7	CO1	K2
20. b)	Discuss the geometry and principle of MEMS gyroscopes.	7	CO1	K2

AET476	Robotics and Industrial Automation	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: The purpose of this course is providing the knowledge of automation components, tools, systems and to give an overview on the classification and components of industrial robots.

Prerequisite: NIL

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

CO 1	Design and implement automated systems using pneumatics.
CO 2	Provide hydraulic solutions for designing automated systems.
CO 3	Devise Assembly automated systems using feeders, orienteers and escapement devices
CO 4	Perform selection of gripping mechanism for robotic application.
CO 5	Perform kinematic and dynamic analyses with simulation.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	30	30	80
Apply	K3	10	10	10
Analyze	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 and implement automated systems using pneumatics.

1. Mention the applications of hydraulic in engineering field.
2. Sketch and explain the basic hydraulic system.

Course Outcome 2 (CO2): Provide hydraulic solutions for designing automated systems.

1. What are the factors that influence the power input to the compressor?

Course Outcome 3 (CO3): Devise Assembly automated systems using feeders, orienteers and escapement devices.

1. Discuss about the need for robots
2. Explain about major parts of a robot with their functions.

Course Outcome 4 (CO4): Perform selection of gripping mechanism for robotic application.

1. What is repeatability of industrial robot?
2. Classify sensors for robot applications.
3. Discuss in detail about functions & need of industrial robots.

Course Outcome 5 (CO5): Perform kinematic and dynamic analyses with simulation.

1. What is g-factor? How grippers are classified based on g factor.
2. Give two applications where vacuum grippers are widely used in robots.

SYLLABUS

Module 1:

Hydraulic System Elements: Pumps, types, working, characteristics, applications: Types of conductors, and connectors, their selection: Seals and packing, types, materials, applications.

Hydraulic Actuators: Linear and Rotary, types, working, cushioning effect, mounting,

Control Elements: Pressure control Valves, direct acting type, pilot operated, sequence, counterbalancing, unloading, pressure reducing, construction and working: Direction control valves, types, construction and working.

Module 2:

Pneumatics: Air compressors, types, working, selection criteria; FRL unit, construction and working; Pneumatic cylinders and air motors, construction and working, Comparison of air, hydraulic and electric motor.

Pneumatic System Control Elements: Flow control valves, working of variable flow control, quick exhaust, time delay and shuttle valve

Module 3:

Robotics-Introduction-Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robot's classification with respect to geometrical configuration (Anatomy), Controlled system & chain type: Serial manipulator & Parallel Manipulator.

Module 4:

Components of Industrial robotics-precession of movement resolution, accuracy & repeatability-Dynamic characteristics- speed of motion, load carrying capacity & speed of response-Sensors-Internal sensors: Position sensors, & Velocity sensors, External sensors: Proximity sensors, Tactile Sensors, & Force or Torque sensors.

Module 5:

Grippers - Mechanical Gripper-Grasping force-Engel Berger-g-factors-mechanisms for actuation, Magnetic gripper, vacuum cup gripper-considerations in gripper selection & design, Industrial robots' specifications. Selection based on the Application

Text Books

1. Espositio A., "Fluid Power with Applications", Pearson, 2002.
2. Majumdar S. R., "Oil Hydraulic Systems", Tata McGraw Hill 2000

Reference Books

1. Majumdar S. R., "Pneumatic systems-principles and Maintenance", Tata Mc Graw Hill, 2000.
2. Janaki Raman P.A., "Robotics and image processing", Tata McGraw Hill, 1995.
3. Yoram Koren, "Robotics", McGraw Hill, 1992.
4. Groover M. P., "Industrial Robotics", Mc Graw Hill
5. John J. Craig, "Introduction to Robotics", Pearson

Course Contents and Lecture Schedule

Sl. No	Topic	No. of Lectures
1	**Hydraulic System Elements**	
1.1	Pumps, types, working, characteristics, applications	1
1.2	Types of conductors, and connectors, their selection	1
1.3	Seals and packing, types, materials, applications	1
	Hydraulic Actuators	
1.4	Linear and Rotary - types and working	1
1.5	Cushioning effect, mounting	1
	Control Elements	
1.6	Pressure control Valves, direct acting type, pilot operated, sequence, construction and working.	1
1.7	Counterbalancing, unloading, pressure reducing, construction and working.	1
1.8	Direction control valves, types, construction and working.	1
2	**Pneumatics**	
2.1	Air compressors, types, working, selection criteria	1
2.2	FRL unit, construction and working	1
2.3	Pneumatic cylinders and air motors, construction and working	1
2.4	Comparison of air, hydraulic and electric motor.	1
	Pneumatic System Control Elements	
2.5	Flow control valves, working of variable flow control	1
2.6	Quick exhaust, time delay and shuttle valve	2
3	**Robotics**	
3.1	Robotics-Introduction-Types of robots	1
3.2	Overview of robot subsystems, resolution, repeatability and accuracy	2
	Degrees of freedom of robot’s classification with respect to geometrical configuration (Anatomy)	2
3.3	Controlled system & chain type	1
3.4	Serial manipulator & Parallel Manipulator.	1
4	**Components of Industrial robotics**	
4.1	Components of Industrial robotics-precession of movement resolution, accuracy & repeatability	2
4.2	Dynamic characteristics- speed of motion, load carrying capacity & speed of response	2
4.3	Sensors-Internal sensors: Position sensors, & Velocity sensors	2
4.4	External sensors: Proximity sensors, Tactile Sensors, & Force or Torque sensors.	2
5	**Grippers**	
5.1	Mechanical Gripper-Grasping force-Engel Berger	1
5.2	G-factors-mechanisms for actuation	1
5.3	Magnetic gripper, vacuum cup gripper	1
5.4	Considerations in gripper selection & design	1
5.5	Industrial robots’ specifications	1
5.6	Selection based on the Application	1

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET476

Program: Applied Electronics and Instrumentation Engineering/Electronics and Instrumentation Engineering

Course Name: Robotics & Industrial Automation

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	What are the types of hydraulic actuators?	CO1	K2
2	Compare hydraulic and pneumatic systems	CO1	K2
3	What is compression ratio?	CO2	K2
4	What are the different types of air compressor?	CO2	K2
5	What are the components of a robot?	CO3	K2
6	What are the laws of robotics?	CO3	K2
7	What do you mean by torque sensor?	CO4	K2
8	What is meant by accuracy of industrial robot?	CO4	K2
9	What is the principle of vacuum cup grippers?	CO5	K2
10	What is meant by grippers? What are the types of grippers	CO5	K2

PART – B

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

Module – I

11. a)	Describe the elements of hydraulic actuation system components in detail	9	CO1	K2
11. b)	explain external gear pump with neat sketch	5	CO1	K2
	OR			
12.a)	How are the control valve classified? Write the classification of the pressure control valve.	8	CO1	K2
12.b)	Define pump and state the purpose of the pump in hydraulic system and classify pumps	6	CO1	K2

Module – II

13 a)	What is the difference between rotary air compressor and reciprocating air compressor?	9	CO2	K2
13 b)	What are shuttle valve?	5	CO2	K2
OR				
14 a)	What are the components of pneumatic system?	8	CO2	K2
14 b)	What is a quick exhaust valve? Mention it's application.	6	CO2	K2

Module – III

15 a)	Describe the classification of robots by control system.	9	CO3	K2
15 b)	What is the degree of freedom in the robotics? How can it be determined?	5	CO3	K2
OR				
16 a)	Define a manipulator& also compare serial and parallel manipulator.	8	CO3	K2
16 b)	How to calculate the degree of freedom in serial manipulator.	6	CO3	K2

Module – IV

17 a)	Briefly explain the working principle of any two types of position sensors with neat sketch.	8	CO4	K2
17 b)	Write short notes on the following i). accuracy ii). precision iii). repeatability	6	CO4	K2
OR				
18 a)	Describe the working principle of proximity sensor with neat sketch.	8	CO4	K2
18 b)	Briefly explain the dynamic characteristics of robot.	6	CO4	K2

Module – V

19 a)	Explain mechanical grippers & their linkage mechanism with neat sketches.	9	CO5	K2
19 b)	List out the important factors to be considered in the selection & design of grippers.	5	CO5	K2
OR				
20 a)	Discuss about vacuum cup grippers along with their advantages & disadvantages.	9	CO5	K2
20 b)	Give the specification of industrial robot	5	CO5	K2

ECT418	MECHATRONICS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course introduces students to the rapidly emerging, multi-disciplinary, and exciting field of Mechatronics.

Prerequisite: Nil

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

CO1	Understand the working principles of various sensors and actuators in Mechatronics systems and be able to choose the suitable one for the real world application
CO2	Formulate and simulate models of mechatronics systems
CO3	Explain the implementation of PLC in mechatronics applications
CO4	Explain the standard fabrication techniques and principle of operation of MEMS devices
CO5	Design and Analysis of commonly encountered mechatronics systems for real time applications

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	60
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the working principles of various sensors and actuators in Mechatronics systems and be able to choose the suitable one for the real-world application

1. Illustrate the working of a strain gauged load cell
2. Explain the working of any one non-contact temperature measurement system
3. Explain the principle of operation and suggest two applications of Hall effect sensor in mechatronic systems.
4. With neat sketches explain the working of a double acting hydraulic actuator.
5. Design a hydraulic circuit to operate a winch fitted with a hydraulic motor. The motor should be run clockwise, counter clockwise and stopped. Use a manually operated valve.
6. Explain any two situations when pneumatic actuators are preferred over hydraulic ones.

Course Outcome 2 (CO2): Formulate models of mechatronics systems

1. Derive the mathematical model of a general electrical system and draw its analogy with a mechanical system.
2. Explain the working of a mechanical device using closed loop control system with the help of a suitable example.

Course Outcome 3 (CO3): Explain the implementation of PLC in mechatronics applications

1. Explain 'latching' in PLC logic with an example.
2. Illustrate the significance of Internal Relays in PLC program
3. Consider a pneumatic system with single-solenoid controlled valves and involving two cylinders A and B, with limit switches a–, a+, b–, b+ detecting the limits of the piston rod movements. Design a ladder programme with the requirement being when the start switch is triggered, the sequence A+, B+, A–, 10s time delay, B– occurs and stop at that point until the start switch is triggered again.

Course Outcome 4(CO4): Explain the standard fabrication techniques and principle of operation of MEMS devices

1. Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions.
2. Explain the criteria for choice of surface or bulk micromachining techniques in the design of micro systems.
3. Explain with block diagram the steps in LIGA process. State two advantages of LIGA process over other micro machining techniques.

Course Outcome 5 (CO5): Design and Analysis of commonly encountered mechatronics systems for real time applications

1. With the help of a neat sketch explain the different mechatronics modules used in automatic car park barrier system
2. Explain with a neat sketch the mechatronic implementation of a household weighing machine
3. With a neat sketch, explain the physical system and working of a pick and place robot.

SYLLABUS

MODULE I
Introduction to Mechatronics: Structure of Mechatronics system. Comparison between traditional and mechatronics approach. Sensors - Characteristics -Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute. Resolvers and synchros. Piezoelectric sensors. Acoustic Emission sensors. vibration sensors. Force and tactile sensors. Range finders: ultrasonic and light-based range finders

MODULE II
Actuators: Hydraulic and Pneumatic actuators - Directional control valves, pressure control valves, process control valves. Rotary actuators. Development of simple hydraulic and pneumatic circuits using standard Symbols. Electrical drives: DC, AC, brushless, servo and stepper motors. Harmonic drive. Magneto strictive actuators and piezoelectric actuators.

MODULE III
System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools.
Programmable Logic Controllers (PLC) –Basic structure, input/ output processing. Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes.

MODULE IV
Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Micromachining methods for MEMS -Surface and Bulk, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope.

MODULE V
Mechatronics in Robotics- choice of Sensors and Actuators. Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras. Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding.
Case studies of Mechatronics systems: Automatic camera, bar code reader, simple weighing machine, pick and place robot, automatic car park barrier system, automobileengine management system.

Text Books:

1. Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Person Education Limited, New Delhi, 2007

2. Ramachandran K. P., G. K. Vijayaraghavan, M. S. Balasundaram, Mechatronics: IntegratedMechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi, 2008.

3. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Person Education ,Inc., New Delhi, 2006.

4. Devdas Shetty, Richard A. Kolk, "Mechatronics System Design", Thomson Learning Publishing Company, Vikas publishing house, Second edition, 2001.

Reference Books:

1. David G. Aldatore, Michael B. Histand, Introduction to Mechatronics and MeasurementSystems, McGraw-Hill Inc., USA, 2003.
2. Gordon M. Mair, Industrial Robotics, Prentice Hall International, UK, 1998.
3. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
4. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, John Wiley & Sons Ltd., England, 2006.
5. Bishop, Robert H. The Mechatronics Handbook-2 Volume Set. CRC press, 2002.

Course Plan Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction to Mechatronics: Structure of Mechatronics system. Comparison between traditional and mechatronics approach	1
	Sensors - Characteristics -Temperature, flow, pressure sensors.	1
	Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods	1
	Encoders: incremental and absolute. Resolvers and synchros.	1
	Piezoelectric sensors. Acoustic Emission sensors. vibration sensors, Force and tactile sensors	1
	Range finders: ultrasonic and light-based range finders	1
2	Actuators: Hydraulic and Pneumatic actuators - Directional control valves	1
	pressure control valves, process control valves,	1
	Rotary actuators.	1
	Development of simple hydraulic and pneumatic circuits using standard Symbols.	1
	Electrical drives: DC, AC, and	1
	brushless, servo	1
	stepper motors. Harmonic drive.	1
3	System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems.	2
	Typical elements of open and closed loop control systems, Adaptive controllers for machine tools	1
	Programmable Logic Controllers (PLC) –Basic structure, input/ output processing.	1
	Programming: Timers, Internal Relays, Counters and Shift registers.	2
	Development of simple ladder programs for specific purposes	1
4	Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography	1
	Micromachining methods for MEMS -Surface and Bulk,	2
	Deep Reactive Ion Etching (DRIE) and LIGA processes.	1
	Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope	3
5	Mechatronics in Robotics- choice of Sensors and Actuators.	1
	Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras.	2
	Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding.	2

	Case studies of Mechatronics systems: Automatic camera, bar code reader, simple weighing machine, picks and place robot,	2
	Automatic car park barrier system, automobile engine management system.	1

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

Model Question Paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B TECH DEGREE EXAMINATION

COURSE: ECT418 MECHATRONICS

TIME: 3 HRS MAX. MARKS: 100

PART A

Answer All Questions

1	Differentiate between absolute and incremental encoders	3
2	List six examples of temperature sensors	3
3	Explain how cushioning is achieved in pneumatic actuators with a sketch.	3
4	Mention any two differences between finite position and infinite position valves	3
5	List any 2 controlling factors in wet etching.	3
6	Sketch and label a MEMS based pressure sensor	3
7	What is latching? Draw a simple latched circuit	3
8	Write down the describing equations of basic mechanical building blocks	3
9	Illustrate the histogram processing technique for enhancing the image contrast	3
10	Bring out any 3 differences between CCD and CID camera.	3

PART B

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

Module I

11(A)	Explain the working of an optical absolute encoder. How the number of tracks and sectors of absolute encoder is related to the resolution of the encoder?	*6*
11(B)	Explain the structure of a mechatronics system. How is it different form the traditional approach?	*8*
	OR	
12(A)	Explain the sensor characteristics to be considered when choosing a sensor for a mechatronics application	*8*
12(B)	Compare the working of resolver and synchro	*6*

Module II

13(A)	Develop a pneumatic circuit with standard symbols, to operate two cylinders in sequence. Explain its working.	*8*
13(B)	Explain the constructional features and working of brushless DC motor	*6*
	OR	
14(A)	Illustrate the working of Harmonic Drives with neat sketches	*8*
14(B)	Design a hydraulic circuit to operate a winch fitted with a hydraulic motor. The motor should be run clockwise, counter clockwise and stopped. Use a manually operated valve.	*6*

Module III

15(A)	Draw and explain the block diagram of a feedback control system.	*4*
15(B)	Develop a PLC ladder program for the following sequence: Start a motor with push switch, and then after a delay of 90s, start a pump. When the motor is switched off, the pump will get switched off after a delay of 5s. Mention the logic used for each rung in the program to substantiate your answer.	*10*

OR

16(A)	Explain how a PLC can be used to handle analog inputs?	*4*
16(B)	Explain the model a fluid flow system with basic building blocks, clearly mention all assumptions	*10*

Module IV

17(A)	Explain the steps involved in photolithography. State the chemicals used in each of the stages along with the operating conditions	*6*
17(B)	Compare and contrast various micro manufacturing techniques	*8*

OR

18(A)	Describe the various mechanical problems associated with surface micromachining	*6*
18(B)	Explain the LIGA process associated with MEMS fabrication	*8*

Module V

19(A)	With the help of a neat sketch explain the different mechatronics modules used in automatic car park barrier system	*10*
19(B)	List any four applications of robotic vision systems	*4*

OR

20(A)	Explain the working of Barcode reader with reference to the coding schemes. Mention the steps to process the digits in a barcode for a particular product. Develop the steps in a program for reading the barcode.	*10*
20(B)	List the steps in thresholding technique in image processing	*4*

AET428	Automotive Electronics	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course provides an overview of the electronic systems found in automotive designs including critical systems, navigation, sensor interfacing, safety systems and communication systems.

Prerequisites: Fundamentals of analog and digital circuits, Control Engineering, Microcontrollers.

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

CO 1 (K2)	Explain the fundamentals of automotive electronics
CO 2 (K2)	Discuss the various communication technologies on board vehicles
CO 3 (K3)	Illustrate the working of various control algorithms implemented in vehicles for the purpose of automation
CO4 (K2)	Describe the need and working of various sensors used for vehicle automation
CO5 (K3)	Apply the knowledge of electronics for safety and security in vehicles

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	20
Understand	K2	30	40	80
Apply	K3	10		

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the fundamentals of automotive electronics

1. What are the major roles of electronics in an automobile?
2. Differentiate between Open loop and Closed loop systems.
3. Differentiate between External exhaust-gas recirculation and Exhaust-gas turbocharging.
4. Explain the actuation process of HDEV high-pressure fuel injector.

Course Outcome 2 (CO2): Discuss the various communication technologies on board vehicles.

1. Explain various Network topologies used in automotive.
2. Draw and explain a typical network topology in a new generation compact class car.
3. With a neat diagram explain Data transfer during turn signalling
4. With neat diagrams, explain function of a Basic CAN Bus.

Course Outcome 3 (CO3): Illustrate the working of various control algorithms implemented in vehicles for the purpose of automation

1. What are the digital modules available in the automotive control unit?
2. Enumerate the structural features of a control software.
3. Explain crankshaft position calculation procedure.
4. What is meant by Combustion-synchronous interrupt?

Course Outcome 4 (CO4): Describe the need and working of various sensors used for vehicle automation.

1. What are the characteristics of Position sensors?
2. Explain the principle of Potentiometric fuel-level sensor.
3. What are the applications of Magneto static sensors.
4. Explain the working principle of Hall Effect sensor.

Course Outcome 5 (CO5): Apply the knowledge of electronics for safety and security in vehicles.

1. Illustrate the working of ABS.
2. Explain the working principle of ACC.
3. How EBD avoid accidents? Explain its principle.
4. Explain the principle of Pedestrian Airbags in modern cars.

SYLLABUS

AET 428: AUTOMOTIVE ELECTRONICS

.

Module 1: Introduction to Automotive Electronics (7Hrs)

Overview of vehicle electronic systems, Review the trends in automotive electronics as well as issues that are driving the automotive industry, Integration of electronic components and systems in vehicles, Embedded processors and microcontrollers, Interfaces to peripherals and to sensors.

Module 2: Automotive Communications Systems (7Hrs)

Introduction to communications standards, Introduction to networks, safety critical issues and reliability, Communication protocols for automotive application. CAN, LIN Bus and others, Telematics for automotive applications, GPRS, GPS for use in and automotive environment. Automotive Diagnostics.

Module 3: Automotive Control and Power Systems (7Hrs)

Electronic control methods (analog and digital). Stability algorithms for control (cruise control, traction control), Actuator limiting, wind-up, gain scheduling and others, Energy management strategies: regenerative breaking, start-stop, torque boost, Sensing and control systems. Interfacing using power devices.

Module 4: Sensors and Interfacing (7Hrs)

Introduction to electronic instrumentation for sensors: temperature, distance, velocity, speedometer, anti-collision and others, Interfacing electronics with Operational Amplifiers.
DA/AD converters, limitations, topologies and processing for sensors.

Module 5: Automotive Safety Systems and DAS (7Hrs)

Introduction to safety systems, Passive system electronics: Airbag and sensors Active systems electronics: Antilock-braking system (ABS), Electronic Stability Program (ESP), Anti-slip regulation (ASR) and others, Driver Assistance Systems**:** Advanced active systems electronics: ACC, Active safety system applications: lane detection, blind spot, crash avoidance control electronics.

Text Books

1.Robert Bosch Gmbh 2013, Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive. Publication Date: July 31, 2013 ISBN-13: 978-3658017835. 6th
2. Williams B. Ribbens, 2012. Understanding Automotive Electronics. Seventh Edition, Elsevier Åström, Wittenmark. Computer Controlled Systems. 3rd ed. Prentice Hall, 1997 Ed.

Reference Books

1. James D. Halderman. 2013. Advanced Automotive Electricity and Electronics. Prentice Hall.
2. S. Krueger, W.Gessner 2002, Advanced Microsystems for Automotive Applications. Springer
3.Tom Denton 2004, Automobile Electronic & Electronic Systems, 3rd edition Ed.

Course Content and Lecture schedule

	Topic	No. of Lectures
	Module 1: Introduction to Automotive Electronics (7Hrs)	
1.1	Overview of vehicle electronic systems	1
1.2	Review the trends in automotive electronics as well as issues that are driving the automotive industry	2
1.3	Integration of electronic components and systems in vehicles	1
1.4	Embedded processors and microcontrollers	1
1.5	Interfaces to peripherals and to sensors	1
	Module 2: Automotive Communications Systems (7Hrs)	
2.1	Introduction to communications standards	1
2.2	Introduction to networks, safety critical issues and reliability	1
2.3	Communication protocols for automotive application CAN, LIN Bus and others	2
2.4	Telematics for automotive applications	1
2.5	GPRS, GPS for use in and automotive environment	1
2.6	Automotive diagnostics	1
	Module 3: Automotive Control and Power Systems (7Hrs)	
3.1	Electronic control methods (analog and digital)	1
3.2	Stability algorithms for control (cruise control, traction control)	1
3.3	Actuator limiting, wind-up, gain scheduling and others	2
3.4	Energy management strategies: regenerative breaking, start-stop, torque boost, Sensing and control systems	2
3.5	Interfacing using power devices.	1
	Module 4: Sensors and Interfacing (7Hrs)	
4.1	Introduction to electronic instrumentation for sensors: temperature, distance, velocity, speedometer, anti-collision and others,.	2
4.2	Interfacing electronics with Operational Amplifiers	2
4.3	DA/AD converters	1
4.4	Limitations, topologies and processing for sensors	2
	Module 5: Automotive Safety Systems and DAS (7Hrs)	
5.1	Introduction to safety systems: Passive and Active systems electronics	1
5.2	Antilock-braking system (ABS), Electronic Stability Program (ESP), Anti-slip regulation (ASR) and others	2
5.3	Driver Assistance Systems: Advanced active systems electronics: ACC	2
5.4	Active safety system applications: lane detection, blind spot, crash avoidance control electronics	**2**

Model Question paper
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B. TECH. DEGREE EXAMINATION,

Program: Applied Electronics & Instrumentation Engineering/ Electronics and Instrumentation

Course Code: AET428

Course Name: Automotive Electronics

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark

1	What are the functions of Motronic engine-management? System?	3	CO1	K2
2	How the fuel injector works?	3	CO1	K2
3	Enumerate the requirements of a typical automotive bus system.	3	CO2	K1
4	What are the major components of Multimedia networking?	3	CO2	K1
5	What is meant by Combustion-synchronous interrupt?	3	CO3	K2
6	List out the essential digital modules in an automotive control unit.	3	CO3	K1
7	Explain the functions of a temperature sensor in an IC engine.	3	CO4	K2
8	What are D/A converters? Give any two applications in automobiles.	3	CO4	K2
9	What are the advantages of ESP? Explain	3	CO5	K1
10	What is the principle behind Line detection?	3	CO5	K2

PART – B
Answer one question from each module; each question carries 14 marks.
Module – I

11 (a)	With a neat diagram, Explain Electronic ignition system configuration.	8	CO1	K2
(b)	Draw a basic automotive computer block diagram and explain	6	CO1	K2
	OR			
12(a)	With a neat diagram, explain Automotive digital instrumentation system.	8	CO1	K2
(b)	What are the functions of a microcontroller in an IC Engine?	3	CO1	K1
(c)	What is meant by COP in an ignition system?	3	CO2	K1

Module2

13 (a)	What is the need for a communication network in an automobile? Explain	6	CO2	K2
(b)	Explain LIN bus standard in detail.	8	CO2	K1
	OR			
14(a)	Explain the GPS system structure in a vehicle with necessary diagrams.	8	CO2	K2

(b)	What is meant by OBD? Explain	6	CO2	K2

Module 3

15(a)	What are the essential components of a digital control system? Explain	5	CO3	K2
(b)	Differentiate between Cruise control and Traction Control.	4	CO3	K2
(c)	With a diagram, explain digital speed measurement system.	7	CO3	K2
	OR			
16(a)	With necessary sketches, explain various energy management strategies in an automobile.	10	CO3	K2
(b)	Explain the concept of Actuator Limiting.		CO3	K2

Module 4

17(a)	Explain the principle of Anti-collision sensor.	6	CO4	K2
(b)	What is the need for an Op-amp in electronic control? Explain,	6	CO4	K2
(c)	What is meant by interfacing? OR	2	CO4	K2
18 (a)	Give the principle of distance measurement using sensor.	4	CO4	K2
(b)	Explain how an A/D converter is interfaced with a temperature sensor.	6	CO4	K2
(c)	What is a knock sensor? Explain	4	CO4	K1

Module 5

19(a)	With examples, differentiate between passive and active safety systems.	4	CO5	K2
(b)	Explain ACC in detail with neat diagrams. OR	10	CO5	K2
20(a)	Illustrate the working of ABS in detail.	8	CO5	K2
(b)	How Blind spot detection is done in vehicles?	3	CO5	K2
(c)	What are the pedestrian safety measures available in modern cars?	3	CO5	K2

AET 438	CYBER SECURITY	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble:
Cyber security is the protection of computer systems and networks from information disclosure, theft of or damage to their hardware, software, or electronic data, as well as from the disruption or misdirection of the services they provide. The objective of this course is to familiarize various types of cyber-attacks and cyber-crimes and to give an overview of the cyber laws. Students should also aware of the defensive techniques against these attacks.

Prerequisite: A Sound knowledge in Computer networks, the Internet and computer operating systems.

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

CO1	Explain the basic concepts and terminologies of cyber security, cyber forensic and cyber forensics investigation process. (K2)
CO2	Illustrate the basic concepts of system and network vulnerabilities and usage of vulnerability scanning tools. (K3)
CO3	Describe the principles of network forensics and network defense tools. (K2)
CO4	Analyze different cybercrimes and understand provisions of Indian IT Act 2000. (K2, K4)
CO5	Evaluate critically, the anti-forensic practices and understand steps in cybercrime investigation. (K2)

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		2								2
CO 2	3	3			2							2
CO 3	3	2			2				2	3		2
CO 4					2				3	2		2
CO 5	2	3		2								2

Assessment Pattern

Bloom's Category		**Continuous Assessment /Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	40
Apply	K3	10	10	30
Analyze	K4	10	10	20
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the basic concepts and terminologies of cyber security, cyber forensic, and cyber forensics investigation process.

1. Understand the basic concepts and terminologies in cyber security.
2. Familiarize basic concepts and terminologies of cyber forensic.
3. Understand basic steps in cyber forensic investigation.

Sample questions:

1.Explain the need for cyber security. Discuss different issues and terminologies associated with cyber security.

2. Explain what do you mean by digital evidence? Comment on digital forensics standards and guidelines.

3. Discuss the steps involved in cyber forensic investigation. Illustrate the steps of an email forensic investigation.

Course Outcome 2 (CO2): Illustrate the basic concepts of system and network vulnerabilities and usage of vulnerability scanning tools.

1. Understand the vulnerabilities of stand alone and networked systems
2. Describe the usage of vulnerability scanners for stand alone and networked systems.
3. Familiarize the functionalities and usages of different network sniffers and injection tools.

Sample Questions:

1. Explain the need for vulnerability scanners. Explain how vulnerability scanners assess computers, networks or application programs for known weakness.

2. Compare and contrast between authenticated and unauthenticated vulnerability scanners.

3. Illustrate the usage of vulnerability scanners such as OpenVAS, Metasploit.

4. Compare the functionalities of vulnerability scanners for stand-alone systems and networked systems.

5. Illustrate the usage of network vulnerability scanners Netcat, Socat.

6. Briefly explain the need for port and service tools.

7. Explain the need for Network Sniffers and Injection tools. Also discuss the usage of the following utilities: Tcpdump and Windump, Wireshark, Ettercap and Hping.

Course Outcome 3 (CO3): Describe the principles of Network Forensics and Network Defense tools.

1. Study the basic principles layered network architecture and its vulnerability to attacks.
2. Understand the basic principles of forensic foot print and forensic artifacts.
3. Describe the functionalities and usages of firewalls and packet filters.

Sample questions:

1. With a neat sketch explain the OSI reference model for computer networks. Discuss the layers and services that take care of the system security.

2. Compare and contrast between firewalls and packet filters. Discuss how do you configure firewall for a networked system.

3. Discuss the need for virtual private network, Explain how do you create a VPN.

Course Outcome 4 (CO4): Analyze different cybercrimes and understand provisions of Indian IT Act 2000.

1. Categorize different cybercrimes. What do you mean by ethical hacking?

2. Prepare a list of cybercrimes happened in the past. Comment on cyberspace and criminal behavior in the post Internet world.

3. Discuss different anti forensic practices. Explain anti-forensics detection techniques.

Sample questions:

1. Prepare a list of computer crimes that happened in the past. Comment on the criminal behavior in the cyberspace in a post Internet scenario.

2. Discuss the term contaminant. Comment on the destruction of data due to cyber-attacks. Explain how data can be recovered?

Course Outcome 5 (CO5): Evaluate critically, anti-forensic practices and understand steps in cybercrime investigation.

1. Evaluate critically the anti-forensic practices such as data wiping and shredding.
2. Understand basic steps in cyber-crime investigations.
3. Familiarize with the terminologies of computer forensics analysis.

Sample questions:

1. Briefly explain different anti forensic practices demonstrated by cyber attackers and hackers. Comment on data wiping and shredding.
2. Describe spoofing and data modification. Discuss how to detect the spoofing and data modifications.
3. Discuss the steps in cyber-crime investigation. Also explain steps in network intrusion detection and investigation of network traffic.

SYLLABUS

Module - 1 (Introduction Cyber Security)

Introduction to Cyber Security: Basic terminologies, practices and standards**.** Vulnerability Scanning: Overview of vulnerability scanning, Open Port / Service Identification, Banner / Version Check, Traffic Probe, Vulnerability Probe, Vulnerability Examples, OpenVAS, Metasploit. Networks Vulnerability Scanning - Netcat, Socat, understanding Port and Services tools - Datapipe, Fpipe. Network Sniffers and Injection tools – Tcpdump and Windump, Wireshark, Ettercap, Hping.

Module -2 (Cyber Forensics)

Introduction to Cyber Forensics, Cyber Forensics, Forensics Investigation Process - Forensic Protocol for Evidence Acquisition - Digital Forensics Standards and Guidelines - Digital Evidence – Cybercrime, Types of Cybercrimes - Recent Data Breaches - Recent Cyber security Trends - Case Study: Sim Swapping Fraud, ATM Card Cloning, Hacking email for money, Google Nest Guard. Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert, Cyber Forensic Tools.

Module 3 (Network Forensics and Defense tools)

The OSI Model, Forensic Footprints, Seizure of Networking Devices, Network Forensic Artifacts, ICMP Attacks, Drive-By Downloads, Network Forensic Analysis Tools, Phishing, Types of Phishing, Email Forensics, Steps of an email forensic investigation. Network Defense toolsFirewalls and Packet Filters: Firewall Basics, Packet Filter Vs Firewall, Virtual Private Networks, Linux Firewall, Windows Firewall.

Module -4 (Introduction to Cyber Crime and law)

Cyber Crimes, Types of Cybercrime, Hacking, Attack vectors, Cyberspace and Criminal Behavior, Clarification of Terms, Traditional Problems Associated with Computer Crime, Introduction to Incident Response, Digital Forensics, Computer Language, Network Language, Realms of the Cyber world, A Brief History of the Internet, Recognizing and Defining Computer Crime, Contemporary Crimes, Computers as Targets, Contaminants and Destruction of Data, Indian IT ACT 2000.

Module- 5 (Anti Forensic practices and Cyber Crime Investigation)

Anti-forensic Practices - Data Wiping and Shredding: Data Remanence, Degaussing, Trail Obfuscation: Spoofing, Data Modification, Anti-forensics Detection Techniques.
Cyber Crime Investigation**-** Investigating Network Intrusions and Cyber Crime, Network Forensics and Investigating logs, investigating network Traffic, Investigating Web attacks, Router Forensics. Computer Forensics Analysis- Discovery of Electronic Evidence- Identification of data-Reconstructing Past events networks.

Text Book

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley.
2. Niranjan Reddy, “Practical Cyber Forensics: An Incident-Based Approach to Forensic Investigations”, Apress, 2019.
3. Computer forensics: computer crime scene investigation, Volume 1 (Charles River Media, 2008) By John R. Vacca.

Reference Books

1. Understanding Cryptography: A Textbook for Students and Practitioners: Christofpaar, Jan Pelzl.
2. Live Hacking: The Ultimate Guide to Hacking Techniques & Countermeasures for Ethical Hackers & IT Security Experts Ali Jahangiri
3. Handbook of Digital and Multimedia Forensic Evidence [Paperback] John J. Barbara
4. Computer Forensics: Investigating Network Intrusions and Cyber Crime (EcCouncil Press Series: Computer Forensics)
5. Cyber Forensics: Understanding Information Security Investigations (Springer's Forensic Laboratory Science Series) by Jennifer Bayuk.
6. Information warfare: Information warfare and security: (ACM Press) by Dorothy Elizabeth Robling Denning
7. Shema, Mike. Anti-Hacker Tool Kit, Fourth Edition. McGraw-Hill Osborne Media, 2014.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

Teaching Plan (35 Hours)

	Module 1 : Introduction Cyber Security	(6 hours)
1.1	Introduction to Cyber Security: Basic terminologies, practices and standards. Introduction to Vulnerability Scanning: Overview of vulnerability scanning,	1 hour
1.2	ROpen Port / Service, Identification, Banner / Version Check, Traffic Probe, Vulnerability Probe.	1 hour
1.3	Vulnerability Examples, OpenVAS, Metasploit.	1 hour
1.4	Networks Vulnerability Scanning - Netcat, Socat, understanding Port.	1 hour
1.5	Services tools - Datapipe, Fpipe.	1 hour
1.6	Network Sniffers and Injection tools – Tcpdump and Windump, Wireshark, Ettercap, Hping.	1 hour
	Module 2 : Cyber Forensics	(7 hours)
2.1	Introduction to Cyber Forensics, Cyber Forensics, Forensics Investigation Process - Forensic Protocol for Evidence Acquisition	2 hours
2.2	Digital Forensics Standards and Guidelines - Digital Evidence	1 hour
2.3	Cybercrime, Types of Cybercrimes - Recent Data Breaches	1 hour
2.4	Recent Cyber security Trends - Case Study: Sim Swapping Fraud, ATM Card Cloning, Hacking email for money,	1 hour
2.5	Case Study: Google Nest Guard	1 hour
2.6	Challenges in Cyber Forensics, Skills Required to Become a Cyber Forensic Expert, Cyber Forensic Tools.	1 hour
	Module 3 : Network Forensics and Defense tools	(8 hours)
3.1	The OSI Model, Forensic Footprints, Seizure of Networking Devices	1 hour
3.2	Network Forensic Artifacts, ICMP Attacks, Drive-By Downloads	1 hour
3.4	Network Forensic Analysis Tools, Phishing, Types of Phishing, Email Forensics, Steps of an email forensic investigation.	1 hour
3.5	Nesterov accelerated GD, Stochastic GD.	1 hour
3.6	AdaGrad, RMSProp, Adam.	1 hour
3.7	Network Defense tools. Firewalls and Packet Filters: Firewall Basics, Packet Filter Vs Firewall.	2 hour
3.9	Virtual Private Networks, Linux Firewall, Windows Firewall.	1 hour
	Module 4 : Introduction to Cyber Crime and law	(7 hours)
4.1	Cyber Crimes, Types of Cybercrime, Hacking, Attack vectors, Cyberspace and Criminal Behavior	1 hour
4.2	Clarification of Terms, Traditional Problems Associated with Computer Crime.	1 hour
4.3	Introduction to Incident Response, Digital Forensics, Computer Language, Network Language.	1 hour

4.4	Realms of the Cyber world, A Brief History of the Internet.	1 hour
4.5	Recognizing and Defining Computer Crime, Contemporary Crimes, Computers as Targets, Contaminants and Destruction of Data, Indian IT ACT 2000.	1 hour
4.6	Indian IT ACT 2000.	2 hours
	Module 5 : Anti Forensic practices and Cyber Crime Investigation	(7 hours)
5.1	Anti-forensic Practices - Data Wiping and Shredding.	1 hour
5.2	Data Remanence, Degaussing, Trail Obfuscation: Spoofing, Data Modification, Anti-forensics Detection Techniques.	1 hour
5.3	Anti-forensics Detection Techniques.	1 hour
5.4	Cyber Crime Investigation- Investigating Network Intrusions and Cyber Crime.	1 hour
5.5	Network Forensics and Investigating logs, Investigating network Traffic	1 hour
5.6	Investigating Web attacks, Router Forensics.	1 hour
5.7	Computer Forensics Analysis- Discovery of Electronic Evidence- Identification of data- Reconstructing Past events networks.	1 hour

Assignments:

Assignment 1: Case Study: Windows Malware Analysis of Data Stealing Malware
Assignment 2: Case Study: Listing Partitions, Memory Acquisition of Linux System, SysScout Tool, Raw Image Analysis.
Assignment 3: Case Study: Anti-forensics Detection Techniques- Stegdetect

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Program: Applied Electronics and Instrumentation Engineering/ Electronics and Instrumentation Engineering

Course Code: AET438

Course Name: Cyber Security

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	Explain the need for vulnerability scanning for standalone computers and networked computers.	CO1	K3
2	Discuss the functionalities of port and service tools.	CO1	K2
3	What do you mean by digital evidence? Comment on forensic protocol for evidence acquisition.	CO2	K2
4	Explain the skills required to become a cyber forensic expert.	CO2	K2
5	Discuss network forensic artifacts. Also explain ICMP attacks.	CO3	K3
6	Explain the term Phishing, Discuss different types of Phishing. Also explain how to identify Phishing.	CO3	K3
7	Comment on hacking in cyber space. What do you understand by ethical hacking?		K2
8	Briefly explain the provisions in Indian IT Act for the protection of data.	CO4	K3
9	Explain data wiping and shredding. What are the steps to be taken if you lose your data due to attacks ?	CO5	K2
10	Discuss the consequence of trail obfuscation.	CO5	K2

PART – B

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

Module – I

11. a)	Explain steps in vulnerability scanning in computer networks. Briefly explain the usages of networks vulnerability scanning using Netcat and Socat utilities	8	CO1	K3
11. b)	Comment on authenticated and unauthenticated vulnerability scanners.	6	CO2	K3
	OR			
12.a)	Illustrate how network vulnerability scanners identify and detect vulnerabilities arising from the mis-configurations or flawed	8	CO1	K3

	programming within a network-based asset such as a firewall, router or a web server			
12. b)	Explain the functionalities of sniffers and injection tools. Explain the usages of Tcpdump.	6	CO2	K3

Module – II

13 a)	Explain the steps in forensics investigation process. Comment on digital forensics standards and guidelines. Also prepare a list of digital evidences.	9	CO2	K2
13 b)	Briefly explain the recently happened cybercrimes such as sim swapping fraud, ATM card cloning.	5	CO2	K2
	OR			
14 a)	Discuss different cyber forensic tools and their usage. Explain email based frauds that happened in the past. Also discuss how you can secure your emails.	9	CO2	K2
14 b)	Comment on recent data breaches. Explain how to make the data secure in your systems?	5	CO2	K2

Module – III

15 a)	Illustrate with a neat sketch the OSI reference model for computer networks. Explain the functionalities of each layer. Also explain how data security is maintained.	9	CO3	K3
15 b)	Compare and contrast between firewalls and packet filters. Discuss how do you configure firewall for a networked system.	5	CO3	K3
	OR			
16 a)	Explain the concept of forensic footprints. Discuss how do you conduct Network Forensic Analysis? Also comment on network forensic analysis tools	6	CO3	K2
16 b)	Discuss the need for virtual private networks. Explain how do you set up a VPN.	4	CO3	K2
16 c)	Discuss the operating system dependency of firewalls. Compare and contrast between Linux firewall, Windows firewall.	4	CO3	K3

Module – IV

17 a)	Briefly explain different type of cybercrimes. Also comment on traditional problems associated with computer crimes. Prepare a list of notorious cyber crimes happened in the past.	9	CO3	K2

17 b)	Comment on different provisions in the Indian IT Act 2000 for information security.	5	CO4	K3
	OR			
18 a)	Explain the term contaminants and destruction of data. Critically investigate the vulnerability of data stored in web servers. Comment on the protection of shared data in the web.	9	CO3	K2
18 b)	Comment on the criminal behavior in cyber space in the 21st century.	5	CO3	K2

Module – V

19 a)	Describe spoofing and data modification. Discuss how to detect the spoofing and data modifications.	8	CO4	K3
19 b)	Briefly explain different anti forensic practices demonstrated by cyber attackers and hackers.	6	CO4	K3
	OR			
20 a)	Illustrate network intrusion with example. Explain steps involved in investigating network intrusions.	6	CO4	K3
20 b)	Discuss data remanence. What are the uses of these data that persists beyond noninvasive means to delete it in cyber forensic investigation?	4	CO4	K3
20 c)	Briefly explain the steps in router forensics. How digital evidences collected from the routers help in investigation?	4	CO2	K2

AET448	INSTRUMENTATION AND CONTROL FOR PETROCHEMICAL INDUSTRIES	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble:

The course is designed to learn about the instrumentation systems used in petrochemical industries. The major objectives of the course are to give an exposure on the important parameters to be monitored and analysed in these industries and to imbibe knowledge in various techniques used for the measurement of primary industry parameters.

Course Outcomes:

After the completion of the course the student will be able to

CO 1	Discuss the origin and favourable geological conditions for the formation and accumulation of petroleum and natural gas.
CO 2	Explain the processes involved in petroleum production.
CO 3	Interpret or create P&I diagrams for any process.
CO 4	Understand the control of petroleum industries equipment such as Distillation Column, Heat Exchangers, Evaporators and Pumps.
CO 5	Explain the necessity of considering economic and safety/pollutionfactors in petrochemical engineering design and practice

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember			
Understand	40	40	80
Apply	10	10	20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern:

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Summarize about source rock maturation and migration.
2. Discuss in detail the process of entrapment of oil and gas in a petroleum reservoir with a neat diagram.
3. Describe the process of generation of petroleum in source rocks in detail.
4. Explain about different oil and gas traps: Anticline trap, Fault trap, Stratigraphic trap, Salt dome trap.
5. Understand the different refinery products.

Course Outcome 2 (CO2):

1. Explain the process of extracting the petroleum products through distillation column and thermal conversion process.
2. How ethylene, acetylene and propylene are produced from petroleum.
3. Explain the conversion process such as catalytic cracking and catalytic hydro reforming.

Course Outcome 3 (CO3):

1. What are instrument categories and which instruments are handled by piping department?

2. What is the use of P&ID diagram and how many of its types?
3. Draw the P&ID diagram of the given process?

Course Outcome 4 (CO4):

1. Explain the cascade control of a chemical reactor with heating and cooling facilities.
2. Describe the physical mechanism and importance of dryers in petroleum refineries and the construction of tray dryers.
3. Explain the temperature and pressure control in the chemical reactors.
4. Explain Instrumentation and control of evaporators
5. Explain the Physics of a Liquid to liquid heat exchanger. Discuss the mechanisms involved

Course Outcome 5 (CO5):

1. With sketches and block diagrams, explain effluent and water treatment control.
2. How is chemical oxidation method utilized in waste water treatment?
3. Give an account of instrumentation and control in effluent treatment.

Model Question paper

Course Code: AET448

Course Name: INSTRUMENTATION AND CONTROL FOR PETROCHEMICAL INDUSTRIES

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

PARTA

Answer all Questions. Each question carries 3 Marks

1. Summarize about source rock maturation and migration.
2. Discuss in detail the process of entrapment of oil and gas in a petroleum reservoir with a neat diagram.
3. What is meant by the term coking? How it is performed?
4. How ethylene and propylene is produced from petroleum?
5. Draw the P&ID diagram of various process lines?
6. How are variables detected in continuous dryers?
7. Explain the operation of heat exchangers used in petroleum industry?
8. What is Reboiler? Sum up their salient features?
9. What do you mean by throttling control?
10. How is chemical oxidation method utilized in waste water treatment?

PART B

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

Module 1

11. Describe the process of generation of petroleum in source rocks in detail.
12. Explain about different oil and gas traps: Anticline trap, Fault trap, Stratigraphic trap, Salt dome trap.

Module 2

13. Explain the catalytic cracking process with neat sketch?

14. Explain the process of crude oil distillation with a brief process flow diagram

Module 3

15. With the help of a neat sketch explain cascade control of a chemical reactor with heating and cooling facilities
16. Explain any two methods of temperature control in chemical reactors

Module 4

17. Explain Instrumentation and control of any two types of evaporators
18. Explain the aspects of a feed forward control. How will you apply computer technologies to this system?

Module 5

19. Explain ON-OFF control and throttling control of reciprocating pumps in detail.
20. Discuss the methods of ON/OFF control of

    a) Rotary Pumps
    b) Reciprocating Pumps

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

INSTRUMENTATION AND CONTROL FOR PETROCHEMICAL INDUSTRIES

Syllabus

Module 1: BASICS OF PETROLEUM ENGINEERING (7 Hours)

Origin of Petroleum, oil and gas traps. Physical and chemical characteristics of crude oil, source rock and maturation, Migration of oil mechanism. Reservoir rock and cap rocks. Application of remote sensing in petroleum resource development, Basin exploration strategies. Entrapment of oil-type mechanisms. Refinery Products, Refinery Steps.

Module 2: PROCESSES IN PETROLEUM INDUSTRIES (7 Hours)

Atmospheric Distillation of Crude oil – Vacuum Distillation of Crude Oil – Coking Thermal Process- Chemical oxidation-Chemical reduction-Polymerisation-Alkylation-Isomerisation-Production of Ethylene, Acetylene- and propylene from petroleum.

Catalytic Cracking Process, Catalytic reforming process.

Module 3: CONTROL IN PETROLEUM INDUSTRIES (7 Hours)

P&I Symbols: Process lines, Instrument bubbles, Process Equipment, Valve Types. P&I Diagram of Petroleum Refinery – Control of Distillation Column – Temperature Control – Feed Control – Reflux Control – Reboiler Control- Control of Chemical Reactors: Temperature Control, Pressure Control

Module 4: CONTROL IN PETROLEUM INDUSTRIES (7 Hours)

Control of Heat Exchangers and Evaporators – Variables and Degrees of freedom – Liquid to Liquid Heat Exchangers – Steam Heaters – Condenser – Reboiler and Vaporizers – Cascade Control – Feed forward Control. Evaporators: Types of Evaporators.

Module 5: CONTROL and SAEFTY IN PETROLEUM INDUSTRIES (7 Hours)

Control of Pumps: Centrifugal Pumps: On-off control – Pressure Control- Flow Control – Throttling Control – Rotary Pumps: On-off Control Pressure Control. Reciprocating Pumps: On-off Control and Throttling Control.

Effluent and Water Treatment Control: Chemical Oxidation – Chemical Reduction – Naturalization – Precipitation – Biological control.

Reference Books

1. J. CH Garry, Hardward G.E and M.J.Kaiser, Petroleum Refining Technology and economics CRC Press V Edition

2. Liptak B.G. Instrumentation in process industries, Chilton book Company, 1994

3. Dr. Ram Prasad, "Petroleum Refining Technology", Khanna Publisher, 1st edition, 2000.

4. Liptak B.G, "Instrument Engineers Handbook", Volume II, 1989.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1 (7 hours)**	
1.1	Origin of Petroleum, oil and gas traps. Physical and chemical characteristics of crude oil, source rock and maturation. Migration of oil mechanism.	3 hrs
1.2	Reservoir rock and cap rocks. Application of remote sensing in petroleum resource development, Basin exploration strategies. Entrapment of oil-type mechanisms.	3 hrs
1.3	Refinery Products and Refinery Steps	1hr
2	**Module 2 (7 hours)**	
2.1	Atmospheric Distillation of Crude oil	1 hr
2.2	Vacuum Distillation of Crude Oil	1 hr
2.3	Coking and Thermal Process	1 hr
2.4	Chemical oxidation-Chemical Reduction-Polymerisation-Alkylation-Isomerisation	2 hrs
2.5	Production of Ethylene, Acetylene- and propylene from petroleum	1 hr
2.6	Catalytic Cracking Process, Catalytic reforming process.	1 hr
3	**Module 3 (7 hours)**	
3.1	P&I Symbols: Process lines, Instrument bubbles, Process Equipments, Valve Types. P&I Diagram of Petroleum Refinery	2 hrs
3.2	Control of Distillation Column – Temperature Control – Feed Control, Reflux Control – Reboiler Control	3 hrs

3.3	Control of Chemical Reactors: Temperature Control, Pressure Control	2 hrs
4	**Module 4 (7 hours)**	
4.1	Control of Heat Exchangers and Evaporators	1 hr
4.2	Variables and Degrees of freedom	1 hr
4.3	Liquid to Liquid Heat Exchangers – Steam Heaters – Condenser	2 hrs
4.4	Reboiler and Vaporizers	1 hr
4.5	Cascade Control – Feed forward Control.	1 hr
4.6	Evaporators: Types of Evaporators	1 hr
5	**Module 5 (7 hours)**	
5.1	Control of Pumps: Centrifugal Pumps: On-off control – Pressure Control- Flow Control – Throttling Control	2 hrs
5.2	Rotary Pumps: On-off Control, Pressure Control Reciprocating Pumps: On-off Control and Throttling Control.	2 hrs
5.4	Effluent and Water Treatment Control: Chemical Oxidation – chemical Reduction – Naturalization – Precipitation – Biological control.	3 hrs

Assignment:

At least two assignments should be given.

AET 458	WIRELESS COMMUNICATION	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to impart the concepts of communication engineering and the basics of wireless communication.

Prerequisite: AET401 COMMUNICATION ENGINEERING

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

CO 1	Illustrate the knowledge of mobile radio propagation mechanism in the wireless communication scenario (K3).
CO 2	Explain the effect of small-scale fading and multipath in the wireless communication systems (K2).
CO 3	Apply the knowledge of wireless channel capacity and diversity in the wireless communication system design (K3).
CO 4	Describe the features of Cellular concept in the mobile communication scenario (K2).
CO 5	Demonstrate the characteristics of modern wireless communication systems and the multiple access techniques (K2).

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	2									
CO 2	2	1	2									
CO 3	3	2	2									
CO 4	2	1	2									
CO 5	2	1	2									

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1			
Understand	K2	30	30	66
Apply	K3	20	20	34
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): To illustrate the knowledge of mobile radio propagation mechanism in the wireless communication scenario.

1. Which are the basic propagation mechanisms in the mobile communication systems?
2. Define Brewster angle?
3. Derive the expression for two the power received at a distance of d from the transmitter T? The receiver is assumed with a height of h_r using Two ray ground reflection model?
4. How do you describe the Fresnel zones while calculating the diffraction of wireless signals?

Course Outcome 2 (CO2): To explain the effect of small scale fading and multipath in the wireless communication systems.

1. Define level crossing rate (LCR) and average fade duration of a Rayleigh fading channel?
2. Define outage probability?
3. Discuss the features of small-scale fading channel based on multipath time delay spread?
4. Which are the factors influencing small scale fading?

Course Outcome 3 (CO3): To apply the knowledge of wireless channel capacity and diversity in the wireless communication system design.

1. Draw the block schematic representation of Maximal ratio combiner?
2. What is the importance of diversity in the wireless communication systems?
3. Derive the expression for bit error probability of QPSK under AWGN channel
4. Prove with the help of necessary equations, “The average SNR of the receiver shall be improved by selection diversity”

Course Outcome 4 (CO4): To describe the features of Cellular concept in the mobile communication scenario (K2).

1. Discuss the methods to improve the capacity of cellular networks?
2. Differentiate between hard and soft handoff in mobile communication?
3. Differentiate cochannel interference and adjacent channel interference?
4. What do you mean by 'microcell' in a cellular system?

Course Outcome 5 (CO5): To demonstrate the characteristics of modern wireless communication systems and the multiple access techniques

1. Discuss the features of 4G cellular systems?
2. Discuss any one method to generate PN sequences?
3. Explain the importance of multi carrier communication?
4. Discuss the features of maximal length codes?

SYLLABUS

MODULE I:

Mobile radio propagation: Introduction to radio propagation, Free space propagation model, Basic propagation mechanisms, Reflections, Ground reflection (Two ray) model. Diffraction: Fresnel Zone geometry, Knife edge diffraction model, Scattering: Radar cross section model.

MODULE II

Small scale fading and multipath: Small scale multipath propagation, Impulse response model of a multipath channel, Parameters of mobile multipath channels, Types of small scale fading, Rayleigh and Ricean distributions, Shadow fading, Combined pathloss and shadowing, Outage probability under fading and shadowing [2]. Level crossing and fading statistics.

MODULE III:

Capacity of wireless channels: Capacity in AWGN, capacity of flat fading channels, capacity of frequency selective fading channel [2].

Diversity: Realization of independent fading paths, Receiver diversity: System model, Selection combining, Threshold combining, maximum ratio combining, equal gain combining. Transmitter diversity: Channel known at the transmitter, channel unknown at the transmitter- The Alamouti scheme.

MODULE IV

Mobile Communication

Cellular concept: Cellular concept, Frequency reuse, Channel assignment strategies, hand off strategies, Interference and system capacity: Co channel interference and system capacity, channel planning for wireless systems, adjacent channel interference. Improving coverage and capacity in cellular system: Cell splitting, Sectoring, Repeaters, and Microcells.

MODULE V

Advanced wireless Communication Techniques: Introduction to Modern Wireless Communication Systems, Second generation cellular networks, third generation wireless networks, fourth generation wireless technologies, fifth generation wireless technologies.
Spread spectrum communication: Pseudo–noise sequences: Properties of PN sequences. Generation of PN Sequences, generator polynomials, Maximal length codes.
Multiple Access Techniques: TDMA, FDMA and CDMA– RAKE receiver. Introduction to Multicarrier communication- OFDM.

Text Books

1. Theodore S. Rappaport: Wireless communication principles and practice, Pearson Education, 1990
2. Andrea Goldsmith: Wireless communications, Cambridge university Press, 2005.

Reference Books

1. Savo G. Glisic, Advanced Wireless Communications 4G Technologies, John Wiley& Sons, Ltd, 2004
2. Wayne Tomasi, Advanced Electronic Communications Systems, Pearson, 2014.
3. Andreas F. Molisch, Wireless communications, Wiley, 2011

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Course Contents and Lecture Schedule

No.	Topic	No. of lecture hours
1	**Mobile radio propagation**	
1.1	Introduction to radio propagation, Free space propagation model,	1
1.2	Basic propagation mechanisms, Reflections	1
1.3	Ground reflection (Two ray) model.	1
1.4	Diffraction: Fresnel Zone geometry	1
1.5	Knife edge diffraction model	1
1.6	Scattering:	1
1.7	Radar cross section model	1
2	**Small scale fading and multipath**	
2.1	Small scale multipath propagation	1
2.2	Impulse response model of a multipath channel	1
2.3	Parameters of mobile multipath channels	1
2.4	Types of small scale fading	2
2.5	Rayleigh and Ricean distributions, Shadow fading	1
2.6	Combined pathloss and shadowing, Outage probability under fading and shadowing , Level crossing and fading statistics	1
3	**Capacity of wireless channels**	
3.1	Capacity in AWGN	1
3.2	Capacity of flat fading channels	1
3.3	Capacity of frequency selective fading channel	1
	Diversity:	
3.4	Realization of independent fading paths, Receiver diversity: System model,	1
3.5	Selection combining, Threshold combining, maximum ratio combining, equal gain combining	1
3.6	Transmitter diversity: Channel known at the transmitter,	1
3.7	Channel unknown at the transmitter- The Alamouti scheme	1
4	**Mobile Communication**	
4.1	Cellular concept, Frequency reuse	1

4.2	Channel assignment strategies	1
4.3	Hand off strategies	1
4.4	Interference and system capacity	1
4.5	Co channel interference and system capacity	1
4.6	Channel planning for wireless systems, adjacent channel interference.	1
4.7	Improving coverage and capacity in cellular system: Cell splitting, Sectoring, Repeaters, and Microcells	1
5	**Advanced wireless Communication Techniques**	
5.1	Introduction to Modern Wireless Communication Systems, Second generation cellular networks, third generation wireless networks	1
5.2	Fourth generation wireless technologies, fifth generation wireless technologies.	1
	Spread spectrum communication	
5.3	Pseudo–noise sequences: Properties of PN sequences	1
5.4	Generation of PN Sequences, generator polynomials	1
5.5	Maximal length codes	1
	Multiple Access Techniques:	
5.6	TDMA, FDMA and CDMA– RAKE receiver.	1
5.7	Introduction to Multicarrier communication- OFDM	1

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET458

Program: Applied Electronics and Instrumentation Engineering

Course Name: Wireless Communication

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	Derive the expression for the free space pathloss for a radio signal. Calculate the free pace path loss for a signal having frequency of 42 GHz when it travels a distance of 100meter? What is the physical significance of the result?	CO1	K3
2.	How do you define radar cross section (RCS) of a scattering object?	CO1	K2
3.	Briefly describe the multipath channel parameters that can be determined from the power delay profile?	CO2	K2
4.	Write down the expression for the probability density function of Rayleigh distribution and Ricean distribution?	CO2	K2
5.	Differentiate between SNR and SINR of wireless signals?	CO3	K3
6.	Draw the generalized block schematic for the space diversity	CO3	K2
7.	Define frequency reuse in the cellular communication system?	CO4	K2
8.	How do you define cochannel reuse ratio in mobile communication?	CO4	K2
9.	Draw the block schematic of M branch RAKE receiver	CO5	K2
10.	Write short notes on OFDM	CO5	K2

PART – B

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

Module – I

11.	Derive the expression for the free space propagation model of a wireless communication system?	14	CO1	K3
	OR			
12	A mobile is located 5km away from a base station and uses a vertical λ/4 monopole antenna with a gain of 2.55 dB to receive cellular radio signals. The E field at 1 km from the transmitter is measured to be $10^{-3}\,V/m$. The carrier frequency used for this system is 900 MHz. a) Find the length and the effective aperture of the receiving antenna? b) Find the received power at the mobile using two ray ground reflection model assuming the height of the transmitting antenna is 50m and the receiving antenna is 1.5m above the ground.?	14	CO1	K3

Module – II

13.	Discuss the features of the impulse response model of a multi path channel?	14	CO2	K2
OR				
14.	Discuss the features of the small scale fading based on the doppler spread?	14	CO2	K2

Module – III

15 a).	Discuss the features of various space diversity techniques.?	8	CO3	K3
b)	Derive the expression for bit error probability of BPSK under AWGN channel?	6	CO3	K3
OR				
16 a).	Derive the expression for average SNR of maximal ratio combining diversity technique?	7	CO3	K3
b).	Discuss the features of Alamouti scheme?	7	CO3	K3

Module – IV

17 a).	Discuss the channel assignment strategies in the mobile communication system	9	CO4	K2
b).	Discuss the use of cell splitting in mobile communication system?	5	CO4	K2
OR				
18 a).	Briefly discuss the handoff strategies associated with cellular communication system?	14	CO4	K2

Module – V

19 a).	Compare TDMA, FDMA and CDMA technologies?	9	CO5	K2
b).	Discuss the properties of PN sequences?	5	CO5	K2
OR				
20	Compare the features of 1G, 2G, 3G mobile communication technologies?	14	CO5	K2

AET468	OPTICAL INSTRUMENTATION	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to study about optical communication and optical instruments

Prerequisite: Nil

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

CO 1	Explain the basic concepts of fiber optics
CO 2	Learn the basic concepts of fiber optic sensors and fiber connection techniques
CO 3	Elaborate study of various types of Interferometers
CO 4	Acquire basic knowledge in Laser and discuss its applications

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	35	35	60
Apply	K3	5	5	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): Explain the basic concepts of fiber optics

1. Explain the operating principle of Optical fiber.
2. Discuss Fiber fabrication process in detail.
3. Define Numerical Aperture and Acceptance cone.

Course Outcome 2 (CO2): Learn the basic concepts of fiber optic sensors and fiber connection techniques

1. Illustrate the working of fiber optic system for measurement of different fiber characteristics.
2. Explain the different connecting methods of optical fibers.
3. Discuss about various optical modulators.

Course Outcome 3 (CO3): Elaborate study of various types of Interferometers

1. Illustrate the working of various interferometers.
2. Discuss the Interferometric method for measurement of pressure, temperature, current, voltage.

Course Outcome 4 (CO4): Acquire basic knowledge in Laser and discuss its applications

1. Derive Einstein relations of Laser.
2. Demonstrate the application of Laser in Material processing.
3. Demonstrate the medical application of Laser.

SYLLABUS

Module 1:

Optical Fiber Concepts: Principle of Optical fiber – Acceptance angle and acceptance cone – Numerical aperture – V-number –Types of optical fibers (Material, Refractive index and mode) – properties – Optical source: LED – Optical detectors: PIN and APD – Optical fiber fabrication.

Module 2:

Optic sensors and modulators: Fibre optic sensors – Fibre optic instrumentation system for measurement of fibre characteristics – Modulators – fiber optic gyroscope – Optical Spectrum Analyzer.

Fiber connections: Fiber connectors – Splicing Techniques.

Module 3:

Interferometers: Fabry-perot and Michelson interferometers – Interferometric method for measurement of pressure, temperature, current, voltage – Interferometeric method of measurement of optical components.

Module 4:

Lasers: Principles of operation – Einstein relations – Population inversion – Optical feedback – Classes of laser – Solid state, gas and liquid dye lasers– Semiconductor lasers – Q-switching and mode locking – Properties of laser light.

Module 5:

Laser applications: Laser for measurement of atmospheric effect and pollutants – Laser Doppler Anemometry (LDA) – Material processing: Laser heating, Melting, Cutting and Welding.

Medical application of lasers: Laser and Tissue interaction – Oncology: Removal of tumors of vocal chords, Dermatology.

Text Books

1. G. Keiser, "Optical Fibre Communication", McGraw Hill, 1995.
2. J. Wilson and J. F. B. Hawkes, "Optoelectronics: An Introduction", Prentice Hall of India.

Reference Books

1. John M. Senior, Optical Fibre Communications-Principles and practice", Pearson Education Limited.
2. Fowles G. R., "Introduction to Modern Optics", 2nd Edition, Holt, Rienhart, Winston, 1975.
3. Rudolf Kingslake, "Applied Optics and Optical Engineering", Vol: I-V, Academic Press.
4. K. Thyagarajan, and A. K. Ghatak, "Lasers: Theory and Applications", Plenum Press.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Optical Fiber Concepts**	
1.1	Principle of Optical fiber, Acceptance angle and acceptance cone, Numerical aperture	1
1.2	V-number, Types of optical fibers (Material, Refractive index and mode), properties	1
1.3	Optical source: LED	1
1.4	Optical detectors: PIN and APD	2
1.5	Optical fiber fabrication	1
2	**Optic sensors and modulators**	
2.1	Fibre optic sensors	1
2.2	Fibre optic instrumentation system for measurement of fibre characteristics	1
2.3	Modulators	1
2.4	Fiber optic gyroscope – Optical Spectrum Analyzer	1
	Fiber connections	
2.5	Fiber connectors & Splicing Techniques	2
3	**Interferometers**	
3.1	Fabry-perot and Michelson interferometers	2
3.2	Interferometric method for measurement of pressure, temperature, current, voltage.	2
3.3	Interferometeric method of measurement of optical components	3
4	**Lasers**	
4.1	Principles of operation, Einstein relations	2
4.2	Population inversion, Optical feedback	2
4.3	Classes of laser – Solid state, gas and liquid dye lasers– Semiconductor lasers	2
4.4	Q-switching and mode locking – Properties of laser light	3

5	**Laser applications**	
5.1	Laser for measurement of atmospheric effect and pollutants – Laser Doppler Anemometry (LDA)	2
5.2	Material processing: Laser heating, Melting, Cutting and Welding	2
	Medical application of lasers	
5.3	Laser and Tissue interaction	1
5.4	Oncology: Removal of tumors of vocal chords, Dermatology	2

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Program: Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation Engineering

Course Code: AET468

Course Name: OPTICAL INSTRUMENTATION

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 marks.

1.	Define: (a) Acceptance cone (b) V-number	K1
2	Differentiate between Step-index and Graded index fiber.	K2
3	Explain the working of an Optical spectrum analyzer with neat block diagram.	K2
4	Explain Fiber optic current sensor.	K2
5	Discuss how interference patterns are formed.	K2
6	Discuss on the different variations of Beam Splitter.	K2
7	Explain the working of any one Solid state laser.	K2
8	List out the properties of Laser light.	K1
9	Discuss any one application of Laser in Dermatology.	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)	Explain the principle behind light propagation through an optical fiber. Derive the expression for Numerical aperture.	6	CO1	K3
11.b)	Explain the working of LED with neat diagrams. Compare the working of Edge emitting LED & Surface emitting LED.	8	CO1	K2
	OR			
12.a)	Explain the fiber fabrication process in detail using fiber drawing apparatus with outside vapor phase oxidation process.	9	CO1	K2
12.b)	With necessary diagrams explain the operation of PIN photodiode.	5	CO1	K2

Module – II

13 a)	What are fiber optic sensors? Explain how Temperature can be measured using extrinsic fiber optic sensors.	8	CO2	K2

13 b)	Explain how fiber dispersion can be measured using Optic fiber instrumentation system.	6	CO2	K2
	OR			
14 a)	Explain the working of Fiber optic gyroscope. Derive the expression for phase shift.	9	CO2	K3
14 b)	Explain any **one** type of Splicer and Connector used in optical field.	5	CO2	K2

Module – III

15 a)	Discuss how an optical flat is being tested using Fizeau interferometer.	5	CO3	K2
15 b)	Derive the expression for path difference in a Fabry-perot interferometer.	9	CO3	K3
	OR			
16 a)	Explain Interferometric method for measurement of pressure and temperature.	8	CO3	K2
16 b)	Explain the working of a Michelson interferometer.	6	CO3	K2

Module – IV

17 a)	Derive the Einstein relations for two-level atomic energy system and calculate the ratio of rate of spontaneous emission to the rate of stimulated emission.	9	CO4	K3
17 b)	Explain how population inversion can be achieved in a Laser.	5	CO4	K2
	OR			
18 a)	Discuss the principle of Q-switching? Explain the three different methods of Q switching in detail.	14	CO4	K2

Module – V

19 a)	Explain the working of Laser Doppler Anemometer with neat diagrams and expressions.	8	CO4	K2
19 b)	Explain the interaction between lasers and tissues.	6	CO4	K2
	OR			
20 a)	Explain the application of Laser in Material Processing in detail.	14	CO4	K3

AET478	RENEWABLE ENERGY TECHNOLOGY	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble:
This course introduces about different new and renewable sources of energy. Design of some of the systems are also discussed

Prerequisite: Nil

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

CO 1	Describe the environmental aspects of renewable energy resources.
CO 2	Explain the operation of various renewable energy systems.
CO 3	Design solar PV systems.
CO 4	Explain different emerging energy conversion technologies and storage.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	10
Understand (K2)	20	20	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

End Semester Examination Pattern :

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the environmental impacts of wind energy systems. (K1)
2. Explain the limitations of renewable energy systems (K2)

Course Outcome 2 (CO2):

1. With the help of a block diagram, explain the working of a wind energy conversion system. (K2)
2. Explain the working of a small hydro power plant with the help of a diagram. (K2)

Course Outcome 3 (CO3):

1. Design a grid connected solar photovoltaic system. (K3).
2. Design a solar photovoltaic system for a water pumping system. (K3).

Course Outcome 4 (CO4):

1. Explain how energy can be generated from alcohol. (K2)
2. Explain the need for energy storage systems. Discuss how energy can be stored in batteries. (K2).

Syllabus

Module 1

Introduction, Environmental Aspects Of Energy-Ecology-Greenhouse Effect-Global Warming-Pollution-Various Pollutants and their Harmful Effects-Green Power-The United Nations Framework Convention On Climate Change (UNFCC)- Environment-Economy-Energy and Sustainable development-Kyoto Protocol -Classification of Energy Resources; Conventional Energy Resources - Availability and their limitations; Non-Conventional Energy Resources –Classification, Advantages, Limitations; Comparison of Conventional and Non-Conventional Energy Resources; World Energy Scenario; Indian Energy Scenario.

Module 2

SOLAR THERMAL SYSTEMS: Introduction, Solar Constant, Basic Sun-Earth Angles, Measurement of Solar Radiation Data(Numerical Problems)–Pyranometer and Pyrheliometer -Solar Thermal Collectors –General description and characteristics –Flat plate collectors –Heat transfer processes –Solar concentrators(Parabolic trough, Parabolic dish, Central Tower Collector)
SOLAR ELECTRIC SYSTEMS: Introduction- Solar Photovoltaic –Solar Cell fundamentals, characteristics, classification, construction of Module, Panel and Array-Effect of shadowing-.Maximum Power Point Tracker (MPPT) using buck-boost converter. Solar PV Systems – stand-alone and grid connected-Design steps for a Stand-Alone system; Applications –Street lighting, Domestic lighting and Solar Water pumping systems.

Module 3

Wind Energy–Introduction–Wind Turbine Types (HAWT and VAWT) and their construction- Wind power curve-Betz's Law-Power from a wind turbine(Numerical Problems)-Wind energy conversion system(WECS) – Fixed–speed drive scheme-Variable speed drive scheme.-Effect of wind speed and grid condition(system integration).
Small hydro power: Classification as micro, mini and small hydro projects -Basic concepts and types of turbines - Classification, Characteristics and Selection

Module 4

ENERGY FROM OCEAN: Tidal Energy –Principle of Tidal Power, Components of Tidal Power Plant (TPP), Classification of Tidal Power Plants, Advantages and Limitations of TPP.
Ocean Thermal Energy Conversion (OTEC): Principle of OTEC system, Methods of OTEC power generation –Open Cycle (Claude cycle), Closed Cycle (Anderson cycle) and Hybrid cycle (block diagram description of OTEC); Site-selection criteria, Biofouling, Advantages & Limitations of OTEC.

Module 5

BIOMASS ENERGY: Introduction, Photosynthesis process, Biomass fuels, Biomass conversion technologies, Urban waste to Energy Conversion, factors affecting biogas generation, types of biogas plants –KVIC and Janata model;.
EMERGING TECHNOLOGIES: Fuel Cell, Hydrogen Energy, alcohol energy and power from satellite stations.

ENERGY STORAGE: Necessity Of Energy Storage-Pumped storage-Compressed air storage-Flywheel storage-Batteries storage-Hydrogen storage.

Text books

1. A.A.M. Saigh(Ed): Solar Energy Engineering, Academic Press, 1977
2. Abbasi S. A. and N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, 2001.
3. Thomas E. Kissell, David M. Buchla, Thomas L. Floyd Renewable energy systems, Pearson 2017

References:

1. Boyle G. (ed.), Renewable Energy -Power for Sustainable Future, Oxford University Press, 1996
2. Earnest J. and T. Wizelius, Wind Power Plants and Project Development, PHI Learning, 2011.
3. F. Kreith and J.F. Kreider: Principles of Solar Engineering, McGraw Hill, 1978
4. G.N. Tiwari: Solar Energy-Fundamentals, Design, Modelling and Applications, Narosa Publishers, 2002
5. J.A. Duffie and W.A. Beckman: Solar Energy Thermal Processes, J. Wiley, 1994
6. Johansson T. B., H. Kelly, A. K. N. Reddy and R. H. Williams, Renewable Energy –Sources for Fuel and Electricity, Earth scan Publications, London, 1993.
7. Khan B. H., Non-Conventional Energy Resources, Tata McGraw Hill, 2009.
8. D.P.Kothari, K.C.Singal, RakeshRanjan, *Renewable Energy Sources and Emerging Technologies*, Prentice Hall of India, New Delhi, 2009
9. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 1999.
10. Sab S. L., Renewable and Novel Energy Sources, MI. Publications, 1995.
11. Sawhney G. S., Non-Conventional Energy Resources, PHI Learning, 2012.
12. Tiwari G. N., Solar Energy-Fundamentals, Design, Modelling and Applications, CRC Press, 2002.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**Environmental impacts of various energy resources. (7 hours)**	
1.1	Introduction, Environmental Aspects Of Energy-Ecology-Greenhouse Effect-Global Warming	1
1.2	Pollution-Various Pollutants and their Harmful Effects-Green Power - The United Nations Framework Convention On Climate Change (UNFCC)	2
1.3	Environment-Economy-Energy and Sustainable development-Kyoto Protocol -Classification of Energy Resources	1
1.4	Conventional Energy Resources -Availability and their limitations	1
1.5	Non-Conventional Energy Resources –Classification, Advantages, Limitations; Comparison of Conventional and Non-Conventional Energy Resources; World Energy Scenario; Indian Energy Scenario.	2
2	**Solar radiation data, solar thermal and electric systems. (7 hours)**	
2.1	Introduction, Solar Constant, Basic Sun-Earth Angles, Measurement of Solar Radiation Data(Numerical Problems)–Pyranometer and Pyrheliometer	2
2.2	Solar Thermal Collectors –General description and characteristics –Flat plate collectors –Heat transfer processes	1
2.3	Solar concentrators(Parabolic trough, Parabolic dish, Central Tower Collector)	1
2.4	Solar Photovoltaic –Solar Cell fundamentals, characteristics, classification, construction of Module, Panel and Array-Effect of shadowing	1
2.5	Maximum Power Point Tracker (MPPT) using buck-boost converter. Solar PV Systems –stand-alone and grid connected-Design steps for a Stand-Alone system	1
2.6	Applications –Street lighting, Domestic lighting and Solar Water pumping systems.	1
3	**Wind energy and small hydro plant (6 Hours)**	
3.1	Wind Energy–Introduction–Wind Turbine Types (HAWT and VAWT) and their construction	1
3.2	-Wind power curve-Betz's Law-Power from a wind turbine(Numerical Problems)	1
3.3	Wind energy conversion system(WECS) – Fixed–speed drive scheme-	1
3.4	Variable speed drive scheme.-Effect of wind speed and grid condition(system integration)	1
3.5	Small hydro power: Classification as micro, mini and small hydro projects -Basic concepts and types of turbines - Classification, Characteristics and Selection	2
4	**Energy from ocean (7 Hours)**	
4.1	Tidal Energy –Principle of Tidal Power, Components of Tidal Power Plant (TPP)	2

4.2	Classification of Tidal Power Plants, Advantages and Limitations of TPP.	1
4.3	Ocean Thermal Energy Conversion (OTEC): Principle of OTEC system, Methods of OTEC power generation	1
4. 4	Open Cycle (Claude cycle), Closed Cycle (Anderson cycle)	1
4. 5	Hybrid cycle (block diagram description of OTEC)	1
4. 6	Site-selection criteria, Biofouling, Advantages & Limitations of OTEC.	1
5	**Emerging technologies (9 Hours)**	
5.1	Introduction, Photosynthesis process, Biomass fuels, Biomass conversion technologies	2
5.2	Urban waste to Energy Conversion, factors affecting biogas generation, types of biogas plants –KVIC and Janata model	2
5.3	Types of biogas plants –KVIC and Janata model	1
5.4	Fuel Cell, Hydrogen Energy	1
5.5	Alcohol energy and power from satellite stations.	1
5.6	Necessity Of Energy Storage-Pumped storage-Compressed air storage	1
5.7	Flywheel storage-Batteries storage-Hydrogen storage.	1

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

EIGHTH SEMESTER B. TECH. DEGREE EXAMINATION

Program: Applied Electronics & Instrumentation Engineering/ Electronics & Instrumentation

Course Code: AET478

Course Name: RENEWABLE ENERGY TECHNOLOGY

Max. Marks: 100 Duration: 3 Hours

PART A (3 x 10 = 30 Marks)

Answer all Questions. Each question carries 3 Marks

1. What do you mean by global warming? Explain its adverse effects.
2. Write notes on Indian energy scenario.
3. Determine the local apparent time corresponding to 11.30 IST on July 1, at Delhi (280 35' N,770 12'E). The equation of time correction on July 1 is -4 minutes.
4. Draw and explain the V- I characteristics of a solar cell.
5. Define tip speed ratio, cut in speed and cut out speed of a wind turbine.
6. Explain the factors to be considered for the selection of small hydro plants.
7. Discuss the advantages and disadvantages of tidal power plants.
8. Explain the principle of operation of a OTEC plant. What are its advantages?
9. Explain how power can be derived from satellite stations.
10. Explain how energy can be stored using flywheels.

PART B (14 x 5 = 70 Marks)

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

Module 1

11. a. Illustrate the relation between energy and sustainable development. **(4)**

b. Compare the advantages and disadvantages of different conventional sources of energy. **(10)**

12. a. Write notes on Kyoto protocol. **(4)**

b. List out the advantages and disadvantages of different non-conventional sources of energy. **(10)**

Module 2

13. a. With the help of a diagram, explain the working of a pyrheliometer. **(7)**

b. Explain how a stand-alone solar PV system can be designed. **(7)**

14. a. With the help of a diagram, explain the working of a flat plate collector. **(7)**

b. Explain how Maximum Power Point Tracking can be done using a buck boost converter. **(7)**

Module 3

15. a. Derive an expression for power derived from wind. Explain the characteristic of a wind turbine. **(7)**

b. A propeller wind machine has rotor diameter of 40 m. It is operating at location having wind speed of 35kmph and rotating at 20 rpm. Calculate theoretically the power which the machine can extract from the wind considering both wake rotation and effect of drag. Assume ξ=.012. **(7)**

16. a. With the help of a diagram, explain a wind energy conversion system with variable speed drive scheme. **(8)**

b. Explain the different types of turbines used in small hydro plants. **(6)**

Module 4

17. With the help of a diagram, explain the working of different types of tidal powerplants. **(14)**

18. a. With the help of a diagram, explain the working of an OTEC system using hybrid cycle. **(10)**

b. Write notes on the factors to be considered for site selection of OTEC plants. **(4)**

Module 5

19. a. With the help of a diagram, explain a biomass gasification based electric power generation. **(8)**

b. Explain the working of a fuel cell with the help of a diagram **(6)**

20. a. With the help of a diagram, explain the working of KVIC model biogas plant. **(10)**

b. Write notes on pumped storage plants **(4)**

AET404	**COMPREHENSIVE COURSE VIVA**	**CATEGORY**	**L**	**T**	**P**	**CREDIT**
		PCC	**1**	**0**	**0**	**1**

Preamble: The objective of this Course viva is to ensure the basic knowledge of each student in the most fundamental core courses in the curriculum. The viva voce shall be conducted based on the core subjects studied from third to eighth semester. This course helps the learner to become competent in placement tests and other competitive examinations.

Guidelines

1. The course should be mapped with a faculty and classes shall be arranged for practicing questions based on the core courses listed in the curriculum.
2. The viva voce will be conducted by the same three-member committee assigned for final project phase II evaluation. It comprises of Project coordinator, expert from Industry/research Institute and a senior faculty from a sister department.
3. The pass minimum for this course is 25.
4. The mark will be treated as internal and should be uploaded along with internal marks of other courses.
5. Comprehensive Viva should be conducted along with final project evaluation by the three-member committee.

Mark Distribution

Total marks: 50, only CIE, minimum required to pass : 25 Marks

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY KTU Estd. 2014

AED 416	PROJECT PHASE II	CATEGORY	L	T	P	CREDIT
		PWS	0	0	12	4

Preamble: The course 'Project Work' is mainly intended to evoke the innovation and invention skills in a student. The course will provide an opportunity to synthesize and apply the knowledge and analytical skills learned, to be developed as a prototype or simulation. The project extends to 2 semesters and will be evaluated in the 7th and 8th semester separately, based on the achieved objectives. One third of the project credits shall be completed in 7th semester and two third in 8th semester. It is recommended that the projects may be finalized in the thrust areas of the respective engineering stream or as interdisciplinary projects. Importance should be given to address societal problems and developing indigenous technologies.

Course Objectives

1. To apply engineering knowledge in practical problem solving.
2. To foster innovation in design of products, processes or systems.
3. To develop creative thinking in finding viable solutions to engineering problems.

Course Outcomes [COs]: After successful completion of the course, the students will be able to:

CO1	Model and solve real world problems by applying knowledge across domains (Cognitive knowledge level: **Apply**).
CO2	Develop products, processes or technologies for sustainable and socially relevant applications (Cognitive knowledge level: **Apply**).
CO3	Function effectively as an individual and as a leader in diverse teams and to comprehend and execute designated tasks (Cognitive knowledge level: **Apply**).
CO4	Plan and execute tasks utilizing available resources within timelines, following ethical and professional norms (Cognitive knowledge level: **Apply**).
CO5	Identify technology/research gaps and propose innovative/creative solutions (Cognitive knowledge level: **Analyze**).
CO6	Organize and communicate technical and scientific findings effectively in written and oral forms (Cognitive knowledge level: **Apply**).

Mapping of course outcomes with program outcomes

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	2	2	1	1	1	1	2
CO2	2	2	2		1	3	3	1	1		1	1
CO3									3	2	2	1
CO4					2			3	2	2	3	2
CO5	2	3	3	1	2							1
CO6					2			2	2	3	1	1

Abstract POs defined by National Board of Accreditation			
PO #	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO0	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

PROJECT PHASE II

Phase 2 Targets

1. In depth study of the topic assigned in the light of the report prepared under Phase - I;
2. Review and finalization of the approach to the problem relating to the assigned topic.
3. Preparing a detailed action plan for conducting the investigation, including teamwork.
4. Detailed Analysis/ Modeling / Simulation/ Design/ Problem Solving/Experiment as needed.
5. Final development of product/ process, testing, results, conclusions and future directions.
6. Preparing a paper for Conference Presentation/ Publication in Journals, if possible.
7. Presenting projects in Project Expos conducted by the University at the cluster level and/ or state level as well as others conducted in India and abroad.
8. Filing Intellectual Property Rights (IPR) if applicable.
9. Preparing a report in the standard format for being evaluated by the Department Assessment Board.
10. Final project presentation and viva voce by the assessment board including the external expert.

Evaluation Guidelines & Rubrics

Total: 150 marks (Minimum required to pass: 75 marks).

11. Project progress evaluation by guide: 30 Marks.
12. Two interim evaluations by the Evaluation Committee: 50 Marks (25 marks for each evaluation).
13. Final evaluation by the Final Evaluation committee: 40 Marks
14. Quality of the report evaluated by the evaluation committee: 30 Marks

(The evaluation committee comprises HoD or a senior faculty member, Project coordinator and project supervisor. The final evaluation committee comprises of Project coordinator, expert from Industry/research/academic Institute and a senior faculty from a sister department).

Evaluation by the Guide

The guide/supervisor must monitor the progress being carried out by the project groups on regular basis. In case it is found that progress is unsatisfactory it should be reported to the Department Evaluation Committee for necessary action. The presence of each student in the group and their involvement in all stages of execution of the project shall be ensured by the guide. Project evaluation by the guide: 30 Marks. This mark shall be awarded to the students in his/her group by considering the following aspects:

Project Scheduling & Distribution of Work among Team members: Detailed and extensive Scheduling with timelines provided for each phase of project. Work breakdown structure well defined. (5)

Literature survey: Outstanding investigation in all aspects. (4)

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily/weekly activity diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily/weekly activity diary shall be signed after every day/week by the guide. (7)

Individual Contribution: The contribution of each student at various stages. (9)

Completion of the project: The students should demonstrate the project to their respective guide. The guide shall verify the results and see that the objectives are met. (5)

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation - 1						
No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-a	Novelty of idea, and Implementation scope [CO5] [Group Evaluation]	**5**	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea can be implemented. There is still lack of originality in the work done so far by the team. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team . There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable / publishable work.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-b	Effectiveness of task distribution among team members. [CO3] [Group Evaluation]	**5**	No task distribution of any kind. Members are still having no clue on what to do.	Task allocation done, but not effectively, some members do not have any idea of the tasks assigned. Some of the tasks were identified but not followed individually well.	Good evidence of task allocation being done, supported by project journal entries, identification of tasks through discussion etc. However, the task distribution seems to be skewed, and depends a few members heavily than others. Mostly the tasks are being followed by the individual members.	Excellent display of task identification and distribution backed by documentary evidence of team brainstorming, and project journal entries. All members are allocated tasks according to their capabilities, and as much as possible in an equal manner. The individual members are following the tasks in an excellent manner.
			(0 – 1 Marks)	(2 – 3 Marks)	(4 Marks)	(5 Marks)
2-c	Adherence to project schedule. [CO4] [Group Evaluation]	**5**	Little or no evidence of continued planning or scheduling of the project. The students did not stick to the plan what they were going to build nor plan on what materials / resources to use in the project. The students do not have any idea on the budget required even after the end of phase - I. No project journal kept or the journal.	There is some improvement in the primary plan prepared during phase I. There were some ideas on the materials /resources required, but not really thought out. The students have some idea on the finances required, but they have not formalized a budget plan. Schedules were not prepared. The project journal has no useful details on the project.	Good evidence of planning done and being followed up to a good extent after phase I. Materials were listed and thought out, but the plan wasn't followed completely. Schedules were prepared, but not detailed, and needs improvement. Project journal is presented but it is neither complete nor updated regularly.	Excellent evidence of enterprising and extensive project planning and follow-up since phase I. Continued use of project management/version control tool to track the project. Material procurement if applicable is progressing well. Tasks are updated and incorporated in the schedule. A well-kept project journal showed evidence for all the above, in addition to the interaction with the project guide.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-d	Interim Results. [CO6] [Group assessment]	**5**	There are no interim results to show.	The team showed some interim results, but they are not complete / consistent to the current stage, Some corrections are needed.	The interim results showed were good and mostly consistent/correct with respect to the current stage. There is room for improvement.	There were significant interim results presented which clearly shows the progress.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-e	Presentation [Individual assessment]	**5**	Very poor presentation and there is no interim results. The student has no idea about the project proposal.	Presentation is average, and the student has only a feeble idea about the team work.	Good presentation. Student has good idea about the team's project. The overall presentation quality is good.	Exceptionally good presentation. Student has excellent grasp of the project. The quality of presentation is outstanding.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
Phase-II Interim Evaluation - 1 Total Marks: 25						

Applied Electronics and Instrumentation

EVALUATION RUBRICS for PROJECT Phase II: Interim Evaluation – 2

No	Parameters	Marks	Poor	Fair	Very Good	Outstanding
2-f	Application of engineering knowledge [CO1] [Individual Assessment]	**10**	The student does not show any evidence of applying engineering knowledge on the design and the methodology adopted. The student's contribution in application of engineering knowledge in the project is poor.	The student appears to apply some basic knowledge, but not able to show the design procedure and the methodologies adopted in a comprehensive manner.	The student is able to show some evidence of application of engineering knowledge in the design and development of the project to good extent.	Excellent knowledge in design procedure and its adaptation. The student is able to apply knowledge from engineering domains to the problem and develop solutions.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-g	Involvement of individual members [CO3] [Individual Assessment]	**5**	No evidence of any Individual participation in the project work.	There is evidence for some amount of individual contribution, but is limited to some of the superficial tasks.	The individual contribution is evident. The student has good amount of involvement in core activities of the project.	Evidence available for the student acting as the core technical lead and has excellent contribution to the project.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-h	Results and inferences upon execution [CO5] [Group Assessment]	**5**	None of the expected outcomes are achieved yet. The team is unable to derive any inferences on the failures/ issues observed. Any kind o f observations or studies are not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Documentation and presentation. .[CO6] [Individual assessment]	**5**	The individual student has no idea on the presentation of his/her part. The presentation is of poor quality.	Presentation's overall quality needs to be improved.	The individual's presentation performance is satisfactory.	The individual's presentation is done professionally and with great clarity. The individual's performance is excellent.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

Phase-II Interim Evaluation - 2 Total Marks: 25

EVALUATION RUBRICS for PROJECT Phase II: Final Evaluation						
No	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-j	Engineering knowledge. [CO1] [Group Assessment]	10	The team does not show any evidence of applying engineering knowledge on the design and the methodology adopted.	The team is able to show some of the design procedure and the methodologies adopted, but not in a comprehensive manner.	The team is able to show evidence of application of engineering knowledge in the design and development of the project to good extent. There is scope for improvement.	Excellent knowledge in design procedure and its adaptation. The team is able to apply knowledge from engineering domains to the problem and develop an excellent solution.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)
2-k	Relevance of the project with respect to societal and/or industrial needs. [Group Assessment] [CO2]	5	The project as a whole do not have any societal / industrial relevance at all.	The project has some relevance with respect to social and/or industrial application. The team has however made not much effort to explore further and make it better.	The project is relevant to the society and/or industry. The team is mostly successful in translating the problem into an engineering specification and managed to solve much of it.	The project is exceptionally relevant to society and/or industry. The team has made outstanding contribution while solving the problem in a professional and/ or ethical manner.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
2-i	Innovation / novelty / Creativity [CO5] [Group Assessment]	5	The project is not addressing any useful requirement. The idea is evolved into a non-implementable one. The work presented so far is lacking any amount of original work by the team.	Some of the aspects of the proposed idea appears to be practical. There is still lack of originality in the work done. The project is a regularly done theme/topic without any freshness in terms of specifications, features, and/ or improvements.	Good evidence of an implementable project. There is some evidence for the originality of the work done by the team. There is fresh specifications/ features/improvements suggested by the team. The team is doing a design from fundamental principles, and there is some independent learning and engineering ingenuity. Could be translated into a product / process if more work is done.	The project has evolved into incorporating an outstandingly novel idea. Original work which is not yet reported anywhere else. Evidence for ingenious way of innovation which is also Implementable. Could be a patentable publishable work.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)

2-m	Quality of results / conclusions / solutions. [CO1] [Group Assessment]	10	None of the expected outcomes are achieved. The team is unable to derive any inferences on the failures/issues observed. Any kind of observations or studies is not made.	Only a few of the expected outcomes are achieved. A few inferences are made on the observed failures/issues. No further work suggested.	Many of the expected outcomes are achieved. Many observations and inferences are made, and attempts to identify the issues are done. Some suggestions are made for further work.	Most of the stated outcomes are met. Extensive studies are done and inferences drawn. Most of the failures are addressed and solutions suggested. Clear and valid suggestions made for further work.
			(0 – 3 Marks)	(4 – 6 Marks)	(7 - 9 Marks)	(10 Marks)

2-n	Presentation - Part I Preparation of slides. [CO6] [Group Assessment].	5	The presentation slides are shallow and in a clumsy format. It does not follow proper organization.	Presentation slides follow professional style formats to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly, or acknowledged. Presentation slides needs to be more professional.	Presentation slides follow a good style format and there are only a few issues. Organization of the slides is good. Most of references are cited properly. The flow is good and team presentation is neatly organized. Some of the results are not clearly shown. There is room for improvement.	The presentation slides are exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and l i s ted. Results/ inferences clearly highlighted and readable.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
	Presentation - Part II: Individual Communication [CO6] [Individual Assessment].	5	The student is not communicating properly. Poor response to questions.	The student is able to explain some of the content. The student requires a lot of prompts to get to the idea. There are language issues.	Good presentation/ communication by the student. The student is able to explain most of the content very well. There are however, a few areas where the student shows lack of preparation. Language is better.	Clear and concise communication exhibited by the student. The presentation is outstanding. Very confident and tackles all the questions without hesitation. Exceptional traits of communicator.
			(0 - 1 Marks)	(2 - 3 Marks)	(4 Marks)	(5 Marks)
			Phase-II Final Evaluation, Marks: 40			

EVALUATION RUBRICS for PROJECT Phase II: Report Evaluation						
Sl. No.	**Parameters**	**Marks**	**Poor**	**Fair**	**Very Good**	**Outstanding**
2-o	Report [CO6]	30	The prepared report is shallow and not as per standard format. It does not follow proper organization. Contains mostly unacknowledged content. Lack of effort in preparation is evident. References are not cited. Unprofessional and inconsistent formatting.	Project report follows the standard format to some extent. However, its organization is not very good. Language needs to be improved. All references are not cited properly in the report. There is lack of formatting consistency.	Project report shows evidence of systematic documentation. Report is mostly following the standard style format and there are only a few issues. Organization of the report is good. Mostly consistently formatted. Most of references/sources are cited/ acknowledged properly.	The report is exceptionally good. Neatly organized. All references cited properly. Diagrams/Figures, Tables and equations are properly numbered, and listed and clearly shown. Language is excellent and follows professional styles. Consistent formatting and exceptional readability.
			(0 - 11 Marks)	(12 - 18 Marks)	(19 - 28 Marks)	(29 - 30 Marks)
Phase - II Project Report Marks: 30						

S8 MINOR

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd.
2014

AED482	MINI PROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	4

Preamble: Mini Project Phase I: A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The object of Project Work I is to enable the student to take up investigative study in the broad field of Applied Electronics and Instrumentation, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on a group of three/four students, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic;
2. Preparing an Action Plan for conducting the investigation, including team work;
3. Working out a preliminary Approach to the Problem relating to the assigned topic;
4. Block level design documentation
5. Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;
6. Preparing a Written Report on the Study conducted for presentation to the Department;

CO1	Identify and synthesize problems and propose solutions to them.
CO2	Prepare work plan and liaison with the team in completing as per schedule.
CO3	Validate the above solutions by theoretical calculations and through experimental
CO4	Write technical reports and develop proper communication skills.
CO5	Present the data and defend ideas.

Mapping of course outcomes with program outcomes

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

*1-slight/low mapping, 2- moderate/medium mapping, 3-substantial/high mapping

Assessment Pattern

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through minimum of TWO reviews. At the time of the 1st review, students are supposed to propose a new system/design/idea, after completing a thorough literature study of the existing systms under their chosen area. In the 2nd review students are expected to highlight the implementation details of the proposed solution. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1st and 2nd review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brain storming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

Marks Distribution

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Marks awarded by Guide : 15 marks
Project Report : 10 marks
Evaluation by the Committee : 40 Marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.
(a) Demonstration : 50 Marks
(b) Project report : 10 Marks
(d) Viva voce : 15marks

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty-in-charge of miniproject/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews**.**

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.

S8 HONOURS

AED496	MINI PROJECT	CATEGORY	L	T	P	CREDIT
		PWS	0	0	3	4

Preamble: Mini Project Phase I: A Project topic must be selected either from research literature or the students themselves may propose suitable topics in consultation with their guides. The object of Project Work I is to enable the student to take up investigative study in the broad field of Applied Electronics and Instrumentation, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on a group of three/four students, under the guidance of a supervisor. This is expected to provide a good initiation for the student(s) in R&D work. The assignment to normally include:

1. Survey and study of published literature on the assigned topic;
2. Preparing an Action Plan for conducting the investigation, including team work;
3. Working out a preliminary Approach to the Problem relating to the assigned topic;
4. Block level design documentation
5. Conducting preliminary Analysis/ Modelling/ Simulation/ Experiment/ Design/ Feasibility;
6. Preparing a Written Report on the Study conducted for presentation to the Department;

CO1	Identify and synthesize problems and propose solutions to them.
CO2	Prepare work plan and liaison with the team in completing as per schedule.
CO3	Validate the above solutions by theoretical calculations and through experimental
CO4	Write technical reports and develop proper communication skills.
CO5	Present the data and defend ideas.

Mapping of course outcomes with program outcomes

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

*1-slight/low mapping, 2- moderate/medium mapping, 3-substantial/high mapping

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY Estd. 2014

Assessment Pattern

The End Semester Evaluation (ESE) will be conducted as an internal evaluation based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, academic coordinator for that program and project guide/coordinator. The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, working knowledge and involvement.

The Continuous Internal Evaluation (CIE) is conducted by evaluating the progress of the mini project through minimum of TWO reviews. At the time of the 1^{st} review, students are supposed to propose a new system/design/idea, after completing a thorough literature study of the existing systms under their chosen area. In the 2^{nd} review students are expected to highlight the implementation details of the proposed solution. The review committee should assess the extent to which the implementation reflects the proposed design. A well coded, assembled and completely functional product is the expected output at this stage. The final CIE mark is the average of 1^{st} and 2^{nd} review marks.

A zeroth review may be conducted before the beginning of the project to give a chance for the students to present their area of interest or problem domain or conduct open brain storming sessions for innovative ideas. Zeroth review will not be a part of the CIE evaluation process.

Marks Distribution

Total Marks	CIE	ESE
150	75	75

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Marks awarded by Guide : 15 marks
Project Report : 10 marks
Evaluation by the Committee : 40 Marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks.
(a) Demonstration : 50 Marks
(b) Project report : 10 Marks
(d) Viva voce : 15marks

Course Plan

In this course, each group consisting of three/four members is expected to design and develop a moderately complex software/hardware system with practical applications. This should be a working model. The basic concept of product design may be taken into consideration.

Students should identify a topic of interest in consultation with Faculty-in-charge of miniproject/Advisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design/fabrication or develop codes/programs to achieve the objectives. Demonstrate the novelty of the project through the results and outputs. The progress of the mini project is evaluated based on a minimum of two reviews**.**

The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The product has to be demonstrated for its full design specifications. Innovative design concepts, reliability considerations, aesthetics/ergonomic aspects taken care of in the project shall be given due weight.