SEMESTER V

AET301	CONTROL SYSTEMS	CATEGORY	L	T	P	CREDITS
		PCC	3	1	0	4

Preamble: This course aims to analyze and design control systems.

Prerequisite: ECT205: NETWORK THEORY

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

CO 1	Analyze the control systems by transfer function approach.
CO 2	Get an adequate knowledge in the time response of systems & steady state error analysis
CO 3	Learn the concept of stability of control systems and methods of stability analysis.
CO 4	Analyze the control systems using frequency domain method.
CO 5	Apply the State Space Techniques to Control Systems.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2										
CO 2	3	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	10	10	20
Understand	K2	10	10	20
Apply	K3	30	30	60
Analyze	K4			
Evaluate	K5			
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.

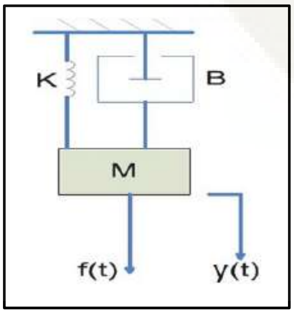
Course Level Assessment Questions

Course Outcome 1 (CO1): Analyze the control systems by transfer function approach

1. Define close loop transfer function and obtain the general equation for the characteristic equation of a system.
2. Explain the terms transmittance and non touching loops with respect to signal flow graphs.

3. (i) Find ***y(t)***, for the given, $Y(s) = \frac{9}{s(s+0.2)(s+3)}$

   (ii) Obtain the transfer function $\frac{Y(s)}{F(s)}$ $for\ f(t) = 1,$ for the $Y(s)$ given in the above question. If the obtained transfer function represents the transfer function of a mass-spring-damper system as shown in Figure, find the values of **M, B and K** and also draw its **equivalent force - voltage analogous circuit** clearly writing the numerical values of **R, L and C.**



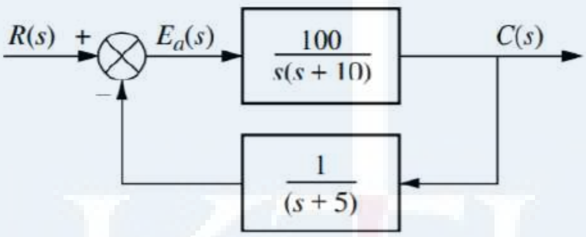
Course Outcome 2 (CO2): Get an adequate knowledge in the time response of systems and steady state error analysis

1. Obtain the ramp response of a general first order system with unity system gain and time constant of 2 seconds. Also draw the time response.

2. Derive the expression for the step response of a second order underdamped system as given below:

$$c(t) = 1 - e^{-\zeta\omega_n t}\left[\cos\omega_d t + \frac{\zeta}{\sqrt{1-\zeta^2}}\sin\omega_d t\right]$$

3. Find the numerical value of steady state error associated with the system shown below for a unit step input.



4. Derive the expression for the maximum percentage overshoot of the second order underdamped system as given below.

$$M_p = e^{-\frac{\pi\zeta}{\sqrt{1-\zeta^2}}} \times 100$$

Course Outcome 3 (CO3): Learn the concept of stability of control systems and methods of stability analysis.

1. Explain briefly the conditions that is to be satisfied for a system to be

   (a) Absolutely stable

   (b) Marginally stable

2. For the transfer function given below, determine how many poles are in the right half s-plane, left half s-plane and on the jω axis.

$$T(s) = \frac{20}{s^8 + s^7 + 12s^6 + 22s^5 + 39s^4 + 59s^3 + 48s^2 + 38s + 20}$$

3. For a unity feedback system, the open loop transfer function is given by

$$G(s)H(s) = \frac{K}{s(s+2)(s^2+6s+25)}$$

(a) Sketch the root locus

(b) At what value of K, the system becomes unstable?

(c) At this point of instability, determine the frequency of oscillation of the system.

Course Outcome 4 (CO4): Analyze the control systems using frequency domain method.

1. Define the frequency domain specifications

   (a) Resonant peak

   (b) Resonant frequency

   (c) Bandwidth

   Also obtain the expressions for the above for a second order underdamped

$$T(s) = \frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\delta\omega_n s + \omega_n^2}$$

   system with transfer function

2. Draw the Bode plot of the system given below. Also find the Gain margin

$$G(s)= \frac{75(1+0.2s)}{s(s^2+16s+100)}.$$

   and Phase margin.

3. State and explain Nyquist Stability criteria.

4. The open loop transfer function for an unmanned under water vehicle is given by

$$G(s) = \frac{20}{s(1+as)(1+0.02s)}$$

   (a) At a frequency of 3 rad/sec, it is known that the gain of the system is 5, hence calculate the value of "a".

   (b) Estimate the phase margin for the above value of "a" without drawing Nyquist Plot.

Course Outcome 5 (CO5): Apply the State Space Techniques to Control Systems.

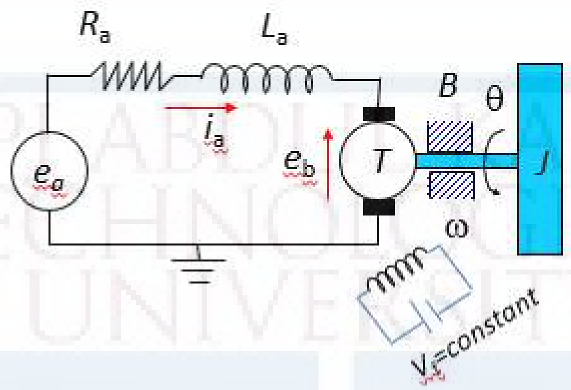
1. Define the following:

   (a) State of a system

(b) State variables

(c) State vector

2. Obtain the state space model of the armature controlled DC motor shown below:



3. Determine the transfer function of the system represented by the state space model given below, for if K=3, B=1 and M=10;

$$\begin{bmatrix} \dot{x} \\ \dot{v} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -\frac{K}{M} & -\frac{B}{M} \end{bmatrix} \begin{bmatrix} x \\ v \end{bmatrix} + \begin{bmatrix} 0 \\ \frac{1}{M} \end{bmatrix} f(t)$$

$$y(t) = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ v \end{bmatrix}$$

4. A dynamic system is given below. Check whether the system is completely controllable.

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} r$$

SYLLABUS

Module 1:

System modeling - Transfer function approach:

Introduction to control systems – Classification of control systems. Principles of automatic control. Feedback control systems – Practical examples – Transfer function – Transfer function of electrical, mechanical and electromechanical system – Block diagram – Signal flow graph – Mason's gain formula.

Module 2:

Time domain analysis:

Standard test signals - Response of systems to standard test signals – Step response of second order systems in detail – Time domain specifications – delay time, rise time, peak time, maximum percentage overshoot and settling time. Steady state response – Steady state error- Static & Dynamic error coefficients.

Module 3:

Stability of linear systems in time domain:

Asymptotic and BIBO stability, Routh-Hurwitz criterion of stability. Root locus - Construction of root locus – Effect of addition of poles and zeros on root locus.

Module 4:

Frequency domain analysis:

Frequency response – Frequency domain specifications – Stability in the frequency domain- Nyquist stability criterion – Stability from polar and Bode plots - Relative stability – Gain margin and phase margin – M & N circles – Nichol's chart.

Module 5:

State variable analysis:

State space representation of Continuous Time systems. Transfer function from State Variable Representation, Solution of state equations, state transition matrix, Concepts of Controllability and Observability, Kalman's Test.

Text Books

1. S. Hassan Saeed, Automatic Control Systems (with MATLAB programs), KATSON Books.
2. Norman S Nise, Control System Engineering, Sixth Edition.

Reference Books

1. Katsuhiko Ogata, Modern Control Engineering, Pearson Education.
2. M. Gopal, Control Systems, McGraw Hill Education India Education, 2012.
3. B.C. Kuo, PHI, Automatic Control Systems.
4. Richard C Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2001.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**System modeling - Transfer function approach:**	
1.1	Introduction to control system – Classification of control systems.	1
1.2	Principles of automatic control.	1
1.3	Feedback control systems – Practical examples	1
1.4	Transfer function – Transfer function of electrical and mechanical systems	2
1.5	Transfer function of electromechanical systems	1
1.6	Block diagram reduction Techniques	1
1.7	Signal flow graph – Mason's gain formula.	2
2	**Time domain analysis:**	
2.1	Standard test signals - Response of systems to standard test signals	1
2.2	Step response of second order systems in detail	2
2.3	Time domain specifications – delay time, rise time, peak time, maximum percentage overshoot and settling time. Example problems.	4
2.4	Steady state response – Steady state error	1
2.5	Static & Dynamic error coefficients.	2
3	**Stability of linear systems in time domain:**	
3.1	Asymptotic and BIBO stability	1
3.2	Routh-Hurwitz criterion of stability	1
3.3	Root locus - Construction of root locus	3
3.4	Root locus- Examples	2
3.5	Effect of addition of poles and zeros on the root locus	1
4	**Frequency domain analysis:**	
4.1	Frequency response – Frequency domain specifications	1
4.2	Stability in the frequency domain - Nyquist stability criterion. Examples.	3
4.3	Relative stability – Gain margin and phase margin. Examples.	2
4.4	M & N circles – Nichol's chart.	2
5	**State variable analysis:**	
5.1	State space representation of Continuous Time systems. Standard canonical forms.	3
5.2	Transfer function from State Variable Representation	2
5.3	Solution of state equations, state transition matrix. Examples	3
5.4	Concepts of Controllability and Observability, Kalman's Test.	2

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET301

Program: Applied Electronics and Instrumentation Engineering

Course Name: Control Systems

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

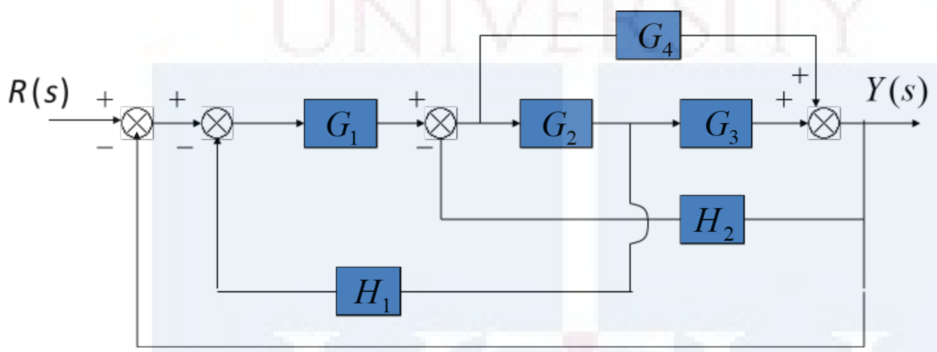
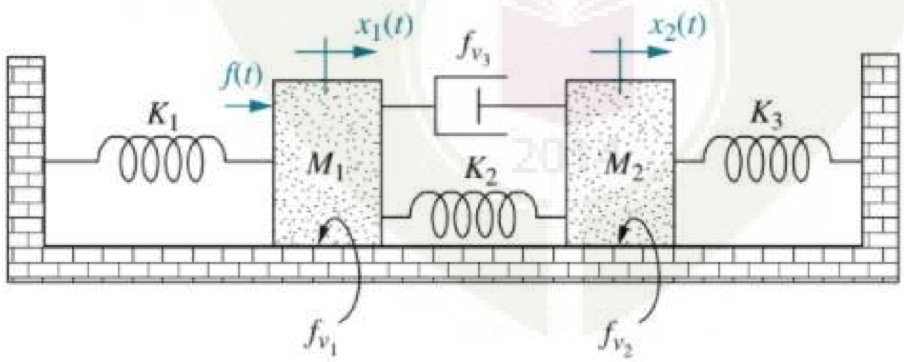
1.	Write the Force – Current analogies for Mass, Spring constant and Damping coefficient of a mechanical system.	K1	
2	Derive the expression for closed loop transfer function.	K2	
3	Impulse response of a 1st order system is given below: $c(t) = 3e^{-0.5t}$ Find out (a) Time constant T (b) D.C Gain K (c) Transfer Function	K3	
4	Write the expressions for K_p, K_v and K_a, for a given system with open loop transfer function G(s)	K1	
5	What is the inference of having all the elements of a row as zeroes in the Routh Table?	K2	
6	Write the angle and magnitude conditions for constructing the root locus of a system.	K1	
7	Briefly explain the steps for drawing a polar plot.	K2	
8	Define (i) Gain cross over frequency (ii) Phase cross over frequency and (iii) Phase Margin	K1	
9	Derive the expression for the state transition matrix from the unforced state equation.	K2	

10	What is duality property between controllable and observable canonical form. Write the 4 equations relating the matrices A, B, C, D in observable and controllable forms.	K2	

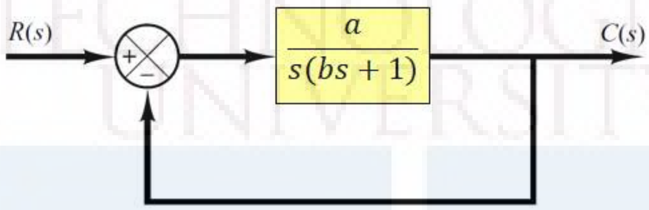
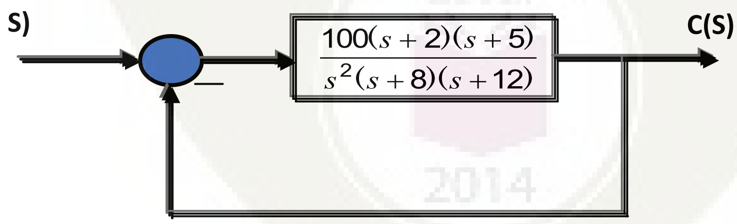
PART – B

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

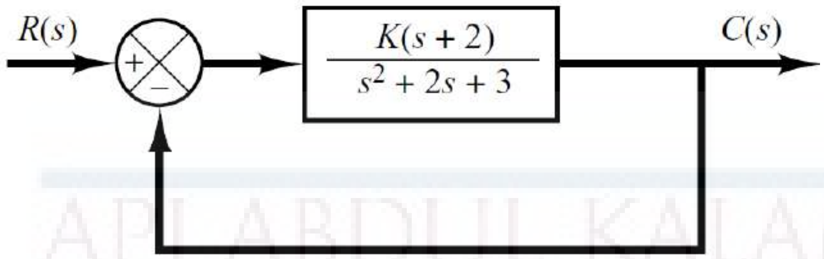
Module – I

11.a)	Write any 2 advantages and disadvantages of closed loop control systems	4	CO1	K1
11.b)	Using block diagram reduction technique, find the overall transfer function of the system shown below: 	10	CO1	K3
	OR			
12.a)	Draw the free-body diagrams of masses M1 and M2, for the system shown below	4	CO1	K1
12.b)	For the mechanical system shown, draw the Force - Current analogous system, after clearly writing the equations of motion for each mass. 	10	CO2	K3

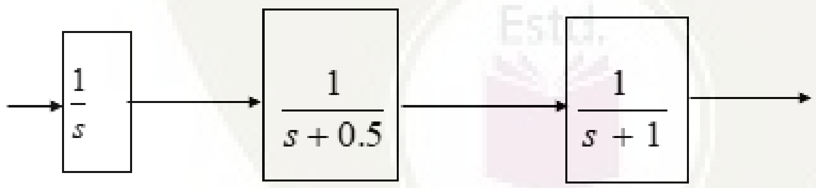
Module – II

13 a)	For the system represented by the block diagram given below, **determine the values** of 'a' and 'b' to yield a unit step response, with maximum percentage overshoot of 5 and undamped natural frequency (ω_n) as 2 rad/sec. 	10	CO2	K3
13 b)	For the obtained values of 'a' and 'b', in the above question, find the **risetime** and **settling time** for a **2%** criterion.	4	CO2	K1
	OR			
14 a)	What are the 4 standard test signals used in control systems. Write the Laplace Transform of the above test signals.	4	CO2	K1
14 b)	For the system shown in figure below, evaluate the static error constants and find the expected steady state errors for the standard step, ramp and parabolic inputs. 	10	CO2	K3

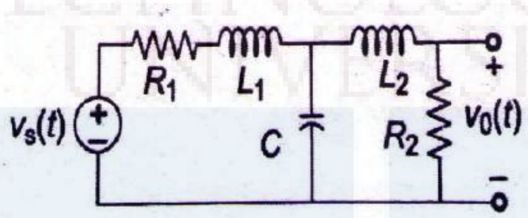
Module – III

15 a)	State and explain the Routh Hurwitz criteria for stability analysis	5	CO3	K2
15 b)	Sketch the complete root locus of the system shown below:  	9	CO3	K3
	OR			
16 a)	Write the 9 rules for construction of root locus.	5	CO3	K2
16 b)	Sketch the root locus for the transfer function given below in a graphsheet $$G(s)H(s) = \frac{K}{s(s+1)(s+5)}$$ Add a zero at s = -2, to the above transfer function and draw the root locus. Also clearly specify the effect of adding the zero to the transfer function.	9	CO3	K3

Module – IV

17	Sketch the asymptotic bode plot of the open loop system for a system represented by block diagram shown in Figure. Estimate the gain and phase margin of the system and calculate the phase crossover frequency and gain crossover frequency.  	14	CO4	K3
	OR			
18	The open loop transfer function of a control system is given by $$G(s) = \frac{K}{s(s+2)(s+10)}$$ Determine the value of K so that the system will be stable with (a) Gain Margin = 6 dB (b) Phase Margin = 45^0	14	CO4	K3

Module – V

19 a)	Draw the block diagram representing the state space model given by $$\dot{x}(t) = Ax(t) + Bu(t)$$ $$y(t) = Cx(t) + Du(t)$$	4	CO5	K3
19 b)	**Obtain the state space model** of the electrical network shown below: Clearly **write the state equation and output equation**. 	10	CO5	K3
	OR			
20 a)	Obtain the observable canonical form of the given transfer function: $$\frac{Y(s)}{U(s)} = \frac{s+3}{s^2+5s+2}$$	8	CO5	K3
20 b)	Determine the controllability and observability of the system shown below: $$\begin{bmatrix}\dot{x}\\ \dot{y}\end{bmatrix} = \begin{bmatrix}-0.5 & 0\\ 0 & -2\end{bmatrix}\begin{bmatrix}x\\ y\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u(t)$$ $$y(t) = \begin{bmatrix}0 & 1\end{bmatrix}\begin{bmatrix}x\\ y\end{bmatrix}$$	6	CO5	K3

AET303	INDUSTRIAL INSTRUMENTATION	CATEGORY	L	T	P	CREDITS
		PCC	3	1	0	4

Preamble: This course aims to develop a strong understanding of the principle of operation of various temperature, pressure, flow and level measuring devices.

Prerequisite: Nil

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

CO 1	Understand the working of different types of temperature sensors
CO 2	Familiarize with the various types of pressure measurement techniques
CO 3	Study the working of various flow measurement devices
CO4	Familiarize with the working of anemometers and viscometers
CO5	Understand the various level measurement techniques

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3										2
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	70
Apply	K3	10	10	10
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): Understand the working of different types of temperature sensors

1. Explain the working principle of Resistance Temperature detectors.
2. Explain the theory of operation of thermocouples.

Course Outcome 2 (CO2): Familiarize with the various types of pressure measurement techniques

1. Explain the construction and principle of operation of Bourdon tubes.
2. Compare the performance of various types of electronic pressure sensors.

Course Outcome 3 (CO3): Study the working of various flow measurement devices

1. Explain how venturi tubes are used in Flow Measurement?
2. Explain the working of Angular-momentum type flow meter.

Course Outcome 4 (CO4): Familiarize with the working of anemometers and viscometers

1. What are anemometers used for? Explain the different categories of anemometers.
2. Explain the working of differential pressure type capillary viscometers

Course Outcome 5 (CO5): Understand the various level measurement techniques

1. What are the different types of float type designs for level measurement and control?
2. Compare the performance of various types of electrical level gauging methods

SYLLABUS

Module 1:
Temperature Measurement: Resistance Temperature Detectors – Applications, Industrial RTD construction requirement, RTD Transmitters. Thermistors – Principle of Operation, Sensor types, Temperature measurement using Thermistors. Thermocouples – Theory of Operation, Thermocouple types. Diode – Type Temperature Sensors, Fluidic Sensors, Johnson noise thermometer, Electronic Temperature Switches.

Module 2:
Pressure Measurement: Manometers, Bourdon Tubes, Diaphragm Elements.
Electronic Pressure Sensors – Strain Gauge Transducers, Capacitance Transducer, Potentiometric Transducer, Resonant Wire Transducer, Piezoelectric Pressure Sensors, Linear Variable Differential Transformer, Optical Transducers.
Differential Pressure Transmitters – Pneumatic transmitter.

Module 3:
Flow Measurement: Introduction, Orifice Plates, Venturi Tubes and Nozzles, Pitot Tubes.
Positive Displacement Flowmeters - Nutating disc flowmeter, Sliding vane flowmeter, Lobed impeller flowmeter, Reciprocating piston flowmeter
Mass Flowmeters – Radiation type, Angular – Momentum type, Impeller-Turbine Flowmeter, Constant torque - Hysteresis Clutch, Twin-Turbine.

Module 4:
Anemometers – Mechanical Anemometer, Hot-wire anemometer, Laser Doppler anemometer.
Cross-Correlation flow meter, Ultrasonic flow meter – Transit-time flow meter, Doppler flow meter
Measurement of Viscosity – Introduction, Viscometer selection and application. Capillary Viscometers – Differential Pressure type.

Module 5 :
Level Measurement – Float Type level indicator, Displacer Type – Torque tube assembly.
Electrical Methods – Resistance, Conductance, Inductive and Capacitive level gauging**.**
Ultrasonic Method, Microwave Level Switches, Noncontacting optical level sensor, Rotating Paddle Switches.

Text Books

1. Patranabis D, "*Principles of Industrial Instrumentation*", 3rd Edition, Tata McGraw Hill, New Delhi, 2010.
2. Liptak B.G, "*Process Measurement and Analysis*", 4th Edition, Chilton Book Company, Radnor, Pennsylvania, 2003.
3. Doebelin E.O, "*Measurement Systems: Application and Design*", 4th Edition, McGraw Hill, New York, 2003.

Reference Books

1. Andrew W.G, "*Applied Instrumentation in Process Industries – A survey*", Vol I & Vol II, Gulf Publishing Company, Houston, 2001.
2. Douglas M. Considine, "*Process / Industrial Instruments & Controls Handbook*", 5th Edition, McGraw Hill, Singapore, 1999.
3. Spitzer D. W., *Flow measurement*, ISA press, New York, 1998 4. Noltingk B.E., *"Instrumentation Reference Book"*, 2nd Edition, Butterworth Heinemann, 1995.
4. Noltingk B.E., *"Instrumentation Reference Book"*, 2nd Edition, Butterworth Heinemann, 1995.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Temperature Measurement**	
1.1	Resistance Temperature Detectors – Applications, Industrial RTD construction requirement, RTD Transmitters	2
1.2	Thermistors – Principle of Operation, Sensor types, Temperature measurement using Thermistors	2
1.3	Thermocouples – Theory of Operation, Thermocouple types.	1
1.4	Diode – Type Temperature Sensors, Fluidic Sensors	2
1.5	Johnson noise thermometer, Electronic Temperature Switches	2
2	**Pressure Measurement**	
2.1	Manometers, Bourdon Tubes, Diaphragm Elements.	2
2.2	Electronic Pressure Sensors – Strain Gauge Transducers, Capacitance Transducer, Potentiometric Transducer	3
2.3	Resonant Wire Transducer, Piezoelectric Pressure Sensors,	1
2.4	Linear Variable Differential Transformer, Optical Transducers.	2
2.5	Differential Pressure Transmitters – Pneumatic Transmitter	1
3	**Flow Measurement**	
3.1	Introduction, Orifice Plates, Venturi Tubes and Nozzles, Pitot Tubes.	2
3.2	**Positive Displacement Flowmeters -** Nutating disc flowmeter, Sliding vane flowmeter, Lobed impeller flowmeter, Reciprocating piston flowmeter	3
3.3	**Mass Flowmeters** – Radiation type, Angular – Momentum type, Impeller-Turbine Flowmeter	2
3.4	Constant torque-Hysterisis Clutch, Twin-Turbine	2
4	**Anemometers**	
4.1	Mechanical Anemometer, Hot-wire anemometer, Laser Doppler anemometer.	3

4.2	Cross-Correlation flow meter, Ultrasonic flow meter – Transit-time flow meter, Doppler flow meter	3
4.3	**Measurement of Viscosity** – Introduction, Viscometer selection and application.	2
4.4	Capillary Viscometers – Differential Pressure type.	1
5	**Level Measurement**	
5.1	Float Type level indicator, Displacer Type – Torque tube assembly.	2
5.2	Electrical Methods – Resistance, Conductance, Inductive and Capacitive level gauging**.**	3
5.3	Ultrasonic Method, Microwave Level Switches,	2
5.4	Noncontacting optical level sensor, Rotating Paddle Switches.	2

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET303

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

Course Name: Industrial Instrumentation

Max. Marks : 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	Explain the theory of operation of thermocouples.	K2	CO1
2	List two advantages and limitation of RTD's.	K2	CO1
3	Explain the working of a diaphragm pressure gauge.	K2	CO2
4	Explain the construction of a potentiometric pressure transducer.	K2	CO2
5	Illustrate the different types of orifice plates.	K2	CO3
6	Draw the schematic of a lobed impeller flow meter and explain.	K2	CO3
7	Explain the working of any one type of mechanical Anemometer.	K2	CO4
8	Explain any two applications of viscometers.	K2	CO4
9	Explain the working of a typical float type level indicator.	K2	CO5
10	Illustrate the working principle of a noncontacting optical level sensor.	K2	CO5

PART – B

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

Module – I

11. a)	What are the considerations that need to be followed in the construction of industrial RTD's ?	8	CO1	K1
11. b)	Explain how temperature measurement is done using thermistors?	6	CO1	K2
	OR			
12.a)	With the help of neat diagrams explain the working of diode type temperature sensor.	7	CO1	K2
12.b)	Explain the working of fluidic sensor with the help of a neat block diagram.	7	CO1	K1

Module – II

13. a)	With the help of neat schematics explain the working of Bourdon pressure gauge.	8	CO2	K2
13. b)	Explain how pressure transducer can be constructed using unbounded strange gauge wires.	6	CO2	K3
	OR			
14.a)	Explain the construction and working of a Resonant wire type differential pressure sensor.	7	CO2	K2
14.b)	Illustrate the working principle of Linear Variable Differential Transformer.	7	CO2	K2

Module III

15. a)	Explain the working principle of pitot tube.	4	CO3	K1
15. b)	With the help of neat schematics explain the working of nutating disc flowmeter and sliding vane flowmeter.	10	CO3	K2
	OR			
16.a)	Draw a neat diagram of a radiation-type mass flowmeter and explain	7	CO3	K2
16.b)	With the help of neat sketches explain the working of Twin-Turbine flowmeter.	7	CO3	K2

Module IV

17. a)	With the help of neat sketches explain the working of Laser Doppler Anemometer.	8	CO4	K2
17. b)	Illustrate the principle of cross-correlation flow monitoring.	6	CO4	K2
	OR			
18.a)	Explain the principle of operation of Doppler flowmeter with the help of neat diagrams	7	CO4	K1
18.b)	With the help of neat schematics explain the working of Differential-pressure-type capillary viscometer	7	CO4	K2

Module – V

19. a)	With neat schematics explain the working of torque tube assembly displacer type level indicator.	6	CO5	K2
19. b)	Draw and explain any two electrical methods for level gauging.	8	CO5	K2

	OR			
20.a)	With the help of a neat block diagram explain about ultrasonic level gauging.	7	CO5	K2
20.b)	Explain how microwave switches are used in level measurement.	7	CO5	K2

AET305	COMPUTER ARCHITECTURE AND EMBEDDED SYSTEMS	CATEGORY	L	T	P	CREDITS
		PCC	3	1	0	4

Preamble: This course aims to impart knowledge of basic computer architecture, microcontroller and embedded programming

Prerequisite: ECT203 Logic Circuit Design & EST102 Programming in C

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

CO 1	Explain the processor architecture and operation.	K2
CO 2	Explain the architecture of 8051 microcontroller.	K2
CO 3	Develop programs using assembly language 8051.	K3
CO4	Develop Programming concepts of Embedded programming in C.	K3
CO5	Explain the concepts of RTOS based embedded system.	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										3
CO 2	3	3										3
CO 3	3	3	3	3	3							3
CO 4	3	3	3	3	3							3
CO5	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	: 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 processor architecture and operation.

1. Write the sequence of elementary operations required to execute an instruction

a. Sub (R4), R3
b. Add (R4), R1

Course Outcome 2 (CO2): Explain the architecture of 8051 microcontroller.

2. Draw the memory map and briefly explain the memory organization for 128 byte internal RAM of 8051 microcontroller.

Course Outcome 3 (CO3): Develop programs using assembly language 8051.

3. Develop following programs for 8051

a. Program to convert the ASCII number into unpacked BCD.

b. Program to swap a number 0 x ab to 0 x ba, where a and b are hex digits.

c. Program to find the number of 1's in an 8-bit data item.

d. Program to display 'M' and 'E' on the LCD connected to 8051 using the BUSY FLAG.

e. Program to rotate a stepper motor 500 in the clockwise direction.

f. Program to toggle pin P1.4 every second using interrupts for a frequency of 22 MHz. Use timer 1 in mode 1.

g. Program to generate a square wave of 1 kHz with duty cycle 33%. Use timer 1 in interrupt mode with a crystal frequency of 11.0592 MHz.

Course Outcome 4 (CO4): Develop Programming concepts of Embedded programming in C.

4. The following examples may be solved in C program

   a. Program to convert the ASCII number into unpacked BCD.

   b. Program to swap a number 0 x ab to 0 x ba, where a and b are hex digits.

   c. Program to find the number of 1's in an 8-bit data item.

Course Outcome 4 (CO5): Explain the concepts of RTOS based embedded system.

5. What are the functional and non functional requirements that needs to be analysed while choosing an RTOS.

SYLLABUS

Module 1: Computer Arithmetic and Processor Basics

Functional units of a computer, Von Neumann and Harvard computer

architectures,. Processing unit- Fundamental concepts, Execution of a complete Instruction, Hardwired Control, Multiple Bus organization, other enhancements Microprogrammed control. Number representations - Fixed and floating point-number representation, Arithmetic operations on floating point numbers

Module 2: 8051 Architecture

Microcontrollers and Embedded Processors. Architecture – Block diagram of 8051, Pin

configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts. Assembly

Language Programming - Addressing Modes, Instruction set of 8051, Simple programming examples in assembly language.

Module 3: Programming and Interfacing of 8051

Interfacing with 8051 using Assembly language programming: LED, Seven segment LED display.. Interfacing of Keyboard, Stepper Motor and DAC -- with 8051 and its programming.

8051 Timers/Counters - Modes and Applications

Module 4: Embedded programming

Introduction to Embedded Systems: Definition of Embedded System, Embedded Systems Vs General Computing Systems. Programming concepts of Embedded programming in C Program Elements, Macros and functions - Use of Pointers - NULL Pointers - Use of Function Calls – Multiple function calls in a Cyclic Order in the Main Function Pointers – Function Queues and Interrupt Service Routines Queues Pointers

Module 5: RTOS Based Embedded System

RTOS Based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling. How to Choose an RTOS

Text Books

1. V. Carl Hamacher, Zvono G. Vranesic, Safwat G. Zaky Computer Organization. McGraw-Hill International Editions
2. Muhammed Ali Mazidi & Janice Gilli Mazidi, R.D. Kinley, The 8051 microcontroller and Embedded System, Pearson Education, 2nd edition.Robert
3. Shibu K.V, *Introduction to Embedded Systems*, Mc Graw Hill

Reference Books

1. Computer organization and design: The Hardware/Software interface/David A.Patterson, John L. Hennessy. — 5th ed.
2. Mano M M, Computer System Architecture, 3rd Ed, Prentice Hall of India.
3. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design – Harcourt India, Morgan Kaufman Publishers, First Indian Reprint 2001
4. Lyla B Das, Embedded Systems An Integrated Approach, Pearson, 2013
5. Rajkamal, Embedded Systems Architecture, Programming and Design, TATA McGraw-Hill, First reprint Oct. 2003

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Computer Arithmetic and Processor Basics**	
1.1	Functional units of a computer, Von Neumann and Harvard computer architectures	1
1.2	Processing unit- Fundamental concepts	1
1.3	Execution of a complete Instruction	2
1.4	Hardwired Control	1
1.5	Multiple Bus organization, Other enhancements	1
1.6	Microprogrammed control	1
1.7	Number representations	1
1.8	Fixed and floating point-number representation	1
1.9	Arithmetic operations on floating point numbers	2
2	**8051 Architecture**	
2.1	Microcontrollers and Embedded Processors, Block diagram of 8051	1
2.2	Pin configuration, Registers	1
2.3	Internal Memory, Port Structures, Interrupts	3
2.4	Addressing Modes	1
2.5	Instruction set of 8051	1
2.6	Programming examples in assembly language	2
3	**Programming and Interfacing of 8051**	

3.1	Programming examples Interfacing with 8051 using Seven segment LED display	2
3.2	Interfacing of Keyboard and Stepper Motor	3
3.3	Interfacing of DAC -- with 8051 and its programming.	2
3.4	8051 Timers/Counters - Modes and Applications	3

4	**Embedded programming**	
4.1	Definition of Embedded System, Embedded Systems Vs General Computing Systems.	1
4.2	Programming concepts of Embedded programming in C Program Elements	2
4.3	Macros and functions	1
4.4	Use of Pointers - NULL Pointers	1
4.5	Function Calls – Multiple function calls in a Cyclic Order in the Main Function Pointers	2
4.6	Function Queues and Interrupt Service Routines Queues Pointers	2
5	**RTOS Based Embedded System**	
5.1	Operating System Basics, Types of Operating Systems,	1
5.2	Tasks, Process and Threads	2
5.3	Multiprocessing and Multitasking	1
5.4	Task Scheduling.	1
5.5	How to Choose an RTOS	1

Assignment:

At least one assignment should be simulation of 8051 using KEIL

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET305

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

Course Name: Computer Architecture and Embedded Systems

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1. Draw IEEE standard floating point number format with single precision K1

2. What are the sequence of operations and control signals generated, for fetching a word from memory K3

3. Draw the bit pattern for 8051 flag register (PSW) K1

4. Explain the following instructions K2
   MOVX A, @DPTR
   DJNZ R0, BACK
   DAA

5. Explain TMOD SFR (Special Function Register) K2

6. How will you generate a 1 ms delay using 8051? K3

7. Compare Embedded System with General Computing System K2

8. How is a pointer different from a NULL pointer? (Any 2 differences) K2

9. Define a thread. What are the advantages of using a multithreaded program K1

10. What are the types of Operating systems K1

PART – B

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

Module – I

11. a)	Rules of Arithmetic operations on floating point numbers	6	CO1	K2
11. b)	With diagrams explain the operation of hardwired control	8	CO1	K3
	OR			
12.a)	Explain with a diagram, how a 3 operand instruction is executed in a 3 bus CPU structure	8	CO1	K2
12.b)	With a diagram explain the basic organization of a microprogrammed control unit	6	CO1	K1

Module – II

13 a)	Draw the memory map and briefly explain the memory organization for 128 byte internal RAM of 8051 microcontroller.	8	CO2	K1
13 b)	Write an 8051 assembly language program to add two 64 bit numbers	6	CO3	K3
	OR			
14 a)	Write a program to find the sum of the values at RAM locations 50 – 54H (5 values) . At the end of the program, register A should contain the low byte of the sum and R7 the high byte of the sum.	8	CO3	K3
14 b)	List the addressing modes of 8051 with proper examples	6	CO2	K2

Module – III

15 a)	Draw a block diagram to interface stepper motor with 8051 with a step angle of 2 degree. Also write an assembly language program to rotate a motor 64 degree in clock wise direction. Use 4 step sequence	14	CO3	K3
	OR			
16 a)	Explain TCON SFR (Special Function Register)	5	CO2	K1
16 b)	How a triangular waveform can be generated using 8051?	9	CO3	K3

Module – IV

17 a)	Explain in detail various data structures used in embedded C programming.	10	CO4	K1
17 b)	Write 4 differences between macros and functions.	4	CO4	K2

	OR			
18 a)	Explain a function pointer with syntax, example and uses.	9	CO4	K2
18 b)	Compare pass by value and pass by reference	5	CO4	K2

Module – V

19 a)	What are the Functional and Non functional requirements that needs to be analysed while choosing an RTOS.	10	CO4	K1
19 b)	What is the use of a watch dog timer.	4	CO4	K2
	OR			
20 a)	What is meant by task synchronization? Discuss on various task synchronization issues and solutions in real time systems.	10	CO4	K2
20 b)	What is a semaphore? How they are classified?	4	CO4	K1

AET307	ANALOG INTEGRATED CIRCUITS	CATEGORY	L	T	P	CREDITS
		PCC	3	1	0	4

Preamble: This course aims to develop the skill to design circuits using operational amplifiers and other linear ICs for various applications.

Prerequisite: ECT202 Analog Circuits

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

CO 1	Outline Op Amp fundamentals and differential amplifier configurations
CO 2	Design operational amplifier circuits for various applications
CO 3	Design Oscillators and active filters using opamps
CO4	Explain the working and applications of timer, VCO and PLL ICs
CO5	Outline the working of Voltage regulator IC's and Data converters

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	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): Understand Op Amp fundamentals and differential amplifier configurations.

1. Explain the working of BJT differential amplifiers.
2. Calculate the input resistance, output resistance, voltage gain and CMRR of differential amplifiers.
3. Explain the non-ideal parameters of differential amplifiers.
4. Derive CMRR, input resistance and output resistance of a dual input balanced output differential amplifier configuration.

Course Outcome 2 (CO2): Design operational amplifier circuits for various applications.

1. Design an opamp circuit to obtain an output voltage $V_0=-(2V_1+4V_2+3V_3)$
2. A 741C op-amp is used as an inverting amplifier with a gain of 50. The voltage gain vs frequency curve of 741C is flat upto 20kHz.What maximum peak to peak input signal can be applied without distorting the output?
3. With the help of a neat circuit diagram, derive the equation for the output voltage of an Instrumentation amplifier.
4. With the help of circuit diagrams and graphs, explain the working of a Full wave Precision rectifier.

Course Outcome 3 (CO3): Design Oscillators and active filters using opamps.

1. Derive the design equations for a second order Butterworth active low pass filter.
2. Design a Notch filter to eliminate power supply hum (50 Hz).
3. Design a first order low pass filter at a cut-off frequency of 2kHz with a pass band gain of 3

Course Outcome 4 (CO4): Explain the working and applications of timer, VCO and PLL ICs .

1. With the help of internal diagram explain the monostable operation of timer IC 555. Draw the input and different output waveforms. Derive the equation for pulse width.
2. Explain the operation of Phase Locked Loop. What is lock range and capture range? Realize a summing amplifier to obtain a given output voltage.
3. Design a circuit to multiply the incoming frequency by a factor of 5 using 565 PLL.

Course Outcome 5 (CO5): Outline the working of Voltage regulator IC's and Data converters

1. What is the principle of operation of Dual slope ADC. Deduce the relationship between analogue input and digital output of the ADC.
2. Explain how current boosting is achieved using I.C 723
3. Explain the working of successive approximation ADC

SYLLABUS

Module 1:

Operational amplifiers (Op Amps): The 741 Op Amp, Block diagram, Ideal op-amp parameters, typical parameter values for 741, Equivalent circuit, Open loop configurations, Voltage transfer curve, Frequency response curve.

Differential Amplifiers: Differential amplifier configurations-Dual input Balanced Output, Dual input Unbalanced Output, Single input Balanced Output, Single input Unbalanced Output- using BJT, Basic Differential pair using BJT- DC Analysis- transfer characteristics; AC analysis- differential and common mode gains, CMRR, input and output resistance, Voltage gain. Virtual ground. Concept of current mirror-the two transistor current mirror, Wilson and Widlar current mirrors.

Module 2:

Op-amp with negative feedback: General concept of Voltage Series, Voltage Shunt, current series and current shunt negative feedback, Op Amp circuits with voltage series and voltage shunt feedback, Virtual ground Concept; analysis of practical inverting and non-inverting amplifiers for closed loop gain, Input Resistance and Output Resistance.

Op-amp applications: Summer, Voltage Follower-loading effects, Differential and Instrumentation Amplifiers, Voltage to current and Current to voltage converters, Integrator, Differentiator, Precision rectifiers, Comparators, Schmitt Triggers, Log and antilog amplifiers.

Module 3:

Op-amp Oscillators and Multivibrators: Phase Shift and Wien-bridge Oscillators, Triangular and Sawtooth waveform generators, Astable and monostable multivibrators.

Active filters: Comparison with passive filters, First and second order low pass, High pass, Band pass and band reject active filters, state variable filters.

Module 4:

Timer and VCO: Timer IC 555- Functional diagram, Astable and monostable operations;. Basic concepts of Voltage Controlled Oscillator and application of VCO IC LM566,

Phase Locked Loop – Operation, Closed loop analysis, Lock and capture range, Basic building blocks, PLL IC 565, Applications of PLL.

Module 5:

Voltage Regulators: Fixed and Adjustable voltage regulators, IC 723 – Low voltage and high voltage configurations, Current boosting, Current limiting, Short circuit and Fold-back protection.

Data Converters: Digital to Analog converters, Specifications, Weighted resistor type and R-2R Ladder type.

Analog to Digital Converters: Specifications, Flash type and Successive approximation type.

Text Books

1. Roy D. C. and S. B. Jain, Linear Integrated Circuits, New Age International, 3/e, 2010

Reference Books

1. DFranco S., Design with Operational Amplifiers and Analog Integrated Circuits, 3/e, Tata McGraw Hill, 2008
2. Gayakwad R. A., Op-Amps and Linear Integrated Circuits, Prentice Hall, 4/e, 2010
3. Salivahanan S. and V. S. K. Bhaaskaran, Linear Integrated Circuits, Tata McGraw Hill, 2008.
4. Botkar K. R., Integrated Circuits, 10/e, Khanna Publishers, 2010
5. C.G. Clayton, Operational Amplifiers, Butterworth & Company Publ. Ltd. Elsevier, 1971
6. David A. Bell, Operational Amplifiers & Linear ICs, Oxford University Press, 2nd edition,2010
7. R.F. Coughlin & Fredrick Driscoll, Operational Amplifiers & Linear Integrated Circuits,6th Edition, PHI,2001
8. . Sedra A. S. and K. C. Smith, Microelectronic Circuits, 6/e, Oxford University Press, 2013.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Operational amplifiers**	**(9)**
1.1	The 741 Op Amp, Block diagram, Ideal op-amp parameters, typical parameter values for 741	1
1.2	Equivalent circuit, Open loop configurations, Voltage transfer curve, Frequency response curve.	1
1.3	Differential amplifier configurations using BJT, DC Analysis- transfer characteristics	2
1.4	AC analysis- differential and common mode gains, CMRR, input and output resistance, Voltage gain	2
1.5	Constant current bias and constant current source	1
1.6	Concept of current mirror, the two transistor current mirror Wilson and Widlar current mirrors.	2
2	**Op-amp with negative feedback and Op-amp applications**	**10**
2.1	General concept of Voltage Series, Voltage Shunt, current series and current shunt negative feedback,	1
2.2	Op Amp circuits with voltage series and voltage shunt feedback, Virtual ground Concept	1
2.3	analysis of practical inverting and non-inverting amplifier	1
2.4	Summer, Voltage Follower-loading effect	1
2.5	Differential and Instrumentation Amplifiers	1

2.6	Voltage to current and Current to voltage converters	1
2.7	Integrator, Differentiator	1
2.8	Precision rectifiers-half wave and full wave	1
2.9	Comparators, Schmitt Triggers	1
2.10	Log and antilog amplifier	1
3	**Op-amp Oscillators and Multivibrators**	9
3.1	Phase Shift and Wien-bridge Oscillators,	2
3.2	Triangular and Sawtooth waveform generators, Astable and monostable multivibrators	2
3.3	Comparison, design of First and second order low pass and High pass active filters	2
3.4	Design of Second Order Band pass and band reject filters	2
3.5	State variable filters	1
4	**Timer, VCO and PLL**	8
4.1	Timer IC 555- Functional diagram, Astable and monostable operations.	2
4.2	Basic concepts of Voltage Controlled Oscillator	1
4.3	application of VCO IC LM566,	2
4.4	PLL Operation, Closed loop analysis Lock and capture range.	1
4.5	Basic building blocks, PLL IC 565, Applications of PLL	2
5	**Voltage regulators and Data converters**	**9**
5.1	Fixed and Adjustable voltage regulators	1
5.2	IC 723 – Low voltage and high voltage configurations,	2
5.3	Current boosting, Current limiting, Short circuit and Fold-back protection.	2
5.4	Digital to Analog converters, Specifications, Weighted resistor type and R-2R Ladder type.	2
5.5	Analog to Digital Converters: Specifications, Flash type and Successive approximation type.	2
	Total	**45**

Assignment:

Assignment may be given on related innovative topics on linear IC, like Analog multiplier- Gilbert multiplier cell, variable trans-conductance technique, application of analog multiplier IC AD633., sigma delta or other types of ADC etc

At least one assignment should be simulation of opamp circuits on any circuit simulation software

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET307

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

Course Name: Analog Integrated Circuits

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1. Draw and list the functions of 741 IC pins K1
2. Define slew rate with its unit. What is its effect at the output signal? K2
3. How the virtual ground is different from actual ground? K2
4. A differential amplifier has a common mode gain of 0.05 and difference mode gain of 1000.Calculate the output voltage for two signals V1 = 1mV and V2 = 0.9Mv K3
5. Design a second order Butterworth Low Pass Filter with f_H= 2KHz K3
6. Draw the circuit of monostable multivibrator using opamp. K1
7. What is the principle of VCO? K1
8. Design a non inverting amplifier for a gain of 11. K3
9. Define the following terms with respect to DAC (i) Resolution (ii) Linearity (iii) Full scale output voltage K2
10. Differentiate between line and load regulations. K3

PART – B

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

Module – I

11. a)	Derive CMRR, input resistance and output resistance of a dual input balanced output differential amplifier configuration.	7	CO1	K3
11. b)	What is the principle of operation of Wilson current mirror and its advantages? Deduce the expression for its current gain.	7	CO1	K2

	OR			
12.a)	Draw the equivalent circuit of an operational amplifier. Explain voltage transfer characteristics of an operational amplifier.	7	CO1	K3
12.b)	Explain the following properties of a practical opamp (i) Bandwidth (ii) Slew rate (iii) Input offset voltage (iv) Input offset current	7	CO1	K2

Module – II

13. a)	Design a fullwave rectifier to rectify an ac signal of 0.2V peak-to-peak. Explain its principle of operation.	7	CO2	K3
13. b)	Draw the circuit diagram of a differential instrumentation amplifier with a transducer bridge and show that the output voltage is proportional to the change in resistance.	7	CO2	K2
	OR			
14.a)	Derive the following characteristics of voltage shunt amplifier: i) Closed loop voltage gain ii)Input resistance iii) Output resistance iv)Bandwidth	7	CO2	K3
14.b)	Explain the working of an inverting Schmitt trigger and draw its transfer characteristics.	7	CO2	K2

Module-III

15 a)	Derive the equation for frequency of oscillation (f0) of a Wein Bridge oscillator. Design a Wein Bridge oscillator for f0 = 1KHz.	7	CO3	K3
15 b)	Derive the equation for the transfer function of a first order wide Band Pass filter.	7	CO3	K3
	OR			
16a	Derive the design equations for a second order Butterworth active low pass filter.	7	CO3	K3
16b	Design a circuit to generate 1KHz triangular wave with 5V peak.	7	CO3	K3

Module-IV

17 a)	Design a circuit to multiply the incoming frequency by a factor of 5 using 565 PLL.	8	CO4	K3
17 b)	With the help of internal diagram explain the monostable operation of timer IC 555. Draw the input and output waveforms. Derive the equation for pulse width.	6	CO4	K2

	OR			
18 a)	Design a monostable multi-vibrator for a pulse duration of 1ms using IC555.	8	CO4	K3
18 b)	Explain the operation of Phase Locked Loop. What is lock range and capture range?	6	CO4	K2

Module-V

19 a)	Explain the working of R-2R ladder type DAC. In a 10 bit DAC, reference voltage is given as 15V. Find analog output for digital input of 1011011001.	7	CO5	K2
19 b)	Explain how short circuit, fold back protection and current boosting are done using IC723 voltage regulator.	7	CO5	K2
	OR			
20 a)	With a functional diagram, explain the principle of operation of Successive approximation type ADC.	7	CO5	K2
20 b)	With a neat circuit diagram, explain the operation of a 3-bit flash converter.	7	CO5	K2

Simulation Assignments (AET307)

The following simulations can be done in QUCS, KiCad or PSPICE. (The course tutor is free to add or modify the list)

1. Design and simulate a BJT differential amplifier. Observe the input and output signals. Plot the AC frequency response.
2. Design and simulate Wien bridge oscillator for a frequency of 10 kHz. Run a transient simulation and observe the output waveform.
3. Design and implement differential amplifier and measure its CMRR. Plot its transfer characteristics.
4. Design and simulate non-inverting amplifier for gain 5. Observe the input and output signals. Run the ac simulation and observe the frequency response and 3− db bandwidth.
5. Design and simulate a 3 bit flash type ADC. Observe the output bit patterns and transfer characteristics
6. Design and simulate R − 2R DAC circuit.
7. Design and implement Schmitt trigger circuit for upper triggering point of +8 V and a lower triggering point of −4 V using op-amps.
8. Design a function generator using Op Amp and observe output waveforms.

AEL331	ANALOG INTEGRATED CIRCUITS AND INSTRUMENTATION LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This course aims to

i) Develop skills in designing and testing analog integrated circuits
ii) Expose the students to a variety of practical circuits using various analog ICs
iii) Understand the working principle of various transducers and their application in engineering

Prerequisite: Nil

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

CO 1	Design the linear and non-linear applications of an opamp and special application ICs.
CO 2	Explain and compare the working of multivibrators using special application IC 555
CO 3	Illustrate the function of application specific ICs such as Voltage regulators, Data converters and PLL.
CO4	Explain the working of various transducers and their applications

Mapping of course outcomes with program outcomes

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
CO 1	3		2	2	3	3		3	3	2		1
CO 2	3		2	2	3	3		3	3	2		2
CO 3	3		2	2	3	3		3	3	2	2	3
CO4	3		2		2	3		3	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)	:	30marks

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

(a) Preliminary work	: 15 Marks
(b) Implementing the work/Conducting the experiment	: 10 Marks
(c) Performance, result and inference (usage of equipments and trouble shooting)	: 25 Marks
(d) Viva voce	: 20 marks
(e) Record	: 5 Marks

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

Part A Analog Integrated Circuits Lab (At least 8 experiments are mandatory)

1. Design and plot the frequency response of i) Inverting and Non inverting amplifiers ii) Differentiator and Integrator.
2. Design of Adder circuits.
3. Measurement of Opamp parameters.
4. Difference Amplifier and Instrumentation amplifier
5. Schmitt trigger circuit using Op –Amps.
6. Astable and Monostable multivibrator using Op -Amps.
7. Triangular and square wave generators using Op- Amps.
8. RC Phase shift Oscillator using Op-Amps
9. Wien bridge oscillator using Op-Amp - without & with amplitude stabilization.
10. Active second order filters using Op-Amp (LPF, HPF, BPF and BSF).
11. Notch filters to eliminate the 50Hz power line frequency.
12. Astable and Monostable multivibrator using Timer IC NE555.
13. IC voltage regulators.
14. A/D converters - Flash type.
15. D/A Converters-R-2R ladder circuit.
16. Study of PLL IC: free running frequency lock range capture range

Part B Instrumentation lab (At least 4 experiments are mandatory)

1. Determination of the characteristics of LVDT
2. Determination of characteristics of temperature sensor (AD590).
3. Determination of the characteristics of thermocouple.
4. Determination of the characteristics of RTD
5. Determination of the characteristics of optical transducers using LDR.
6. Measurement of pressure using piezoelectric pick up.
7. Measurement of strain and load using strain gauges.
8. Level measurement using capacitive transducer

AEL333	EMBEDDED SYSTEMS LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This course aims to

(i) Familiarize the students with Assembly Language Programming of modern microcontrollers.
(ii) Impart the skills for interfacing the microcontroller with the help of Embedded C/Assembly Language Programming.

Prerequisite: Nil

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

CO 1	Write an Assembly language program/Embedded C program for performing data manipulation.
CO 2	Develop ALP/Embedded C Programs to interface microcontroller with peripherals
CO 3	Perform programming/interfacing experiments with IDE for modern microcontrollers.

Mapping of course outcomes with program outcomes

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

Assessment

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

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

(a) Preliminary work : 15 Marks
(b) Implementing the work/Conducting the experiment : 10 Marks

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

(d) Viva voce : 20 marks

(e) Record : 5 Marks

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

PART – A (At least 6 experiments are mandatory)

These experiments shall be performed using 8051 trainer kit. The programs shall be written either in embedded C or in assembly language.

1. Data transfer/exchange between specified memory locations.
2. Largest/smallest from a series.
3. Sorting (Ascending/Descending) of data.
4. Addition / subtraction / multiplication / division of 8/16 bit data.
5. Sum of a series of 8 bit data.
6. Multiplication by shift and add method.
7. Square / cube / square root of 8 bit data.
8. Matrix addition.
9. LCM and HCF of two 8 bit numbers.
10. Code conversion – Hex to Decimal/ASCII to Decimal and vice versa.

PART – B (At least 4 experiments are mandatory.)

Interfacing experiments shall be done using modern microcontrollers such as 8051 or ARM. The interfacing modules may be developed using Embedded C.

1. Time delay generation and relay interface.
2. Display (LED/Seven segments/LCD) and keyboard interface.
3. ADC interface.
4. DAC interface with wave form generation.
5. Stepper motor and DC motor interface.
6. Realization of Boolean expression through port.

SEMESTER V

MINOR

AET381	DIGITAL IMAGE PROCESSING	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble: This course aims to develop a strong understanding of the basic image processing operations.

Prerequisite: AET281Introduction to Signals and Systems

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

CO 1	Explain the fundamental concepts related to digital image processing and generation of digital images.
CO 2	Apply the principles of various 2D transforms in digital image processing.
CO 3	Implement spatial and frequency domain image enhancement techniques using mathematical principles.
CO4	Interpret the techniques involved in image segmentation and image restoration algorithms.
CO5	Compare different techniques involved in image compression and implement the fundamental image processing algorithms on computers.

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				3	3						3
CO 2	3	3			3	3						3
CO 3	3	3			3	3						3
CO 4	3	3			3	3						3
CO5	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 fundamental concepts related to digital image processing and generation of digital images.

1. Explain the fundamental steps in image processing.
2. Explain image digitization.

Course Outcome 2 (CO2): Apply the principles of various 2D transforms in digital image processing.

1. Explain the properties of 2D DFT.
2. Find the KL transform for the given image patch.

Course Outcome 3 (CO3): Implement spatial and frequency domain image enhancement techniques using mathematical principles.

1. Explain the various spatial domain image enhancement techniques.
2. Compare smoothening and sharpening filters.

Course Outcome 4 (CO4): Interpret the techniques involved in image segmentation and image restoration algorithms.

1. Explain region based segmentation.
2. What is image restoration? Give the model of image degradation/restoration process.

Course Outcome 5 (CO5): Compare different techniques involved in image compression and implement the fundamental image processing algorithms on computers.

1. Explain an image compression model.
2. Obtain the Huffman code for the word 'SEGMENTATION'

SYLLABUS

Module 1:

Image fundamentals: Fundamental Steps in Image Processing, Elements of a Digital Image Processing System, Elements of Visual Perception, A Simple Image Model. Digital Image representation- 2D Sampling and Quantization. Two dimensional systems - 2D convolution, 2D correlation. Colour image fundamentals-RGB, CMY, HIS models

Module 2:

Image transforms: Introduction to Fourier Transform, 2D Discrete Fourier Transform and Properties. Haar Transform, Hadamard Transform, Walsh transform, Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) , KL transform and Singular Value Decomposition.

Module 3:

Image Enhancement in spatial domain: Point operations and Neighbourhood Operations , Gray-Level Transformation, Bit plane slicing , Histogram Processing. Spatial filtering- smoothing filters, sharpening filters. Image Enhancement in frequency domain: Low pass and high pass filters, homomorphic filtering.

Module 4:

Image Restoration: Image Degradation model, Types of Image blur, Classification of image restoration Techniques, Estimation of degradation function. Inverse filtering, Weiner filtering.

Image segmentation: Classification of Image segmentation techniques, Type of edges, Edge detection, Segmentation based on thresholding, Region based segmentation, Hough Transform.

Module 5:

Image Compression: Types of redundancy, Image Compression Model, Lossless Compression methods: Arithmetic Coding, Huffman Coding, Vector quantization - Types.

Image compression standards – JPEG &MPEG, Wavelet based image compression, Introduction to fractal image compression.

Text Books

1. Gonzalez Rafel C, Digital Image Processing, Pearson Education, 2009
2. S Jayaraman, S Esakkirajan, T Veerakumar, Digital image processing , Tata Mc Graw Hill, 2015.

Reference Books

1. Anil K Jain , Fundamentals of digital image processing: , PHI,1988
2. Kenneth R Castleman , Digital image processing:, Pearson Education,2/e,2003
3. Pratt William K, Digital Image Processing: , John Wiley,4/e,2007.
4. Milan Sonka et. Al., 'Image Processing, Analysis and Machine Vision', Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Image Fundamentals	
1.1	Fundamental Steps in Image Processing, Elements of a Digital Image Processing System	1
1.2	Elements of Visual Perception, A Simple Image Model.	1
1.3	Digital Image representation- 2D Sampling and Quantization	2
1.4	Two dimensional systems – 2D convolution	2
1.5	2D Correlation	1
1.6	Colour image fundamentals-RGB, CMY, HIS models	2
2	**Image transforms**	
2.1	Introduction to Fourier Transform, 2D Discrete Fourier Transform and Properties.	2
2.2	Hadamard Transform, Walsh transform, Discrete Cosine Transform (DCT), Haar Transform	4
2.3	Discrete Wavelet Transform (DWT)	1
2.4	KL transform and Singular Value Decomposition.	2
3	**Image Enhancement**	
3.1	Point operations and Neighbourhood Operations , Gray-Level Transformation, Bit plane slicing	2
3.2	Histogram Processing	2
3.3	Spatial filtering- smoothing filters, sharpening filters	1
3.4	Image Enhancement in frequency domain: Low pass and high pass filters, homomorphic filtering.	2
4	**Image Restoration**	
4.1	Estimation of degradation function, Image Degradation model	2
4.2	Types of Image blur, Classification of image restoration Techniques.	2
4.2	Inverse filtering, Weiner filtering	1
4.3	**Image segmentation**: Classification of Image segmentation techniques, Type of edges	2
4.4	Edge detection	1
4.5	Segmentation based on thresholding, Region based segmentation.	2

4.6	Hough Transform	1
5	**Image Compression**	
5.1	Types of redundancy, Image Compression Model	2
5.2	Lossless Compression methods : Arithmetic Coding, Huffman Coding	2
5.3	Vector quantization - Types	1
5.5	Image compression standards -JPEG &MPEG	2
5.4	Wavelet based image compression.	1
5.5	Introduction to fractal image compression.	1

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET381

Program: Applied Electronics and Instrumentation Engineering

Course Name: Digital Image Processing

Max. Marks : 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	Explain the fundamental steps in image processing.		CO1
2	What is image digitization?		CO1
3	For the image segment I $=\begin{bmatrix} 2 & 2 \\ 1 & 3 \end{bmatrix}$, compute the transform coefficients using DFT.		CO2
4	What are orthogonal transforms?		CO2
5	Distinguish between unsharp masking and high boost filtering.		CO3
6	What is histogram equalization?		CO3
7	Give the model of image degradation/restoration process and explain.		CO4
8	Mention the different types of edges in an image.		CO4
9	State and explain the state of redundancies in images.		CO5
10	Draw the block diagram of an image compression model.		CO5

PART – B

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

Module – I

11. a)	State and explain 2D sampling theorem for band limited images.	8	CO1	K2
11. b)	Explain how colour images are represented using HSI colour space model.	6	CO1	K2
	OR			
12.a)	An image $f(x, y) = 2 \cos 2\pi (3x + 4y)$ is sampled with sampling intervals $\Delta x = 0.2$ and $\Delta y = 0.2$ in x and y direction respectively. Determine the i) Sampled image spectrum ii) Fourier transform of image after it has been low pass filtered iii) Reconstructed image. Will the system produce aliasing error?	7	CO1	K2
12.b)	Explain the basic elements in a digital image processing system.	7	CO1	K2

Module – II

13. a)	State and prove any two properties of 2D DFT.	4	CO2	K1
13. b)	Find the DCT of the sequence x(n) = {11,22,33,44}	10	CO2	K2
	OR			
14.a)	Perform KL transform of the following matrix $X = \begin{matrix} 4 & -1 \\ -2 & 3 \end{matrix}$	10	CO2	K2
14.b)	Define the energy compaction property of a unitary transform.	4	CO2	K1

Module-III

15. a)	Given an image in which the stars are barely visible, owing to superimposed illumination resulting from atmospheric dispersion. Give an enhancement procedure based on homomorphic filtering to bring out the image components due to the stars themselves.	10	CO3	K3
15. b)	Briefly explain the various image enhancement operations in spatial domain.	4	CO3	K2
	OR			
16.a)	What are the advantages of filtering in frequency domain?	4	CO3	K2

16.b)	A 4 x 4 image patch (4 bits/pixel) is given by $I=\begin{bmatrix} 12 & 9 & 12 & 10 \\ 12 & 14 & 8 & 10 \\ 9 & 13 & 12 & 10 \\ 12 & 14 & 12 & 10 \end{bmatrix}$ Apply histogram equalization to the image by rounding the resulting image pixels to integers. Sketch the histograms of original image and histogram equalised image.	10	CO3	K3

MODULE IV

17. a)	Explain the Wiener filter for image restoration. State the advantages and disadvantages of wiener filter.	8	CO4	K2
17. b)	Explain split and merge procedure in image segmentation.	6	CO4	K2
	OR			
18.a)	Explain how a degraded image can be restored using an inverse filter. Explain its limitations.	7	CO4	K2
18.b)	How edge detection is performed in images?	7	CO4	K2

MODULE – V

19. a)	With the help of a block diagram, explain DCT based JPEG compression standard.	6	CO5	K2
19. b)	Explain the analytics of Arithmetic Coding based Compression.	8	CO5	K3
	OR			
20.a)	Obtain the Huffman code for the word 'SEGMENTATION'	8	CO5	K3
20.b)	Discuss Vector quantization.	6	CO5	K2

	OR			
16.a)	Explain the advantages of filtering in frequency domain?	4	CO3	K2
16.b)	A 4 x 4 image patch (4 bits/pixel) is given by I= $\begin{bmatrix} 12 & 9 & 12 & 10 \\ 12 & 14 & 8 & 10 \\ 9 & 13 & 12 & 10 \\ 12 & 14 & 12 & 10 \end{bmatrix}$ Apply histogram equalization to the image by rounding the resulting image pixels to integers. Sketch the histograms of original image and histogram equalised image.	10	CO3	K3

Module IV

17. a)	Explain the Wiener filter for image restoration. State the advantages and disadvantages of wiener filter.	8	CO4	K2
17. b)	Explain split and merge procedure in image segmentation.	6	CO4	K2
	OR			
18.a)	Explain how a degraded image can be restored using an inverse filter. Explain its limitations.	7	CO4	K2
18.b)	How edge detection is performed in images?	7	CO4	K2

Module – V

19. a)	With the help of a block diagram, explain DCT based JPEG compression standard.	6	CO5	K2
19. b)	With a suitable example, discuss Vector quantization	8	CO5	K3
	OR			
20.a)	Obtain the Huffman code for the word 'SEGMENTATION'	8	CO5	K3
20.b)	Explain the analytics of Arithmetic Coding based Compression.	6	CO5	K2

AET383	POWER ELECTRONICS	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble: This course aims to develop the skill of the design of various power electronic circuits.

Prerequisite: AET284- INTRODUCTION TO ANALOG CIRCUITS

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

CO 1	Explain the characteristics of important power semiconductor switches	K2
CO 2	Explain the principle of drive circuits and snubber circuits for power semiconductor switches	K2
CO 3	Build diode bridge rectifiers and Controlled rectifiers	K3
CO4	Explain the principle of DC – DC Switch-Mode Converter.	K2
CO 5	Illustrate the principle of DC – AC Switch-Mode Inverter	K2
CO 6	Apply the principle of power electronics for various applications.	K3

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10marks

Continuous Assessment Test(2numbers) : 25 marks

Assignment/Quiz/Courseproject : 15marks

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the characteristics of important power semiconductor switches.

1. Illustrate the static and dynamic characteristics, Power BJT, Power MOSFET and IGBT.
2. Evaluate the switching losses of the Power diode, Power BJT, Power MOSFET.
3. Model and simulate power semiconductor switches.

Course Outcome 2 (CO2) : Explain the principle of drive circuits and snubber circuits for power semiconductor switches.

1. Explain the base drive circuits for Power BJT.
2. Explain the gate drive circuits forPower MOSFET.
3. Outline the principle of snubber circuits for power switches.
4. Model and simulate above circuits.

Course Outcome 3 (CO3): Build diode bridge rectifiers and Controlled rectifiers.

1. Explain the operation of diode rectifiers and the effect of various loads on the rectifier function.
2. Explain the operation of controlled rectifiers and the effect of various loads on the rectifier function.
3. Model and simulatediode rectifiers and controlled rectifiers for various loads

Course Outcome 4 (CO4): Explain the principle of DC – DC Switch-Mode Converter

1. Illustrate the principle of DC-DC converters under steady state conditions.
2. Model and simulate non-isolated and isolated DC-DC Switch-Modeconverters

Course Outcome 5 (CO5): Illustrate the principle of DC – AC Switch-Mode Inverter.

1. Explain the different types of inverters
2. Construct Driven Inverters for given specifications.
3. Model and simulateDriven Inverters

Course Outcome 6 (CO6) : Apply the principle of power electronics for various applications.

1. Illustrate the principle of Adjustable-speed DC drive.
2. Explain the principle of Variable frequency PWM-VSI Induction Motor drives
3. Give applications of power electronic circuits for residential applications.
4. Explain applications of power electronic circuits for industrial applications

SYLLABUS

Module 1:
Power Semiconductor Switches: Overview of Power electronics application, Power diodes and Bipolar power transistors, Power MOSFET and IGBT,SCR and GTO

Module 2:
Protection circuits and Rectifiers: BJT and MOSFET driver circuits, Semiconductor device temperature control, Single phase and three phase diode bridge rectifiers, Single phase and three phase Controlled rectifiers.

Module 3:
DC – DC Switch-Mode Converter: Buck, Boost and Buck-Boost converters underContinuous conduction mode, Isolated Converters: Forward, Push-Pull, Half bridge and Full bridge configurations, Selection of power switches, Switched Mode Power Supply.

Module 4:
DC – AC Switch-Mode Inverter: Inverter topologies, Driven Inverters: Push-Pull, Half bridge and Full bridge configurations, Three phase Inverter, Pulse width modulation.

Module 5:
Applications: DC Motor Drives, Induction Motor Drives, Residential and Industrial applications, Electric utility applications.

Text Books

1. Mohan N. and T. M. Undeland, Power Electronics: Converters, Applications and Design, John Wiley, 2015
2. Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015.

Reference Books

1. Rashid M. H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi.
2. Daniel W. Hart, Power Electronics, McGraw Hill, 2011.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Power Semiconductor Switches**	
1.1	Power electronics versus Linear Electronics, Overview of Power electronics application	1
1.2	Power diodes and Bipolar power transistors, structure	3
1.3	Power MOSFET and IGBT - structure	3
1.4	SCR and GTO – construction and characteristics	2
2	**Protection circuits and Rectifiers**	
2.1	BJT and MOSFET driver circuits (one circuits each)	2
2.2	Semiconductor device temperature control	2
2.3	Single phase and three phase diode bridge rectifiers – basic principles only	2
2.4	Single phase and three phase Controlled rectifiers (with R, RL & RLE loads) – basic principles only	3
3	**DC – DC Switch-Mode Converter**	
3.1	Buck, Boost and Buck-Boost DC-DCconverters	2
3.2	Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode. (Derivation not required)	2
3.3	Isolated Converters : Forward, Push-Pull, Half bridge, and Full bridge configurations, waveforms and design equations. (Derivation not required)	3
3.4	Selection of power switches	1
3.5	Switched Mode Power Supply, Principles of PWM switching schemes	1
4	**DC – AC Switch-Mode Inverter**	
4.1	Inverter topologies	2
4.2	Driven Inverters : Push-Pull, Half bridge and Full bridge configurations	2
4.3	Three phase Inverter	2
4.4	Sinusoidal PWM in three phase inverters	3
5	**Applications**	

5.1	DC Motor Drives – Adjustable-speed DC drive	2
5.2	Induction Motor Drives – Variable frequency PWM-VSI drives	3
5.3	Residential and Industrial applications	2
5.4	Electric utility applications	2

Assignment:

Atleast one assignment should be simulation of power electronic circuits using any circuit simulation software

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH. DEGREE EXAMINATION

Course Code: AET 383

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

Course Name: Power Electronics

Max. Marks: 100 Duration: 3 Hours

	PART A Answer ALL Questions. Each Carries 3 mark.		
1.	What is the switching losses in a power diode ?	K3	CO1
2	What is the tail current in IGBT ?	K2	CO1
3	What is the purpose of snubbercircuits ?	K2	CO2
4	Obtain the expression for average load voltage in three phase full wave bridge rectifier	K3	CO3
5	What is volt-second balancing?	K2	CO4
6	What is the flux walking problem in push-pull converter ?	K2	CO4
7	What is the distinction between chopper, oscillators and inverters ?	K3	CO5
8	Distinguish between driven and self-driven inverters.	K2	CO5
9	How converters are used in induction heating ?	K2	CO6
10	What is the principle of harmonic filters ?	K2	CO6

	PART – B Answer one question from each module; each question carries 14 marks.			
	Module – I			
11. a)	Compare and contrast power BJT, MOSFET and IGBT for switching applications	7	CO1	K2
11. b)	A diode and a 10 Ω resistor are connected in series to a square wave voltage source of 50V peak. The reverse recovery time for the diode is 200nsec. Find the switching loss of the diode when the input frequency is 100 KHz.	7	CO1	K3
	OR			
12.a)	With the two transistor model of SCR, explain the working principle of SCR	7	CO1	K2
12.b)	Illustrate the dynamic characteristics of GTO	7	CO1	K2
	Module – II			
13.a)	Illustrate the base current requirement of power BJT	7	CO2	K2
b)	Explain the operation of any one of the power BJT base drive circuit	7	CO2	K2
	OR			
14.a)	Illustrate the principle of operation of a single-phase, 2 pulse, fully controlled rectifier for RL load with circuit diagram and waveforms.	10	CO3	K2
b)	Deduce the expression for average load voltage in the circuit.	4	CO3	K2

	Module – III			
15 a)	Explain the operation of Buck-Boost converter and illustrate the operation with the inductor current and switching waveforms.	8	CO4	K2
b)	A Buck-Boost converter that switching at 50 KHz is supplied with an input voltage that varies between 5V to 10V. The output is required to be regulated at 15V. A load resistor of 15Ω is connected across the output. If the maximum allowable inductor current ripple is 10% of the average inductor current, estimate the value of the inductance to be used in the Buck-Boost converter.	6	CO4	K3
	OR			
16 a)	Describe the principle of operation of the full-bridge converter with circuit diagram and waveforms.	8	CO4	K2
b)	How is the flux walking problem solved in full-bridge converter ?	6	CO4	K2
	Module – IV			
17 a)	Explain the operation of push-pull inverter	8	CO5	K2

	b)	Illustrate the PWM switching scheme for sine wave output of the inverter	6	CO5	K2
		OR			
18	a)	Enumerate the principle of operation ofthree phase inverters	8	CO5	K2
	b)	Explain sinusoidal pulse width modulation in three phase inverters	6	CO5	K2
		Module – V			
19	a)	Explain the principle of adjustable speed DC drive using switched mode DC-DC converter.	8	CO6	K2
	b)	Compare adjustable speed DC drives using switched mode DC-DC converter and line frequency controlled converter.	6	CO6	K2
		OR			
20	a)	Illustrate the principle of operation of Variable frequency PWM-VSI Induction Motor drive.	9	CO6	K2
	b)	Explain regenerative braking scheme in Induction Motor drive.	5	CO6	K2

AET385	CONTROL SYSTEMS	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble: This course aims to analyze and design control systems.

Prerequisite: ECT205: NETWORK THEORY

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

CO 1	Analyze the control systems by transfer function approach.
CO 2	Get an adequate knowledge in the time response of systems & steady state error analysis
CO 3	Learn the concept of stability of control systems and methods of stability analysis.
CO 4	Analyze the control systems using frequency domain method.
CO 5	Design of basic control actions and controller characteristics.

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	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	10	10	20
Understand	K2	10	10	20
Apply	K3	30	30	60
Analyze	K4			
Evaluate	K5			
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 in Part A. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

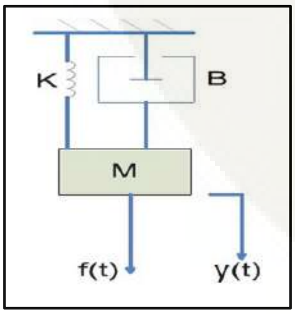
Course Level Assessment Questions

Course Outcome 1 (CO1): Analyze the control systems by transfer function approach

1. Define closed loop transfer function and obtain the general equation for the characteristic equation of a system.
2. Explain the terms transmittance and non touching loops with respect to signal flow graphs.

3. (i) Find ***y(t)***, for the given, $Y(s) = \frac{9}{s(s+0.2)(s+3)}$

   (ii) Obtain the transfer function $\frac{Y(s)}{F(s)}$ for $f(t) = 1$, for the $Y(s)$ given in the above question. If the obtained transfer function represents the transfer function of a mass-spring-damper system as shown in Figure, find the values of **M, B and K** and also draw its **equivalent force - voltage analogous circuit** clearly writing the numerical values of **R, L and C.**



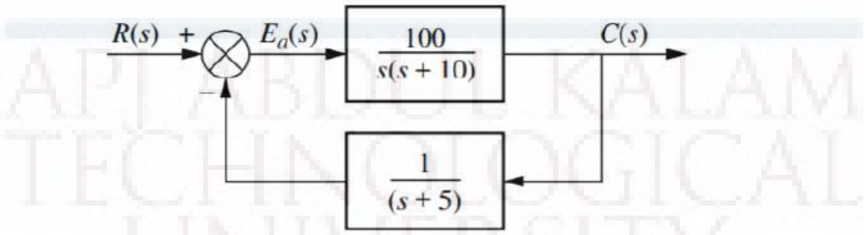
Course Outcome 2 (CO2): Get an adequate knowledge in the time response of systems and steady state error analysis

1. Obtain the ramp response of a general first order system with unity system gain and time constant of 2 seconds. Also draw first order system time response.

2. Derive the expression for the step response of a second order underdamped system as given below:

$$c(t) = 1 - e^{-\zeta\omega_n t}\left[\cos\omega_d t + \frac{\zeta}{\sqrt{1-\zeta^2}}\sin\omega_d t\right]$$

3. Find the numerical value of steady state error associated with the system shown below for a unit step input.



4. Derive the expression for the maximum percentage overshoot of the second order underdamped system as given below.

$$M_p = e^{-\frac{\zeta\pi}{\sqrt{1-\zeta^2}}} \times 100$$

Course Outcome 3 (CO3): Learn the concept of stability of control systems and methods of stability analysis.

1. Explain briefly the conditions that is to be satisfied for a system to be

   (c) Absolutely stable

   (d) Marginally stable

2. For the transfer function given below, determine how many poles are in the right half s-plane, left half s-plane and on the jω axis.

$$T(s) = \frac{20}{s^8 + s^7 + 12s^6 + 22s^5 + 39s^4 + 59s^3 + 48s^2 + 38s + 20}$$

3. For a unity feedback system, the open loop transfer function is given by

$$G(s)H(s) = \frac{K}{s(s+2)(s^2+6s+25)}$$

   (d) Sketch the root locus

   (e) At what value of K, the system becomes unstable?

   (f) At this point of instability, determine the frequency of oscillation of the system.

Course Outcome 4 (CO4): Analyze the control systems using frequency domain method.

1. Define the frequency domain specifications

   (d) Resonant peak

   (e) Resonant frequency

(f) Bandwidth

Also obtain the expressions for the above for a second order underdamped system

$$T(s) = \frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\delta\omega_n s + \omega_n^2}$$

with transfer function

2. Draw the Bode plot of the system given below. Also find the Gain margin and

$$G(s)= \frac{75(1+0.2s)}{s(s^2+16s+100)}.$$

Phase margin.

3. State and explain Nyquist Stability criteria.

4. The open loop transfer function **for an unmanned under water vehicle** is given by

$$G(s) = \frac{20}{s(1+as)(1+0.02s)}$$

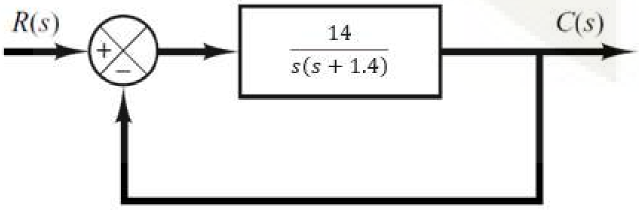
(c) At a frequency of 3 rad/sec, it is known that the gain of the system is 5, hence calculate the value of "a".

(d) Estimate the **phase margin** for the above value of "a" **without drawing Nyquist Plot.**

Course Outcome 5 (CO5): Design of basic control actions and controller characteristics.

1. Obtain the transfer function of a PD controller. Draw its controller characteristics. How the system performance is improved by including the derivative controller?

2. A closed loop control system with unity feedback is shown in Figure. By using the derivative control, the damping ratio is to be made 0.7. Determine **the derivative rate feedback □□ and the derivative time □□.**



3. Draw the circuit diagram of the **PID controller** using a single opamp, resistors and capacitors. Obtain the values of □□, □□ □□□ □□ in terms of □ and □.

4. Briefly explain the principle of **Proportional plus Integral** controller and obtain its transfer function. Also draw the **PI controller characteristics**.

SYLLABUS

Module 1:

System modelling - Transfer function approach:

Introduction to control systems – Classification of control systems. Principles of automatic control. Feedback control systems – Practical examples – Transfer function – Transfer function of electrical, mechanical and electromechanical systems – Block diagram – Signal flow graph – Mason's gain formula.

Module 2:

Time domain analysis:

Standard test signals - Response of systems to standard test signals – Step response of second order systems in detail – Time domain specifications – delay time, rise time, peak time, maximum percentage overshoot and settling time. Steady state response – Steady state error- Static & Dynamic error coefficients.

Module 3:

Stability of linear systems in time domain:

Asymptotic and BIBO stability, Routh-Hurwitz criterion of stability. Root locus - Construction of root locus – Effect of addition of poles and zeros on root locus.

Module 4:

Frequency domain analysis:

Frequency response – Frequency domain specifications – Stability in the frequency domain- Nyquist stability criterion – Stability from polar and Bode plots - Relative stability – Gain margin and phase margin – M & N circles – Nichol's chart.

Module 5:

Controller Design:

Basic Control actions and Controller characteristics: Classification of Controllers, Two position control, proportional, integral and derivative controllers. Integral control action and derivative control action. Electronic Controllers- Design of PI, PD and PID controllers using opamp.

Text Books

1. S. Hassan Saeed, Automatic Control Systems (with MATLAB programs), KATSON Books.
2. Norman S Nise, Control System Engineering, Sixth Edition.

Reference Books

1. Katsuhiko Ogata, Modern Control Engineering, Pearson Education.
2. M. Gopal, Control Systems, McGraw Hill Education India Education, 2012.
3. B.C. Kuo, PHI, Automatic Control Systems.
4. Richard C Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2001.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**System modelling - Transfer function approach:**	
1.1	Introduction to control system – Classification of control systems.	1
1.2	Principles of automatic control.	1
1.3	Feedback control systems – Practical examples	1
1.4	Transfer function – Transfer function of electrical and mechanical systems	2
1.5	Transfer function of electromechanical systems	1
1.6	Block diagram reduction Techniques	1
1.7	Signal flow graph – Mason's gain formula.	2
2	**Time domain analysis:**	
2.1	Standard test signals - Response of systems to standard test signals	1
2.2	Step response of second order systems in detail	2
2.3	Time domain specifications – delay time, rise time, peak time, maximum percentage overshoot and settling time. Example problems.	4
2.4	Steady state response – Steady state error	1
2.5	Static & Dynamic error coefficients.	2
3	**Stability of linear systems in time domain:**	
3.1	Asymptotic and BIBO stability	1
3.2	Routh-Hurwitz criterion of stability	1
3.3	Root locus - Construction of root locus	3
3.4	Root locus- Examples	2
3.5	Effect of addition of poles and zeros on the root locus	1
4	**Frequency domain analysis:**	
4.1	Frequency response – Frequency domain specifications	1
4.2	Stability in the frequency domain - Nyquist stability criterion. Examples.	3
4.3	Relative stability – Gain margin and phase margin. Examples.	2
4.4	M & N circles – Nichol's chart.	2
5	**Basic Control actions and Controller characteristics:**	
5.1	Classification of Controllers, Two position control, proportional, integral and derivative controllers.	3
5.2	Controller characteristics: Proportional, Integral and Derivative Controllers	2
5.3	Design of PI, PD and PID controllers using opamp	3
5.4	Integral Control Action and Derivative Control Action	2

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET385

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

Course Name: Control Systems

Max. Marks: 100 Duration: 3 Hours

PART A

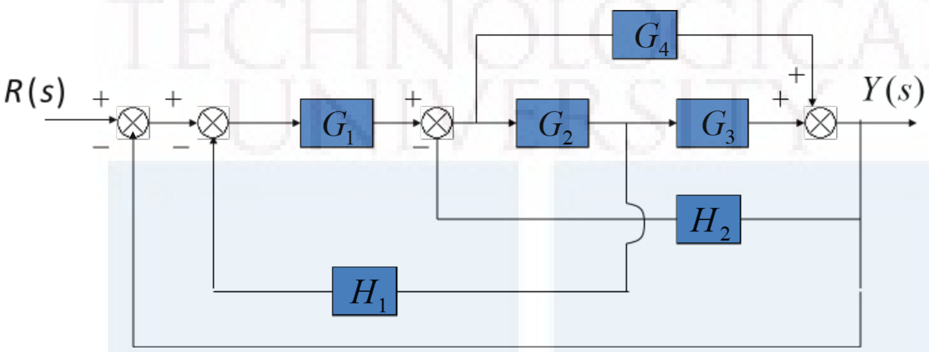
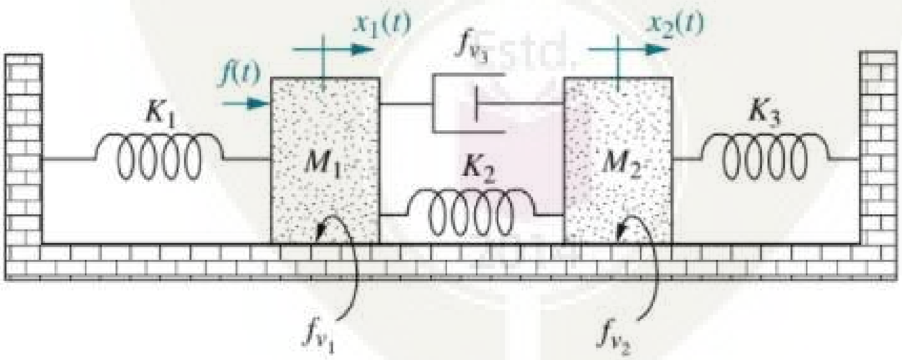
Answer ALL Questions. Each Carries 3 mark.

1.	Write the Force – Current analogies for Mass, Spring constant and Damping coefficient of a mechanical system.	K1
2	Derive the expression for closed loop transfer function.	K2
3	Impulse response of a 1st order system is given below: $c(t) = 3e^{-0.5t}$ Find out (a) Time constant T (d) D.C Gain K (e) Transfer Function	K3
4	Write the expressions for □□, □□ □□□ □□, for a given system with open loop transfer function G(s)	K1
5	What is the inference of having all the elements of a row as zeroes in the Routh Table?	K2
6	Write the angle and magnitude conditions for constructing the root locus of a system.	K1
7	Briefly explain the steps for drawing a polar plot.	K2
8	Define (i) Gain cross over frequency (ii) Phase cross over frequency and (iii) Phase Margin	K1
9	Briefly describe the derivative control action. What is the disadvantage of using the derivative controller alone?	K2
10	Draw the circuit diagram of the PID controller using a single opamp, resistors and capacitors. Obtain the values of □□, □□ □□□ □□ in terms of □ and □.	K2

PART – B

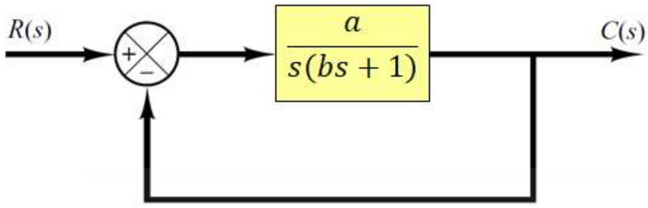
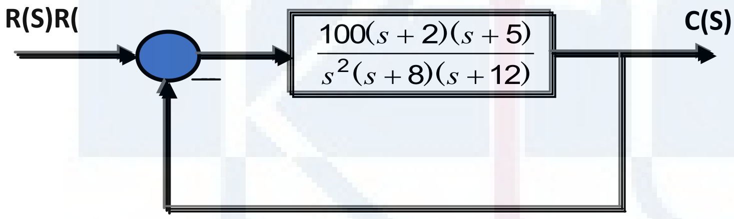
Answer one question from each module; each question carries **14 marks**.

Module – I

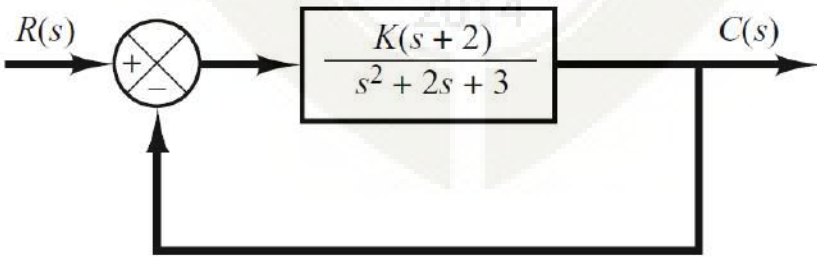
11.a)	Write any 2 advantages and disadvantages of closed loop control systems	4	CO1	K1
11.b)	Using block diagram reduction technique, find the overall transfer function of the system shown below: 	10	CO1	K3
	OR			
12.a)	Draw the free-body diagrams of masses M1 and M2, for the system shown below	4	CO1	K1
12.b)	For the mechanical system shown, draw the Force - Current analogous system, after clearly writing the equations of motion for each mass. 	10	CO2	K3

Module – II

13 a)	For the system represented by the block diagram given below, **determine the values** of ‘□’ and ‘□’ to yield a unit step response, with maximum percentage overshoot of *5* and undamped natural frequency (□□) as 2 rad/sec.	10	CO2	K3

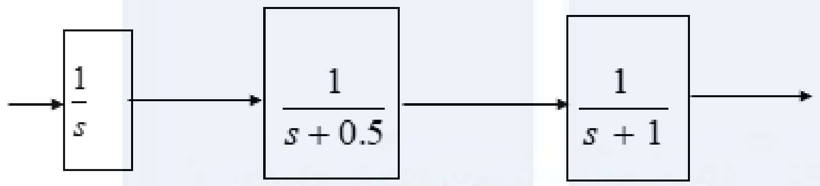
				
13 b)	For the obtained values of '□' and '□', in the above question, find the **risetime** and **settling time** for a **2%** criterion.	4	CO2	K1
	OR			
14 a)	What are the 4 standard test signals used in control systems. Write the Laplace Transform of the above test signals.	4	CO2	K1
14 b)	For the system shown in figure below, evaluate the static error constants and find the expected steady state errors for the standard step, ramp and parabolic inputs. 	10	CO2	K3

Module – III

15 a)	State and explain the Routh Hurwitz criteria for stability analysis	5	CO3	K2
15 b)	Sketch the complete root locus of the system shown below: 	9	CO3	K3
	OR			
16 a)	Write the 9 rules for construction of root locus.	5	CO3	K2

16 b)	Sketch the root locus for the transfer function given below in a graph sheet $$G(s)H(s) = \frac{K}{s(s+1)(s+5)}$$ Add a zero at s = -2, to the above transfer function and draw the root locus. Also clearly specify the effect of adding the zero to the transfer function.	9	CO3	K3

Module – IV

17	Sketch the asymptotic bode plot of the open loop system for a system represented by block diagram shown in Figure. Estimate the gain and phase margin of the system and calculate the phase crossover frequency and gain crossover frequency.  	14	CO4	K3
	OR			
18	The open loop transfer function of a control system is given by $$G(s) = \frac{K}{s(s+2)(s+10)}$$ Determine the value of K so that the system will be stable with (c) Gain Margin = 6 dB (d) Phase Margin = 45^0	14	CO4	K3

Module – V

19	Consider a second order process with the transfer function □(□) = □ / (□² + □₁□ + □₂) The closed loop system with a PI controller is a third order system. Show that it is possible to position the closed loop poles as long as the sum of the poles is $-$□₁. **Give equations** for the parameters that give the **closed loop characteristic polynomial** (□ + □₀)(□² + 2□₀□₀□ + □₀²) Express □□ □□□ □□ in terms of □₀ , □₀ □□□ □₀	14	CO5	K3
	OR			
20	Consider a system with the transfer function: $$P(s) = (s+1)^{-2}$$	14	CO5	K3

	Find an integral controller that gives a closed loop pole at □ = −□ and **determine the value of** □ that maximizes the integral gain. Assume that the integral gain is given by $□_□(□) = \frac{□}{□(−□)}$ **Determine also the other poles of the system.**			

SEMESTER V

HONOURS

AET393	OPTIMIZATION TECHNIQUES	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to provide abroad picture of various applications of optimization methods used in engineering.

Prerequisite: NIL

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

CO 1 K4	Formulate and classify different optimisation problems.
CO 2 K3	Apply classical and numerical methods solving linear and non-linear optimisation problems.
CO 3 K3	Apply modern methods of optimisation for solving optimisation problems.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember K1	10	10	10
Understand K2	20	20	20
Apply K3	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Formulate optimisation problems. (K3)

1. Understand the different classification of optimization problems
2. Apply basic concepts of mathematics to formulate an optimization problem.
3. Formulation of real world problems as linear programming problems.

Course Outcome 2 (CO2) : Obtain optimised solution using classical methods for constrained and unconstrained problems. (K3)

1. Identify extreme points of a given function and classify as minimum, maximum or saddle point.
2. Formulate Lagragian equation for constrained problems and solution using KKT conditions.
3. Find optimum solution using Simplex method for the given problem.

Course Outcome 2 (CO2): Obtain optimised solution using numerical methods for non-linear problems. (K3)

1. Apply elimination search and direct root methods for finding the optimal solution
2. Find optimal point of a given function using gradient methods.

Course Outcome 3 (CO3): Apply modern methods of optimisation for solving optimisation problems. (K3)

1. Explain different steps in the genetic algorithm.
2. Evaluate the strategies to be adopted for players using game theory.
3. Using algorithms find minimum spanning tree and shortest distance for given network path.
3. Two identical sections of the given networks are connected in parallel. Obtain the two port network parameters of the combination.

SYLLABUS

Module 1 : Introduction to classical method

Engineering applications of optimization, Formulation of design problems as mathematical programming problems.

Classification of optimization problems/techniques.

Classical optimization: unconstrained single and multivariable optimisation, Constrained optimization.

Module 2 : Linear programming problems

Mathematical formulation of LP Problems, Solving using Simplex method and Graphical method

Module 3 : Game Theory, Network path models

Game Theory: Introduction, 2- person zero – sum game -Saddle point; Mini-Max and Maxi-Min Theorems (statement only)- Graphical solution (2x n, m x 2 game), dominance property.

Introduction to network tree - Minimal Spanning Tree - Prim's Algorithm.

Shortest path problems- solution methods – Dijkstra's Method.

Module 4 : Nonlinear unconstrained optimization

Single variable optimization methods- Fibonacci search method, Newton Raphson method

Multi-variable methods- Hook-Jeeves pattern search method, Cauchy's (steepest descent) method

Module 5 : Modern methods of optimization

Introduction to Genetic algorithm, Basic GA framework

GA operators: Encoding, Crossover, Selection, Mutation

Introduction to Fuzzy logic. Fuzzy sets and membership functions. Operations on Fuzzy sets. Optimization of Fuzzy Systems.

Text Books

1. S.S.Rao, Engineering Optimization.; Theory and Practice; Revised 3rd Edition, New Age International Publishers, New Delhi

2. H.A. Taha, " Operations Research", 5/e, Macmillan Publishing Company, 1992.

Kanti Swarup, P.K.Gupta and Man Mohan, Operations Research, Sultan Chand and Sons

Reference Books

1. Kalynamoy Deb. "Optimization for Engineering Design- Algorithms and Examples", Prentice-Hall of India Pvt. Ltd., New Delhi.

2. A. Ravindran, D. T. Phillips, J. J. Solberg, Operations Research – Principles and Practice, John Wiley and Sons.

3.. Ashok D Belegundu, Tirupathi R Chandrupatla, "Optimization concepts and Application in Engineering", Pearson Education.

4. Hadley, G. "Linear programming", Narosa Publishing House, New Delhi

5. J. S. Arora, Introduction to Optimum Design, McGraw-Hill Book Company.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to classical method**	
1.1	Engineering applications of optimization, Formulation of design problems as mathematical programming problems, objective function, constraints	1
1.2	Classification of optimization problems/techniques.	1
1.3	**Classical optimization**: unconstrained single and multivariable minimization necessary and sufficient conditions for optimality,	3
1.4	**Constrained optimization:** Lagrangian method - Sufficiency conditions - Kuhn-Tucker optimality conditions.	3
		8
2	**Linear programming problems**	
2.1	Mathematical formulation of LP Problems	1
2.2	Slack, surplus and artificial variables, Reduction of a LPP to the standard form, feasible solutions.	1
2.3	Graphical solution method	2
2.4	simplex algorithm and solution using tabular method,	2
2.5	optimality conditions and degeneracy	1
2.6	Duality in linear programming	2
		9
3	**Game Theory, Network path models**	
3.1	Game Theory: Introduction, 2- person zero – sum game	1
3.2	Saddle point; Mini-Max and Maxi-Min Theorems (statement only)	2
3.3	Graphical solution (2x n, m x 2 game), dominance property.	2
3.4	Introduction to network tree	1
3.5	Minimal Spanning Tree - Prim's Algorithm.	1
3.6	Shortest path problems- solution methods – Dijkstra's Method	1
		8
4	**Nonlinear unconstrained optimization**	
4.1	Single variable optimization methods- Fibonacci search method,	3
4.2	Newton Raphson method	3
4.3	Multi-variable methods- Hook-Jeeves pattern search method,	3
4.4	Cauchy's (steepest descent) method	2
		11
5	**Modern methods of optimization**	
5.1	Introduction to Genetic algorithm, Basic GA framework	1
5.2	GA operators: Encoding, Crossover, Selection, Mutation	2
5.3	Introduction to Fuzzy logic.	1
5.4	Fuzzy sets and membership functions.	1
5.5	Operations on Fuzzy sets.	2
5.6	Optimization of Fuzzy Systems	2
		9

Simulation Assignments:

Atleast one assignment should be simulation of optimization Problems using MATLAB/Scilab/Python. The following simulations .

1. Find the solution of the linear programming problem using simplex method.

$$\text{Minimize } f = -x_1 - 2x_2 - x_3$$

subject to

$$2x_1 + x_2 - x_3 \leq 2$$
$$2x_1 - x_2 + 5x_3 \leq 6$$

Refer MATLAB Solution of LP Problems SS Rao.

2.

In an interval reduction problem, the initial interval is given to be 4.68 units. The final interval desired is 0.01 units. Find the number of interval reductions using Fibonacci method.

Ashok D. Belegundu, Tirupathi R. Chandrupatla

3.

Given $f = x_1^2 + 2x_2^2 + 2x_1x_2$, a point $\mathbf{x}^1 = (0.5, 1)^T$, with $f_1 \equiv f(\mathbf{x}^1) = 3.25$, apply the Hooke and Jeeves algorithm. Assume step $s = 1$, $r = 0.25$, $\varepsilon = 0.001$, $\alpha = 1$.

Ashok D. Belegundu, Tirupathi R. Chandrupatla

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET393

Course Name: OPTIMIZATION TECHNIQUES

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	are the necessary and sufficient conditions for the relative minimum of a function of a single variable?	K2
2	Find the extreme points of the function $f(x_1, x_2) = x_1^3 + x_2^3 + 2x_1^2 + 4x_2^2 + 6$	K3
3	Give five typical applications of optimization techniques in engineering discipline.	K1
4	What is the significance of gradient function in minimization problem?	K2
5	State the duality principle and write the dual of the following LPP. Minimize $Z = 24x_1 + 30x_2$ subject to $2x_1 + 3x_2 \geq 10, 4x_1 + 9x_2 \geq 15, 6x_1 + 6x_2 \geq 20, x_1, x_2 \geq 0$	K3
6	Write a short note on Dijkstra's shortest path algorithm	K1
7	Explain the transformations needed to represent an LPP in standard form	K1
8	State dominance property in game theory	K1
9	Discuss membership function in fuzzy logic	K2
10	Name and describe the main five features of Genetic Algorithm	K2
	PART – B Answer one question from each module; each question carries 14 marks.	
	Module - I	
11 a.	Maximize $f(x) = 2x_1 + x_2 + 10$ subject to $x_1 + 2x_2^2 - 3 = 0$	7 K3
b.	Find the extreme points of the funct $f(x_1, x_2, x_3) = x_1 + 2x_3 + x_2x_3 - x_1^2 - x_2^2 - x_3^2$.	7 K3
	OR	

12 a. Determine whether the following matrix is positive or negative definite. — 7 K3

$$A = \begin{pmatrix} 3 & 1 & -1 \\ 1 & 3 & -1 \\ -1 & -1 & 5 \end{pmatrix}$$

b. Using method of Lagrange multipliers, Minimize $f(x_1, x_2, x_3) = x_1^{\ 2} + x_2^{\ 2} + x_3^{\ 2}$ subject to constraints $4x_1 + x_2^{\ 2} + 2x_3 = 14$ — 7 K3

Module - II

13 a. Solve the following LPP graphically, — 14 K3

Minimize $Z = 20x_1 + 40x_2$

Subject to the constraints

$36x_1 + 6x_2 \geq 108$

$3x_1 + 12x_2 \geq 36$

$20x_1 + 10x_2 \geq 100$

and $x_1, x_2 \geq 0$

OR

14 Solve the following LPP using simplex method. Maximize $Z = 10x_1 + 15x_2 + 20x_3$ subject to the constraints — 14 K3

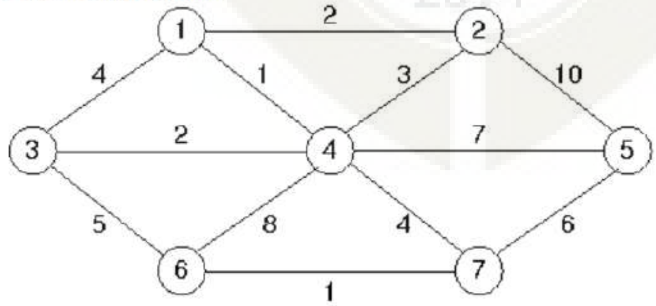
$2x_1 + 4x_2 + 6x_3 \leq 24, 3x_1 + 9x_2 + 6x_3 \leq 30, x_1, x_2, x_3 \geq 0.$

Module - III

15 a. Solve the game using graphical method. — 7 K3

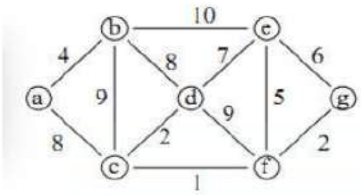
Player	B				
A	2	-4	6	-3	5
A	-3	4	-4	1	0

b. Using Dijkstra's method find the shortest path from node 1 to node 7 from the following network path model. — 7 K3



OR

16 a. Using Prim's algorithm find the minimum spanning tree and the shortest distance from node 'a' to node 'b'. — 7, K3



b. Solve the following payoff matrix using the graphical method. — 7, K3

	1	2	3	4	5
1	-5	5	0	-1	8
2	8	-4	-1	6	-5

a. Find the optimal strategy for player A
b. Find the optimal strategy for player B
c. Value of the game
d. Saddle point

Module - IV

17 Solve the non linear unconstrained minimised optimisation problem by Hooke-Jeeves pattern search method by taking $\Delta x_1 = \Delta x_2 = 0.5$ and the starting point as $(x_1, x_2) = (2, -1)$ where $f(x_1, x_2) = x_1^2 + 3x_2^2 + 6x_1x_2 - x_1 - x_2$. — 14, CO3, K3

OR

18 Using Fibonacci method, minimise $f = x^5 - 5x^3 - 20x + 5$ in the interval (0,5) in six steps. — 14, K3

Module - V

19 . Consider membership function of two fuzzy sets $\tilde{A}$ and $\tilde{B}$ are given by $\mu_A(x) = \frac{x}{x+2}$ and $\mu_B(x) = 3^{-x}$. Find the membership function of i) $\tilde{A}^C$ ii) $\tilde{B}^C$, iii) $\tilde{A} \cup \tilde{B}$, iv) $\tilde{A} \cap \tilde{B}$, v) $(\tilde{A} \cup \tilde{B})^C$, where ^{C} is complement. — 14, K3

OR

20 Consider the fuzzy relation R defined in A x A. Check whether the fuzzy relation is i) Reflexive, ii) Symmetric and iii) Transitive. — 7, K3

$$R = \begin{bmatrix} 0.4 & 0.1 & 0.7 \\ 0.1 & 0.2 & 0.2 \\ 0.4 & 0.5 & 0.3 \end{bmatrix}$$

Explain the working principles of Genetic Algorithms. — 7, K2

AET395	ARM ARCHITECTURE DESIGN	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble: This course aims to develop a basic knowledge of both Hardware and software of ARM processors.

Prerequisite: Basic knowledge of Digital Electronics and Microprocessors

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

CO 1	Summarize the basic architecture of ARM processors	K2
CO 2	Explain the ARM instruction set	K2
CO 3	Compare the features of Thumb mode and ARM mode	K2
CO4	Summarize architectural support and memory	K2
CO5	Explain the architectural features of ARM Cortex	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	3	2										2
CO 3	3	2										2
CO 4	3	2										2
CO 5	3	2										2

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	20
Understand	K2	40	40	80
Apply				
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Summarize the basic architecture of ARM processors

1. Draw a neat diagram of ARM architecture and explain its features.
2. Draw and explain the programmer's model of ARM.
3. Explain about ARM organizations and its implementations.
4. Explain the three stages pipelining in ARM processor.
5. Differentiate between three stages and five stages pipelining in ARM organization.

Course Outcome 2 (CO2): Explain the ARM instruction set

1. Explain the different types of ARM instruction sets and give examples for each.
2. What are the different data types? Explain.
3. Explain coprocessor instructions.
4. Differentiate between Status register to general register transfer instructions and General register to status register transfer instructions.

Course Outcome 3 (CO3): Compare the features of Thumb mode and ARM mode

1. Explain Thumb programmer's model using a neat diagram.
2. What are the different types of thumb instruction sets?
3. Difference between Thumb single and multiple data transfer instructions.
4. Explain about Thumb data processing instructions with an example.

Course Outcome 4 (CO4): Summarize architectural support and memory

1. Explain about ARM memory interfaces.
2. What is ARM debug architecture?
3. Explain the memory management in ARM processor.
4. Describe about the different H/w system prototyping tools.

Course Outcome 5 (CO5): Explain the architectural features of ARM Cortex

1. Explain about memory units and need for the memories. Also briefly describe about the memory declarations in FPGA design tools.
2. What are the Memory handling in ASIC designs?
3. Differentiate between TCM integration and Cache integration.
4. Explain about power management features.

SYLLABUS

MODULE 1(9 Hrs)

ARM Introduction:. Overview of ARM architecture – Architecture inheritance, Programmer`s model, ARM organization and implementation: 3-stage pipeline ARM organization, 5-stage pipeline ARM organization, ARM instruction execution, ARM implementation.

MODULE 2: (9 Hrs)

ARM Instruction set -. ARM instruction set (exceptions, conditional execution, branching instructions, multiply instructions, coprocessor instructions). Data types, Floating point datatypes, Conditional statements, Loops. Multiply instructions, Single word and unsigned byte data transfer instructions, Half-word and signed byte data transfer instructions,

Multiple register transfer instructions, Swap memory and register instructions,

Status register to general register transfer instructions, General register to status register transfer instructions, Coprocessor instructions.

MODULE 3: (9Hrs)

Thumb instruction set-Thumb bit, Thumb programmer`s model, Thumb Branch instructions, Thumb data processing instructions, Thumb single and multiple data transfer instructions, Thumb break point instruction, Thumb implementation, Thumb software interrupt instructions, Thumb application

MODULE 4: (9Hrs)

ARM memory interface, AMBA, ARM reference peripheral specifications, H/w system prototyping tools, ARMulator, JTAG, ARM debug architecture, Embedded trace, signal processing support, ARM processor cores.

Memory size and speed, On-chip memory, Caches, Memory management.

MODULE 5 (9Hrs)

Introduction to system design with Cortex-M processors, Overview of Cortex-M Processors. Need for the memories, Overview of memories -Memory declarations in FPGA design tools, Memory handling in ASIC designs, Memory endianness, Defining the peripherals, Memory map definition, Bus and memory system design, TCM integration, Cache integration, Defining the processor's configuration options, Interrupt signals and related areas. Event interface Clock generation Reset generation SysTick Debug integration Power management features, Major Applications .

Text book

1. ARM System-on-chip architecture, Steve Furber, Pearson Education

2. System-on-Chip Design with Arm® Cortex®-M Processors JOSEPH YIU Arm Education Media is an imprint of Arm Limited, 110 Fulbourn Road, Cambridge, CBI 9NJ, UK

Reference:

1. Valvano, Jonathan W - Embedded systems_ introduction to ARM® Cortex(TM)-M microcontrollers. 1-CreateSpace Independent Publishing Platform (2014)

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**ARM Introduction**	**9**
1.1	ARM Introduction: Overview of ARM architecture – Architecture inheritance, Programmer`s model	3
1.2	ARM organization and implementation: 3-stage pipeline ARM organization, 5-stage pipeline ARM organization	3
1.3	ARM instruction execution, ARM implementation.	3
2	**ARM instruction set**	**9**
2.1	ARM Instruction set and programming -. ARM instruction set (exceptions, conditional execution, branching instructions, multiply instructions, coprocessor instructions	2
2.2	Data types, Floating point datatypes, Conditional statements, Loops.	2
2.3	Multiply instructions, Single word and unsigned byte data transfer instructions, Half-word and signed byte data transfer instructions,	2

	Multiple register transfer instructions	
2.4	Swap memory and register instructions, Status register to general register transfer instructions, General register to status register transfer instructions, Coprocessor instructions.	3
3	**Thumb mode and its instruction set**	**9**
3.1	Thumb instruction set-Thumb bit, Thumb programmer`s model	2
3.2	Thumb Branch instructions, Thumb data processing instructions	2
3.3	Thumb single and multiple data transfer instructions	2
3.4	Thumb break point instruction, Thumb implementation, Thumb software interrupt instructions, Thumb application	3
4	**Architectural support and memory**	**9**
4.1	ARM memory interface, AMBA, ARM reference peripheral specifications	2
4.2	H/w system prototyping tools, ARMulator, JTAG, ARM debug architecture	3
4.3	Embedded trace, signal processing support, ARM processor cores.	2
4.4	Memory size and speed, On-chip memory, Caches, Memory management.	2
5	**Architectural features of ARM Cortex**	**9**
5.1	Introduction to system design with Cortex-M processors, Overview of Cortex-M Processors.	1
5.2	Need for the memories, Overview of memories -Memory declarations in FPGA design tools, Memory handling in ASIC designs, Memory endianness.	2
5.3	Defining the peripherals, Memory map definition, Bus and memory system design	2
5.4	TCM integration, Cache integration, Defining the processor's configuration options	2
5.5	Interrupt signals and related areas. Event interface Clock generation Reset generation SysTick Debug integration Power management features, Major Applications.	2

		Total	45

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET395

Program: Honours in Applied Electronics and Instrumentation Engineering/ Electronics and Instrumentation Engineering

Course Name: ARM Architecture Design

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1. Draw a neat diagram of ARM architecture. K1

2. Explain coprocessor instructions. K2

3. What are the different types of thumb instruction sets? K2

4. Summarize ARM debug architecture? K2

5. Explain TCM integration. K2

6. What are ARM memory interfaces. K2

7. Explain ARMulator. K2

8. What is On-chip memory? K1

9. What are the 3-stage pipeline ARM organization K2

10. What are Cortex-M Processors. K1

PART – B

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

Module – I

11. a)	Draw a neat diagram of ARM architecture and explain its features.	7	CO1	K2
11. b)	Explain about ARM organizations and its implementations.	7	CO1	K2
	OR			
12.a)	Differentiate between three stages and five stages pipelining in ARM organization.	6	CO1	K2
12.b)	Draw and explain the programmer's model of ARM.	8	CO1	K2

Module – II

13. a)	Explain the different types of ARM instruction sets and give examples for each.	7	CO2	K2
13. b)	What are the different data types? Explain	7	CO2	K2
	OR			
14.a)	List the various coprocessor instructions.	7	CO2	K1
14.b)	Differentiate between Status register to general register transfer instructions and General register to status register transfer instructions	7	CO2	K2

Module – III

15 a)	Explain Thumb programmer's model using a net diagram.	7	CO3	K2
15b)	What are the different types of thumb instruction sets?	7	CO3	K2
	OR			
16a)	Difference between Thumb single and multiple data transfer instructions.	7	CO3	K2
16b)	Explain about Thumb data processing instructions with an example.	7	CO3	K2

Module – IV

17 a)	Explain about ARM memory interfaces.	8	CO4	K2
17b)	Discuss ARM debug architecture?	6	CO4	K2
	OR			
18 a)	Explain the memory management in ARM processor.	7	CO4	K2
18b)	Describe about the different H/w system prototyping tools.	7	CO4	K2

Module – V

19 a)	Explain about memory units and need for the memories. Also briefly describe about the memory declarations in FPGA design tools.	7	CO5	K2
19b)	Explain memory handling in ASIC designs?	7	CO5	K2
	OR			
20 a)	Differentiate between TCM integration and Cache integration.	7	CO5	K2
20b)	Write short notes on power management features.	7	CO5	K1

AET397	WAVELETS	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble: This course aims to familiarize with wavelet transform of signals, construction of wavelets, filter implementation and practical applications

Prerequisite: ECT204 Signals and Systems

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

CO 1	Outline the different frequency transform methods and design multirate systems for applications like sub-band coding. (K2)
CO 2	Relate the principles of Short Time Fourier Transform and Wavelet Transform, taking into consideration time frequency analysis. (K2)
CO 3	Build discrete wavelet transforms with multirate digital filters for signal analysis and understand multi resolution analysis (K3)
CO 4	Develop and implement wavelet based systems using different algorithms. (K3)
CO 5	Apply wavelet transforms for image and audio 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									2
CO 2	3	3	3									2
CO 3	3	3	3									2
CO 4	3	3	3									2
CO 5	3	3	3									2

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	20	20	50
Apply	K3	20	20	40
Analyse	K4			
Evaluate	K5			
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): Outline the different frequency transform methods and design multirate systems for applications like sub-band coding.

1. Explain the relation of DFT to DTFT and z-transforms.
2. Find the output of given cascaded multirate blocks.
3. Derive the frequency domain representation of an M-fold down/up sampler.
4. Find the output spectrum of system involving upsampler/downsampler.
5. Explain the applications of multirate systems.

Course Outcome 2 (CO2): Relate the principles of Short Time Fourier Transform and Wavelet Transform, taking into consideration time frequency analysis.

1. Explain time-frequency resolution issues in analysis of signals using Fourier transform
2. State and Prove Heisenburg's Uncertainty Principle
3. Compare STFT and CWT
4. Interpret the filter bank implementation of STFT
5. Find STFT of given signal.
6. Prove any given property of CWT
7. Find CWT of given signal.

8. Explain admissibility condition of wavelets. Check whether the given function is an admissible wavelet.

Course Outcome 3 (CO3): Build discrete wavelet transforms with multirate digital filters for signal analysis and understand multi resolution analysis

1. Draw the time frequency tiling of Short Time Fourier Transform (STFT) and Discrete Wavelet Transform (DWT). Compare the merits and demerits of these transforms.
2. Show the m-level Haar Wavelet decomposition of the given discrete sequence.
3. Prove that the space spanned by scaling function bases is nested and the space spanned by wavelet function bases is orthogonal among themselves.
4. Explain Haar scaling and refinement relations.
5. Derive the filter bank implementation for signal analysis using DWT. Show the filter bank structure and the spectrum involved.
6. Explain the axioms of MRA.

Course Outcome 4 (CO4): Develop and implement wavelet based systems using different algorithms.

1. State and prove the conditions to be satisfied by filter coefficients to satisfy requirements to develop orthogonal wavelet system. (like orthonormality of translates of scaling function)
2. For 8-tap Daubechies wavelet system, derive the equations that must be satisfied by scaling function coefficients.
3. Derive Daubechies wavelet system with three vanishing moment (a 6-tap wavelet - system).
4. Derive the Mallat Filterbank structure (Analysis & Synthesis) for a Orthogonal Wavelet System.
5. Explain Wavelet Transform using Lifting scheme.
6. What are the advantages of Wavelet Packet Transform over Wavelet Transform?
7. Obtain the best wavelet packet basis and then draw the best wavelet packet tree structure for the given data given below using normalized Haar wavelet filter given.

Course Outcome 5 (CO5): Apply wavelet transforms for image and audio processing.

1. Explain how wavelet transform can be used for image compression.
2. Illustrate the filter bank implementation of wavelet transform of images
3. Find the EZW coding of given wavelet decomposed image
4. Explain the application of wavelet transform in image denoising/edge detection/object detection
5. Explain how wavelet transform can be used for audio compression/coding.

6. Explain application of Wavelet packet analysis.

SYLLABUS

Module 1:

Introduction to signals - Stationary and non-stationary signals, Signal representation using basis functions and orthonormal bases.

Signal transforms-Brief introduction to signal transforms from time to frequency domain-CTFT, DTFT, DFT and z-transform, Frequency Response analysis (Detailed analysis not required)

Multirate signal processing-Fundamentals of Multirate systems, Basic Upsampling and downsampling in time domain and frequency domain representation, Noble Identities, Multirate Filter Banks and sub band coding of signals.

Module 2:

Time - frequency analysis of signals - Spectral analysis of signals, Spectral leakage by windowing effect. Time and frequency localization of signals, the uncertainty principle and its implications

Short Time Fourier transform – Continuous time and discrete time STFT, Filterbank implementation of STFT

Continuous Wavelet Transform (CWT) – Concept of wavelets, CWT for signal analysis, Condition of admissibility and its implications, Inverse Continuous Wavelet Transform, Properties of CWT.

Module 3:

Discrete Wavelet Transform – Concept of DWT, Time frequency tiling of DWT and comparison to STFT. Haar Scaling and Wavelet functions, Function Spaces, Refinement relation, Wavelet decomposition of signals. Daubechies wavelets.

Designing orthogonal wavelet systems- Relation of DWT to filter banks for signal decomposition and reconstruction

Multi resolution Analysis (MRA) - Concept of MRA and Relating it to filter banks, Axioms of MRA

Module 4 :

Construction of wavelets: Design of wavelet filter coefficients using time domain and frequency domain approaches, Computation of discrete wavelet transform using Mallat Algorithm and Lifting Scheme

Wavelet Packet Transform – Signal representation using wavelet packet analysis – selection of best basis.

Module 5:

Wavelet Transform Applications in image processing – Wavelet Transform of images, Applications of Wavelets in Image compression, EZW Coding - Applications of Wavelets in Image Denoising, Edge detection and Object detection.

Wavelet Transform Applications in audio processing - Application of wavelets in audio compression, wavelet based audio coding. Applications of wavelet packet analysis.

Text Books

1. K. P. Soman, K. I. Ramachandran, N. G. Resmi, PHI, *Insight into wavelets : From theory to practice*

2. Reghuveer M. Rao, Ajit S. Bopardikar, *Wavelet Transforms – Introduction to Theory and Applications*, Pearson Education

Reference Books

1. Proakis J. G. and Manolakis D. G., *Digital Signal Processing*, 4/e, Pearson Education
2. P. P. Vaidyanathan, *Multirate Systems & Filter banks* , Prentice Hall
3. G. Strang& T. Nguyen , *Wavelets and Filter bank*, Wellesly-Cambridge
4. M. Vetterli & J. Kovacevic, *Wavelets and sub band coding*, Prentice Hall

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to signals**	
1.1	Stationary and non-stationary signals, Signal representation using basis functions and orthonormal bases.	2
	Signal transforms in Fourier domain	
1.2	Introduction to CTFT, DTFT, DFT and z-transform , Frequency Response Analysis	2
	Multirate signal processing	
1.3	Fundamentals of Multirate systems, Basic Upsampling and downsampling in time domain	2
1.4	Frequency domain representation of upsampler and downsampler. Noble Identities	2
1.5	Multirate Filter Banks and sub band coding of signals.	1
2	**Time - frequency analysis of signals**	
2.1	Frequency Analysis of Signals using the DFT, Spectral leakage by windowing effect ,Time and frequency localization of signals	2
2.2	Uncertainty principle and its implications	1
	Short Time Fourier transform	
2.3	Continuous time and discrete time STFT	1
2.4	Filterbank implementation of STFT	1
	Continuous Wavelet Transform	
2.5	CWT for signal analysis, Condition of admissibility and its implications, Inverse Continuous Wavelet Transform.	2
2.6	Properties of CWT.	1
3	**Discrete Wavelet Transform**	
3.1	Concept of DWT, Time frequency tiling of DWT and comparison to STFT.	2
3.2	Haar Scaling and Wavelet functions, Function Spaces, Refinement relation, Wavelet decomposition of signals.	3
3.3	Daubechies wavelets.	1
	Designing orthogonal wavelet systems	
3.4	Relation of DWT to filter banks for signal decomposition and	3

	reconstruction	
	Multi resolution Analysis (MRA)	
3.5	Concept of MRA and Relating it to filter banks, Axioms of MRA	2
4	**Construction of wavelets**	
4.1	Design of wavelet filter coefficients using time domain and frequency domain approaches	3
4.2	Computation of DWT using Mallat Algorithm	2
4.3	Computation of DWT using Lifting Scheme	2
	Wavelet Packet Transform	
4.4	Signal representation using wavelet packet analysis – selection of best basis.	2
5	**Wavelet Transform Applications in image processing**	
5.1	Wavelet Transform of images, Applications of Wavelets in Image compression, EZW Coding	3
5.2	Applications of Wavelets in Image Denoising, Edge detection and Object detection.	2
	Wavelet Transform Applications in audio processing	
5.3	Application of wavelets in audio compression, wavelet based audio coding.	2
5.4	**Applications of wavelet packet analysis**	1

Assignment:

Assignments can be given from textual exercise problems. Atleast two assignments can be given on spectral analysis and wavelet applications using Matlab or any other software.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH HONOURS EXAMINATION

Course Code: AET397

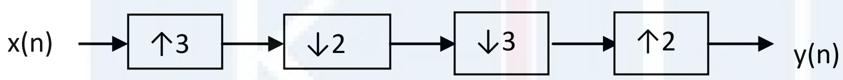
Program: Honours in Applied Electronics and Instrumentation Engineering/ Electronics and Instrumentation Engineering

Course Name: Wavelets

Max. Marks: 100 Duration: 3Hours

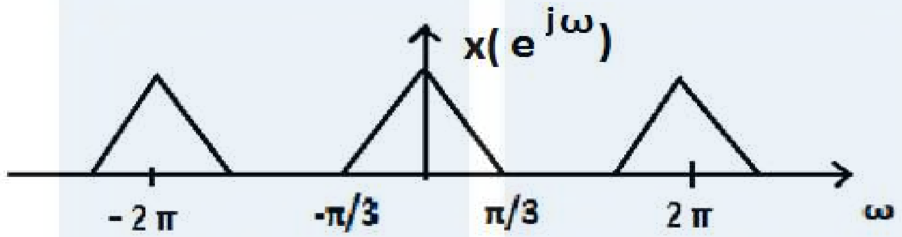
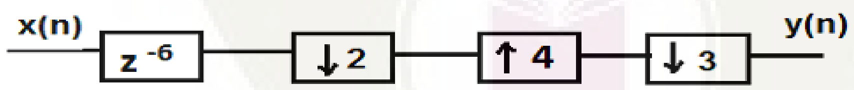
PART A

Answer ALL Questions. Each question carries 3 marks.

1.	How can you deduce that a downsampling system is not a time invariant system?	K3	CO1
2	Simplify the multirate systems shown below and develop an expression for y(n) in terms of x(n). 	K3	CO1
3	Give the advantage of using STFT over Fourier analysis for signal analysis.	K1	CO2
4	Illustrate and interpret the filter bank implementation of STFT	K2	CO2
5	What is the need for Multi Resolution Analysis in images?	K1	CO3
6	Illustrate the time frequency tiling of Short Time Fourier Transform (STFT) and Discrete Wavelet Transform (DWT).	K2	CO3
7	Explain the steps for finding wavelet transform through lifting scheme	K2	CO4
8	What are the advantages of Wavelet Packet Transform over Wavelet Transform?	K1	CO4
9	Bring out a comparison between Wavelet based and DCT based image compression.	K3	CO5
10	Explain the application of Wavelet packet analysis.	K2	CO5

PART – B

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

	Module I			
11. a)	How is DFT related to DTFT ?	6	K2	CO1
11. b)	Prove the orthogonality of basis signals used in Fourier series representation of signals	8	K2	CO1
	OR			
12.a)	Sketch □(□□□) for M=3 and M=4. Given □(□□□)  Also suggest a system to recover x(n) from y(n) if M=3.	8	K2	CO1
12.b)	Simplify the multirate system shown below and develop an expression for y(n) in terms of x(n)  	6	K2	CO1
	Module II			
13.a)	State and Prove Heisenburg's Uncertainty Principle	7	K2	CO2
13.b)	**Given two signals** $x_1(n) = \cos(\frac{□}{□}□) + 0.5\cos(\frac{□}{□}n)$ $x_2(n) = \begin{cases} \cos(\frac{□}{□}□), & 0 \le n \le 35 \\ 0.5\cos(\frac{□}{□}n), & 36 \le n \le 71 \\ 0, & \text{otherwise} \end{cases}$ If X(r, k) denotes the STFT of signal, compute the STFT of two signals when both the DFT length N and sampling interval R equals 36. The window	7	K3	CO2

	w(n) is a rectangular window of length L=36. (r is the time parameter, $-\infty<r<\infty$ and k is the frequency parameter ,$0\le k\le N-1$)			
	OR			
14.a)	Check whether the Haar wavelet satisfies admissibility condition. Justify your answer.	7	K2	CO2
14.b)	For the signal f(t) given by $f(t) = \begin{cases} 1 & 0 \le t < 1 , \\ 0 & \text{otherwise.} \end{cases}$ evaluate Continuous Wavelet Transform using Haar wavelet.	7	K3	CO2
	Module III			
15.a)	Prove that the space spanned by scaling function bases is nested and the space spanned by wavelet function bases is orthogonal among themselves.	6	K2	CO3
15.b)	Decompose the signal x(n)= [4, 8, 2 ,-6 ,2, 14, 12, 6, 2,6,8,12] in V_3 space to its components in V_2,V_1 ,V_0 and W_0 space using Haar Wavelet function.	8	K3	CO3
	OR			
16.a)	Explain the axioms of MRA.	6	K2	CO3
16.b)	From the dilation and wavelet equation derive the filter bank implementation for signal analysis using DWT.	8	K3	CO3
	Module IV			
17.a)	State the conditions to be satisfied by filter coefficients to satisfy the requirements to develop orthogonal wavelet system.	6	K2	CO4
17.b)	For an 8-tap Daubechies wavelet system, derive the equations that must be satisfied by scaling function coefficients.	8	K3	CO4
	OR			
18.a)	Derive the Mallat Filterbank structure (Analysis & Synthesis) for a Orthogonal Wavelet System.	8	K3	CO4
18.b)	Explain wavelet packet best basis algorithm.	6	K2	CO4
	Module V			
19.a)	How can you use wavelet filter bank for perceptual audio coding?	8	K3	CO5

19.b)	Explain the application of wavelet transform in image denoising	6	K2	CO5
	OR			
20. a)	Given a DWT coefficient array for 3 levels on an image. Implement EZW algorithm for coding the image (do atleast 2 dominant passes).	8	K3	CO5

127	69	24	73	13	5	-8	5
-37	-18	-18	8	-6	7	15	4
44	-87	-15	21	8	-11	14	-3
55	18	29	-56	0	-2	3	7
34	38	-18	17	3	-9	-2	1
-27	-41	11	-5	0	-1	0	-3
6	17	5	-19	2	0	-3	1
32	26	-7	5	-1	-5	7	4

20.b)	lllustrate the filter bank implementation of wavelet transform of images	6	K2	CO5

Simulation Assignments in MATLAB

1) Spectral analysis of audio or image signals
2) Wavelet applications for image or audio processing

SEMESTER VI

AET302	DIGITAL SIGNAL PROCESSING	CATEGORY	L	T	P	CREDITS
		PCC	3	1	0	4

Preamble: This course aims to develop skills to realize and implement systems that process discrete time signals.

Prerequisite: ECT204 Signals and Systems

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

CO 1	Outline the fundamental properties relevant to DFT and explain the use of computationally efficient algorithms for finding DFT and IDFT
CO 2	Develop filter response for linear phase FIR digital filters for given specifications
CO 3	Develop filter transfer function for IIR digital filters for given specifications using design concepts of analog filter and analog-to-digital transformations.
CO 4	Implement FIR and IIR filter structures for a given system function.
CO 5	Explain architectural features of general purpose DSP processors and finite word length effects in DSP systems and filters

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							3
CO 3	3	3	3		3							3
CO 4	3	3	3		3							3
CO 5	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				
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): Outline the fundamental properties relevant to DFT and explain the use of computationally efficient algorithms for finding DFT and IDFT.

1. Find the DFT of the given sequence using direct equation.
2. Show that the given property is satisfied by DFT
3. Calculate linear / circular convolutions of given sequence.
4. Explain the relation of DFT to DTFT and z-transforms.
5. Explain the spectrum analysis of discrete signals
6. Draw the butterfly diagram to compute the DFT/ IDFT using DIT/DIF FFT algorithm and find the computational advantage of using FFT algorithm.

Course Outcome 2 (CO2): Develop filter response for linear phase FIR digital filters for given specifications.

1. Prove the linear phase response of type 1 linear FIR filter
2. Find the filter coefficients for a linear phase FIR filter for given order/specifications using given/appropriate window.
3. Find the filter coefficients for a linear phase FIR filter for specifications using frequency sampling method.

Course Outcome 3 (CO3): Develop filter transfer function for IIR digital filters for given specifications using design concepts of analog filter and analog-to-digital transformations.

1. Find the H(z) of the given analog transfer function H(s) using Impulse Invariant/Bilinear Transformation method.
2. Design a Butterworth filter to implement an IIR filter H(z) for given specifications using Impulse Invariant/Bilinear Transformation method .

3. Find the filter transfer functions for high pass, band pass and band reject filters from the given low pass filter transfer function H(s) or H(z).

Course Outcome 4 (CO4): Implement FIR and IIR filter structures for a given system function.

1. Draw the direct form realization of given FIR filter.
2. Develop the direct form realization of given symmetric FIR filter using minimum multipliers.
3. Develop the realization of given IIR filter transfer function H(z) in Direct Form I, Direct Form II, Transposed form, Cascade form, Parallel form.

Course Outcome 5 (CO5): Explain architectural features of general purpose DSP processors and finite word length effects in DSP systems and filters.

1. Explain the representation of numbers in digital systems/digital processors in fixed point and floating point representations.
2. Explain the input/coefficient/product quantization effects in digital filters.
3. Explain the input/coefficient/product quantization effects FFT algorithms .
4. Compare the different architectures used in digital signal processors
5. Explain the architecture of TMS320C67xx digital signal processor.

SYLLABUS

Module 1:

Discrete Fourier Transform: DFT of signals, Relationship of the DFT to other transforms, IDFT, Properties of DFT and examples, Circular convolution, linear convolution using circular convolution.
Spectral Analysis of signals: Frequency Analysis of Signals using the DFT, Spectrum leakage and frequency resolution.
Fast Fourier Transform: Algorithmic development and computational advantages of Radix-2 Decimation in Time and Decimation in Frequency FFT Algorithms for DFT and IDFT computation.

Module 2:

Linear phase FIR filters: Frequency response characteristics of ideal filter and physically realizable filters, Symmetric and Antisymmetric FIR Filters.
Design of FIR Filters: Design of linear phase FIR Filters using Window method and Frequency Sampling method, Introduction to Optimal FIR Filters.

Module 3:

Design of analog prototype filters: Design of IIR Digital Filters from Analog Filters, Butterworth filter design to meet required filter specifications, Overview and comparison of other analog filters.
Design of IIR Filter from Analog filters: IIR Filter Design by Impulse Invariance and Bilinear Transformation methods. Comparison with FIR filter.
Frequency Transformations: Frequency Transformations in the Analog and Digital Domain

Module 4 :

Digital Filter structures: Block diagram and signal flow graph representations of filters
FIR Filter Structures: Direct Form, Cascade Form, Lattice Structures
IIR Filter Structures: Direct Form I, Direct Form II, Transposed Form, Cascade Form and Parallel Form structures

Module 5:

Finite word length effects in DSP systems: Fixed point and floating-point representation of numbers, Errors resulting from rounding and truncating, Quantization effects of digital filters and FFT algorithms (analysis not required).
Computer architecture for digital signal processing: Concepts of Von Neumann and Harvard architectures, Pipelining. Introduction to TMS320C67xx digital signal processor.

Text Books

1. Proakis J. G. and Manolakis D. G., Digital Signal Processing, 4/e, Pearson Education, 2007.
2. Oppenheim A. V., Schafer R. W. and Buck J. R., Discrete Time Signal Processing, 3/e, Prentice Hall, 2007.

Reference Books

1. Ifeachor, E.C., & Jervis, B.W., *"Digital Signal Processing: A Practical Approach*", 2/e, Pearson Education Asia, 2002.
2. Chassaing, Rulph., DSP applications using C and the TMS320C6x DSK. Vol. 13. John Wiley & Sons, 2003.
3. Mitra, S.K., "*Digital Signal Processing: A Computer-Based Approach*", McGraw Hill, NY, 1998
4. Salivahanan, Digital Signal Processing,3e, Mc Graw –Hill Education New Delhi, 2014
5. Chassaing, Rulph., DSP applications using C and the TMS320C6x DSK. Vol. 13. John Wiley & Sons, 2003.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Discrete Fourier Transform**	
1.1	DFT of signals, Relationship of the DFT to other transforms, IDFT.	2
1.2	Circular convolution, linear convolution using circular convolution.	1
1.3	Properties of DFT and examples.	2
	Spectral Analysis of signals	
1.4	Frequency Analysis of Signals using the DFT, Spectrum leakage and frequency resolution.	1
	Fast Fourier Transform	
1.5	Algorithmic development and computational advantages of Radix-2 Decimation in Time and Decimation in Frequency FFT Algorithms.	2
1.6	DFT and IDFT computation using FFT.	2
2	**Linear phase FIR filters**	
2.1	Frequency response characteristics of ideal filter and physically realizable filters –low pass, high pass, band pass and band reject	2

2.2	Symmetric and Antisymmetric FIR Filters, Frequency response of symmetric and antisymmetric filters	1
	Design of FIR Filters	
2.3	Design of linear phase FIR Filters using Window method	2
2.4	Comparison of filter response using different windows	1
2.5	Design of linear phase FIR Filters using frequency sampling Method	2
2.6	Introduction to Optimal FIR Filters	1
3	**Design of analog prototype filters**	
3.1	Design of IIR Digital Filters from Analog Filters	1
3.2	Butterworth filter design to meet required filter specifications	2
3.3	Overview and comparison of other analog filters.	1
	Design of IIR Filter from Analog filters	
3.4	IIR Filter Design by Impulse Invariance method.	2
3.5	IIR Filter Design by Bilinear Transformation method.	2
3.6	Comparison with FIR filter	1
	Frequency Transformations	
3.7	Frequency Transformations in the Analog and Digital Domain	1
4	**Digital Filter structures**	
4.1	Block diagram and signal flow graph representations of filters	1
	FIR Filter Structures	
4.2	Direct Form structure, Direct form of linear phase filter with minimum multipliers, Cascade Form Structures, Lattice structure.	3
	IIR Filter Structures	
4.3	Direct Form I, Direct Form II, Transposed Form	1
4.4	Cascade Form and Parallel Form structures	3
5	**Finite word length effects in DSP systems** (analysis not required)	
5.1	Fixed point and floating-point representation of numbers, Errors resulting from rounding and truncating	3
5.2	Quantization effects of digital filters and FFT algorithms.	2
	Computer architectures for digital signal processing	
5.3	Concepts of Von Neumann and Harvard architectures, Pipelining	1
5.4	Introduction to TMS320C67xx digital signal processor.	2

Assignment:

Assignments can be given from textual exercise problems. Atleast one assignments can be given on spectral analysis or filter design using Matlab or any other software.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET302

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

Course Name: Digital Signal Processing

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	How is DFT related to DTFT?	K1	CO1
2	Show the butterfly diagram to find 4 point DFT	K2	CO1
3	Derive the frequency response of linear phase ideal low pass filter	K2	CO2
4	Show the condition for obtaining linear phase characteristics in FIR filters.	K1	CO2
5	What are the advantages of FIR filter over IIR filter?	K1	CO3
6	Explain the need of frequency warping in Bilinear transformation?	K2	CO3
7	Illustrate the implementation of a linear phase FIR filter of length 9 using minimum number of multipliers	K2	CO4
8	Illustrate the direct form II implementation of a system given by the transfer function $H(z) = \frac{8z^3 - 4z^2 + 11z - 2}{(z - .25)(z^2 - z + 0.5)}$	K2	CO4
9	Compare Von Neumann and Harvard architectures	K2	CO5
10	What is round off error in digital computer?	K1	CO5

PART – B

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

	Module I			
11. a)	If the first 3 points of a 6 point DFT of x(n)={10,3+2j,-4-2j,0}. Find other points without doing calculations.	5	K2	CO1
11. b)	Find DFT of the sequence x(n)={1,2,1,2,1,1,1,1} using DITFFT algorithm.	9	K2	CO1
	OR			
12.a)	Verify convolution property of DFT for the sequences $x_1(n)$={1,2,1,2 } and $x_2(n)$={1,2,-1,1}	7	K2	CO1
12.b)	What is the computational advantage of finding 512 point DFT using FFT over direct calculation ?	7	K1	CO1
	Module II			
13.a)	Develop a linear phase FIR filter with the following specifications using window method. $H_d\left(e^{j\omega}\right) = e^{-j\alpha\omega}; \quad 0.2\pi \le \lvert\omega\rvert \le 0.4\pi$ $= 0 \quad otherwise$ Choose N=7 and Hanning window for the design. Find the filter coefficients and draw the structure of filter.	9	K3	CO2
13.b)	Explain the design of linear phase FIR filter using frequency sampling technique?	5	K2	CO2
	OR			
14.a)	Apply frequency sampling technique to design a low pass linear phase FIR filter of length N=7 with cut off frequency π/2 rad/s using type-1 method.	9	K3	CO2
14.b)	Explain the method of designing optimal FIR filters using Minimax method	5	K2	CO2
	Module III			
15.	Design a Butterworth low pass digital IIR filter with a pass band edge frequency of 0.25π with a ripple not exceeding 0.5 dB and a minimum stop band attenuation 15dB with a stop band edge frequency of 0.55π. Use bilinear transformation.	14	K3	CO3
	OR			

16.a)	Determine the digital transfer function obtained by transforming the following causal analog transfer functions using the impulse invariance method. Assume T=0.25 sec $$H(s) = \frac{2(s+2)}{(s+3)(s^2+4s+5)}$$	7	K2	CO3
16.b)	Give the relevant equations to convert a low pass digital filter transfer function to high pass and band pass filters of similar specifications	4		CO3
16.c)	Compare Butterworth and Chebyshev filter responses	3	K2	CO3
	Module IV			
17.a)	Show the cascade and parallel realizations (direct form II) of an IIR filter with the given transfer function $H(z) = \frac{(1+\frac{1}{2}z^{-1})}{\left(1-z^{-1}+\frac{1}{4}z^{-2}\right)\left(1-z^{-1}+\frac{1}{2}z^{-2}\right)}$	7	K3	CO4
17.b)	Given a three stage lattice filter with coefficients K1 = 0.25, K2 = 0.5 and K3 = 1/3, determine the FIR filter coefficients for the direct-form structure.	7	K3	CO4
	OR			
18.a)	Obtain the direct form II, cascade and transposed direct form II structures for the system. $$y(n) = -0.1y(n-1) + 0.2y(n-2) + 3x(n) + 3.6x(n-1) + 0.6x(n -$$	10	K3	CO4
18.b)	Determine a direct form realization of the FIR filter with the following filter function h(n)={1,2,3,4, }	4	K2	CO4
	Module V			
19.a)	Explain the effect of coefficient quantization in IIR filter structures?	7	K2	CO5
19.b)	With an example illustrate the error introduced by truncation and rounding in fixed point representation of numbers.	7	K2	CO5
	OR			
20	Explain the architecture of TMS320C67xx DSP with block diagram.	14	K2	CO5

Simulation Assignments

1) Implementation of FFT algorithms
2) Spectral analysis of audio or image signals
3) Filtering of noise from audio signals or images
4) Study of finite word length effect in digital systems
5) Implementing simple DSP projects in DSP processor

AET304	PROCESS DYNAMICS AND CONTROL	CATEGORY	L	T	P	CREDITS
		PCC	3	1	0	4

Preamble: This course aims to understand the principles of process dynamics and to analyze the various types of process control systems.

Prerequisite: Fundamentals of differential equations and Laplace transform

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

CO 1	Explain the characteristics and elements of process dynamics
CO 2	Analyze a process control loop
CO 3	Model and tune a feedback controller
CO4	Analyze multi-loop and multi variable controllers

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
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): Explain the characteristic principles and different elements involved in process dynamics

1. For a given physical system with resistive or capacitive characteristics, find the period of oscillation and damping.
2. Distinguish between the following processes - (i) Regulating and non-regulating, (ii) Interacting and non-interacting and (iii) Linear and non linear
3. What are the criteria used for selecting the process variables?

Course Outcome 2 (CO2): Analyze control loops.

1. For a given control loop, derive the expression for steady state gain and process gain.
2. Find the expression for the transfer function of a temperature control system.
3. Compare SLPC and MLPC.

Course Outcome 3 (CO3): Model and tune various control systems such as feedback control systems, multi loop as well as nonlinear systems

1. Design aspects for a feedback -feedforward control system?
2. How can we model a liquid level control system?
3. What can you infer from dead band velocity limiting?

Course Outcome 4 (CO4): Analyze multi variable control systems and model-based controllers

1. Derive the transfer function of a multi variable control system.
2. What is the importance of relative Gain Array?

SYLLABUS

Module 1:

Process characteristics: Incentives for process control, Process Variables types and selection criteria, Process degree of freedom, The period of Oscillation and Damping, Characteristics of physical System: Resistance, Capacitive and Combination of both. Elements of Process Dynamics,

Types of processes- Dead time, Single /multi capacity, self-Regulating /non self-regulating, Interacting /non interacting, Linear/non-linear, and Selection of control action for them. Study of Liquid Processes, Gas Processes, Flow Processes, Thermal Processes in respect to above concepts.

Module 2:

Elements of Process Control Loop: Pneumatic and electric actuators, control valves - characteristics of control valves, valve positioner - I/P and P/I converters- Electronic Controllers. Analysis of Control Loop: Steady state gain, Process gain, Valve gain, Process time constant, Variable time Constant, Transmitter gain, linearizing an equal percentage valve, Variable pressure drop. Analysis of Liquid level Control, Temperature control. SLPC and MLPC features, faceplate, functions, SLPC and MLPC comparison. Scaling: types of scaling, examples of scaling.

Module 3:

Feedback Control: Basic principles, Elements of the feedback Loop, Block Diagram, Control Performance Measures for Common Input Changes, Selection of Variables for Control Approach to Process Control. Controller modes (P, PI, PD and PID) and tuning parameters. Tuning of feedback controllers: Process step testing, tuning for - Quarter Decay ratio response, minimal error integral criteria, sampled data controllers. Controller tuning for integrating processes – model of liquid level control system.

Module 4:

Multi Loop & Nonlinear Systems: Cascade control, Feed forward control, feedback-feed forward control, Ratio control, Selective Control, Split range control- Basic principles, Design Criteria, Performance, Implementation issues, Examples and any special features of the individual loop and industrial applications. Nonlinear Elements in Loop: Limiters, Dead Zones, Backlash, Dead Band Velocity Limiting, Negative Resistance.

Module 5:

Multivariable Control: Concept of Multivariable Control: Interactions and its effects, Modelling and transfer functions, Influence of Interaction on the possibility of feedback control, important effects on Multivariable system behaviour Relative Gain Array, effect of Interaction on stability and tuning of Multi Loop Control system. Model Based controllers: Internal Model control, Model Predictive controller, Dynamic matrix controller (DMC), Self-Tuning Controller.

Text Books

1. B.Wayne Bequette, Process Control: Modeling, Design and Simulation, PHI.
2. Donald Eckman – Automatic Process Control, Wiley Eastern Limited.
3. F.G.Shinskey, Process control Systems ,TMH.
4. Carlos A. Smith, Armando B. Corripio - Principles and practice of Automatic Process Control, John Wiley & Sons, 2nd edition.
5. Curtis D Johnson, Process Control Instrumentation Technology, Eighth Edition.

Reference Books

1. B.G.Liptak, Handbook of Instrumentation -Process control , Chilton.
2. Considine, Process Instrumentation and control Handbook, 5th Ed., McGraw Hill.
3. Krishna Kant, Computer Based Industrial Control, PHI.
4. Murrill, Applications concepts of Process control, ISA.
5. Murrill, Fundamentals of Process Control, ISA.
6. Stephanopoulos George, Chemical Process Control, PHI.
7. T.J.Ross Fuzzy Logic with Engineering Applications, John Wiley & Sons, 2004.
8. Thomas E Marlin - *Process Control- Designing processes and Control Systems for Dynamic performance,* McGraw-Hill International Editions.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Process characteristics:**	
1.1	Incentives for process control, Process Variables types and selection criteria.	1
1.2	Process degree of freedom, The period of Oscillation and Damping.	1
1.3	Characteristics of physical System: Resistance, Capacitive and	1

	Combination of both.	
1.4	Elements of Process Dynamics, Types of processes- Dead time, Single /multi capacity, self-Regulating /non self-regulating, Interacting /non interacting, Linear/non-linear, and Selection of control action for them.	3
1.5	Study of Liquid Processes, Gas Processes, Flow Processes, Thermal Processes in respect to above concepts.	3
2	**Elements of Process Control Loop:**	
2.1	Pneumatic and electric actuators	1
2.2	Control valves - characteristics of control valves, Valve Positioner	2
2.3	I/P and P/I converters, Electronic Controllers	1
	Analysis of Control Loop	
2.4	Steady state gain, Process gain, Valve gain, Process time constant, Variable time Constant, Transmitter gain.	2
2.5	Linearizing an equal percentage valve, Variable pressure drop.	2
2.6	Analysis of Liquid level Control, Temperature control.	2
2.7	SLPC and MLPC features, faceplate, functions, SLPC and MLPC comparison.	1
2.8	Scaling: types of scaling, examples of scaling.	1
3	**Feedback Control:**	
3.1	Basic principles, Elements of the feedback Loop, Block Diagram,	1
3.2	Control Performance Measures for Common Input Changes, Selection of Variables for Control Approach to Process Control.	1
3.3	Controller modes and tuning parameters.	2
	Tuning of feedback controllers:	
3.4	Process step testing, tuning for - Quarter Decay ratio response, minimal error integral criteria, sampled data controllers.	2
3.5	Controller tuning for integrating processes – model of liquid level control system.	1
4	**Multi Loop & Nonlinear Systems:**	
	Basic principles, Design Criteria and Implementation issues of:	

4.1	Cascade control	1
4.2	Feed forward control	1
4.3	Feedback-feed forward control	1
4.4	Ratio control	1
4.5	Selective Control	1
4.6	Split range control	1
4.7	Examples and any special features of the individual loop and industrial applications	1
4.8	Nonlinear Elements in Loop: Limiters, Dead Zones, Backlash, Dead Band Velocity Limiting, Negative Resistance.	2

5	**Multivariable Control:**	
5.1	Concept of Multivariable Control: Interactions and its effects, Modelling and transfer functions, Influence of Interaction on the possibility of feedback control	2
5.2	Important effects on Multivariable system behaviour Relative Gain Array, effect of Interaction on stability and tuning of Multi Loop Control system.	2
5.3	Model Based controllers: Internal Model control	1
5.4	Model Predictive controller	1
5.5	Dynamic matrix controller (DMC)	1
5.6	Self-Tuning Controller.	1

Assignment:

Atleast one assignment should be simulation of any one type of controller using MATLAB or SIMULINK.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B. TECH DEGREE EXAMINATION

Course Code: AET304

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

Course Name: Process Dynamics and Control

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	Mention the various criteria that is taken into account while selecting variables to control a given process.	K2
2	Define degrees of freedom of a process.	K2
3	Draw the block diagram of a liquid level control loop.	K2
4	What is scaling? What are the different types of scaling?	K2
5	How will you select the best tuning constants for a feedback controller?	K3
6	What do you mean by minimal error integral criteria?	K2
7	Define dead band velocity limiting in non linear systems.	K2
8	Mention few characteristics of cascade control.	K2
9	What is Relative Gain Array? How is it useful in predicting the intertaction on stability in a multivariable control system.	K2
10	List a few features of Internal model control.	K2

PART – B

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

Module – I

11. a)	Draw the block diagram of a general process control system and explain its elements.	6	CO1	K2
11. b)	Derive the period of oscillation and damping for a second order resistive-capacitive system	8	CO1	K3
	OR			
12.a)	Compare the following systems with suitable examples (a) self-regulating and non self-regulating systems (b) Interacting and non-interacting systems	14	CO1	K3

Module – II

13 a)	Derive the expression for process gain, valve gain and steady state gain for a flow control system.	8	CO2	K3
13 b)	Compare SLPC and MLPC features.	6	CO2	K2
	OR			
14 a)	Explain linearization of an equal percentage valve into a linear valve.	8	CO2	K2
14 b)	With a neat sketch, explain a temperature control system. Also derive the expression for process time constant.	6	CO2	K3

Module – III

15 a)	Derive the tuning parameters for a PID controller for a second order process.	5	CO3	K4
15 b)	Explain a technique for fine tuning of controller with suitable example.	5	CO3	K3
15 c)	What are the various control performance measures for common input changes for a feedback system?	4	CO3	K2
	OR			
16 a)	Explain the steps involved in tuning a process with feedback controller using step testing procedure.	8	CO3	K2
16 b)	How will you tune a process using feedback controller with Quarter Decay ratio response?	6	CO3	K3

Module – IV

17 a)	Explain the multi loop control performance through decoupling	9	CO4	K2
17 b)	Explain in detail about the various tuning techniques used in multi loop control system.	5	CO4	K3
	OR			
18	Write neat sketches explain the following control loops: (a) Ratio control (b) Split range control	14	CO4	K2

Module – V

19	Write notes on: (a) Dynamic matrix controllers (b) Model predictive controller	14	CO4	K3
	OR			

20 a)	Explain the influence on interaction on the possibility of feedback control using a 2x2 system.	8	CO4	K3
20 b)	A multivariable system has the following state-space model dx/dt = [-3 2; 1 -4]x +[2 0;0 1]u and y=***I***x Obtain the transfer function model matrix for this system.	6	CO4	K3

AET306	POWER ELECTRONICS	CATEGORY	L	T	P	CREDITS
		PCC	3	1	0	4

Preamble: This course aims to develop the skill of the design of various power electronic circuits.

Prerequisite: ECT201 SOLID STATE DEVICES & ECT202 ANALOG CIRCUITS

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

CO 1	Explain the characteristics of important power semiconductor switches	K2
CO 2	Apply the principle of drive circuits and snubber circuits for power semiconductor switches	K3
CO 3	Build diode bridge rectifiers and Controlled rectifiers	K3
CO4	Develop the principle of DC – DC Switch-Mode Converter.	K3
CO 5	Illustrate the principle of DC – AC Switch-Mode Inverter	K2
CO 6	Apply the principle of power electronics for various applications.	K3

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 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): Explain the characteristics of important power semiconductor switches.

1. Illustrate the static and dynamic characteristics, Power BJT, Power MOSFET and IGBT.
2. Evaluate the switching losses of the Power diode, Power BJT, Power MOSFET.
3. Model and simulate power semiconductor switches.

Course Outcome 2 (CO2) : Apply the principle of drive circuits and snubber circuits for power semiconductor switches.

1. Design the base drive circuits for Power BJT.
2. Design the gate drive circuits forPower MOSFET.
3. Outline the principle of snubber circuits for power switches.
4. Model and simulate above circuits.

Course Outcome 3 (CO3): Build diode bridge rectifiers and Controlled rectifiers.

1. Explain the operation of diode rectifiers and the effect of various loads on the rectifier function.
2. Explain the operation of controlled rectifiers and the effect of various loads on the rectifier function.
3. Model and simulatediode rectifiers and controlled rectifiers for various loads

Course Outcome 4 (CO4): Develop the principle of DC – DC Switch-Mode Converter

1. Illustrate the principle of DC-DC converters under steady state conditions.
2. Design non-isolated and isolated DC-DC converters for given specifications.
3. Model and simulatenon-isolated and isolated DC-DC Switch-Modeconverters

Course Outcome 5 (CO5): Illustrate the principle of DC – AC Switch-Mode Inverter.

1. Understand the different types of inverters
2. Construct Driven Inverters for given specifications.
3. Model and simulateDriven Inverters

Course Outcome 6 (CO6) :Apply the principle of power electronics for various applications.

1. Illustrate the principle of Adjustable-speed DC drive.
2. Explain the principle of Variable frequency PWM-VSI Induction Motor drives
3. Give atleast two applications of power electronic circuits for residential applications.
4. Explain atleast two applications of power electronic circuits for industrial applications.

SYLLABUS

Module 1:

Power Semiconductor Switches: Overview of Power electronics application, Power diodes and Bipolar power transistors, static and dynamic characteristics, Power MOSFET and IGBT, SCR and GTO

Module 2:

Protection circuits and Rectifiers: BJT and MOSFET driver circuits, Snubber circuits, Semiconductor device temperature control, Single phase and three phase diode bridge rectifiers, Single phase and three phase Controlled rectifiers.

Module 3:

DC – DC Switch-Mode Converter: Buck, Boost and Buck-Boost converters underContinuous conduction mode, Isolated Converters: Forward, Push-Pull, Half bridge, Full bridge and Flyback configurations, Selection of power switches, Switched Mode Power Supply.

Module 4:

DC – AC Switch-Mode Inverter: Inverter topologies, Driven Inverters: Push-Pull, Half bridge and Full bridge configurations, Three phase Inverter, Pulse width modulation.

Module 5:

Applications: DC Motor Drives, Induction Motor Drives, Residential and Industrial applications, Electric utility applications.

Text Books

1. Mohan N. and T. M. Undeland, Power Electronics: Converters, Applications and Design, John Wiley, 2015
2. Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015.

Reference Books

1. Rashid M. H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi.
2. Daniel W. Hart, Power Electronics, McGraw Hill, 2011.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Power Semiconductor Switches**	
1.1	Power electronics versus Linear Electronics, Overview of Power electronics application	1
1.2	Power diodes and Bipolar power transistors, structure, static and dynamic characteristics, ratings	3
1.3	Power MOSFET and IGBT - structure, static and dynamic characteristics,	3
1.4	SCR and GTO – construction and characteristics	2
2	**Protection circuits and Rectifiers**	
2.1	BJT and MOSFET driver circuits (Atleast two circuits each)	2
2.2	Snubber circuits– On and Off snubbers	1
2.3	Semiconductor device temperature control	1
2.4	Single phase and three phase diode bridge rectifiers – basic principles only	2
2.5	Single phase and three phase Controlled rectifiers (with R, RL & RLE loads) – basic principles only	3
3	**DC – DC Switch-Mode Converter**	
3.1	Buck, Boost and Buck-Boost DC-DCconverters	2
3.2	Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode. (Derivation not required)	2
3.3	Isolated Converters : Forward, Push-Pull, Half bridge, Full bridge and Flyback configurations, waveforms and design equations. (Derivation	3

	not required)	
3.4	Selection of power switches	1
3.5	Switched Mode Power Supply, Principles of PWM switching schemes	1
4	**DC – AC Switch-Mode Inverter**	
4.1	Inverter topologies	2
4.2	Driven Inverters : Push-Pull, Half bridge and Full bridge configurations	2
4.3	Three phase Inverter	2
4.4	Sinusoidal and Space vector modulation PWM in three phase inverters	3
5	**Applications**	
5.1	DC Motor Drives – Adjustable-speed DC drive	2
5.2	Induction Motor Drives – Variable frequency PWM-VSI drives	3
5.3	Residential and Industrial applications	2
5.4	Electric utility applications	2

Assignment:

Atleast one assignment should be simulation of power electronic circuits using any circuit simulation software.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH. DEGREE EXAMINATION

Course Code: AET 306

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

Course Name: Power Electronics

Max. Marks: 100 Duration: 3Hours

	PART A Answer ALL Questions. Each Carries 3 mark.		
1.	What is the switching losses in a power diode ?	K3	CO1
2	What is the tail current in IGBT ?	K2	CO1
3	What is the purpose of snubbercircuits ?	K2	CO2
4	Obtain the expression for average load voltage in three phase full wave bridge rectifier	K3	CO3
5	What is volt-second balancing?	K2	CO4

6	What is the flux walking problem in push-pull converter ?	K2	CO4
7	What is the distinction between chopper, oscillators and inverters ?	K3	CO5
8	Distinguish between driven and self-driven inverters.	K2	CO5
9	How converters are used in induction heating ?	K2	CO6
10	What is the principle of harmonic filters ?	K2	CO6
	PART – B Answer one question from each module; each question carries 14 marks.		

	Module – I			
11. a)	Compare and contrast power BJT, MOSFET and IGBT for switching applications	7	CO1	K2
11. b)	A diode and a 10 Ω resistor are connected in series to a square wave voltage source of 50V peak. The reverse recovery time for the diode is 200nsec. Find the switching loss of the diode when the input frequency is 100 KHz.	7	CO1	K3
	OR			
12.a)	With the two transistor model of SCR, explain the working principle of SCR	7	CO1	K2
12.b)	Illustrate the dynamic characteristics of GTO	7	CO1	K2
	Module – II			
13.a)	Illustrate the base current requirement of power BJT	7	CO2	K2
b)	Explain the operation of any one of the power BJT base drive circuit	7	CO2	K2
	OR			
14.a)	Illustrate the principle of operation of a single-phase, 2 pulse, fully controlled rectifier for RL load with circuit diagram and waveforms.	10	CO3	K2
b)	Deduce the expression for average load voltage in the circuit.	4	CO3	K2

	Module – III			
15 a)	Explain the operation of Buck-Boost converter and illustrate the operation with the inductor current and switching waveforms.	8	CO4	K2
b)	A Buck-Boost converter that switching at 50 KHz is supplied with an input voltage that varies between 5V to 10V. The output is required to be regulated at 15V. A load resistor of 15Ω is connected across the output. If the maximum allowable inductor current ripple is 10% of the average inductor current, estimate the value of the inductance to be used in the Buck-Boost converter.	6	CO4	K3
	OR			

16 a)	Describe the principle of operation of the full-bridge converter with circuit diagram and waveforms.	8	CO4	K2
b)	How is the flux walking problem solved in full-bridge converter ?	6	CO4	K2
	Module – IV			
17 a)	Explain the operation of push-pull inverter	8	CO5	K2
b)	Illustrate the PWM switching scheme for sine wave output of the inverter	6	CO5	K2
	OR			
18 a)	Enumerate the principle of operation ofthree phase inverters	8	CO5	K2
b)	What is Space vector modulation in three phase inverters	6	CO5	K2
	Module – V			
19 a)	Explain the principle of adjustable speed DC drive using switched mode DC-DC converter.	8	CO6	K2
b)	Compare adjustable speed DC drives using switched mode DC-DC converter and line frequency controlled converter.	6	CO6	K2
	OR			
20 a)	Illustrate the principle of operation of Variable frequency PWM-VSI Induction Motor drive.	9	CO6	K2
b)	Explain regenerative braking scheme in Induction Motor drive.	5	CO6	K2

Simulation Assignments (AET306)

The following simulations can be done in LTPICE or any other circuit simulation software.

1. Model and simulate BJT test circuit Fig. 1.50 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.48.
2. Model and simulate MOSFET test circuit Fig. 1.51 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.49.
3. Model and simulate IGBT test circuit Fig. 1.52 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.50.
4. Model and simulate BJT drive test circuit Fig. 2.33 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.86.
5. Model and simulate MOSFET drive test circuit Fig. 2.36 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.88.

6. Model and simulate MOSFET shunt snubber test circuit Fig. 2.37of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.89.
7. Model and simulate MOSFET seriessnubber test circuit Fig. 2.39of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.90.
8. Model and simulate diode rectifiers and controlled rectifiers for various loads.
9. Model and simulate Buck converter circuit Fig. 5.68of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.277.
10. Model and simulate Boost converter circuit Fig. 5.70of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.278.
11. Model and simulate Buck-boost converter circuit Fig. 5.71of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.279.
12. Model and simulate Forward converter circuit Fig. 5.72of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.280.
13. Model and simulate Flyback converter circuit Fig. 5.73of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.281.
14. Model and simulate Driven Inverters
15. Model and simulate Pulse Width Modulator

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
AET308	COMPREHENSIVE COURSE WORK	PCC	1	0	0	1

Preamble: The objective of this Course work is to ensure the comprehensive knowledge of each student in the most fundamental Program core courses in the curriculum. Five core courses credited from Semesters 3, 4 and 5 are chosen for the detailed study in this course work. This course has an End Semester Objective Test conducted by the University for 50 marks. One hour is assigned per week for this course for conducting mock tests of objective nature in all the listed five courses.

Prerequisite:

1. ECT203 Logic Circuit Design
2. ECT205 Network Theory
3. ECT204 Signals & Systems
4. AET206 Measurements & Instrumentation
5. AET 301 Control Systems.

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

CO 1	Design and analyze combinational and sequential logic circuits.
CO 2	Apply the knowledge of fundamental network theory in analyzing any given network.
CO 3	Analyze continuous and discrete time systems in time and frequency domain using various transforms.
CO 4	Illustrate the basic principles involved in measurements and Instrumentation
CO 5	Describe fundamental concepts of control systems and mathematical modelling of the system.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	End Semester Examination
Remember	10
Understand	20
Apply	20
Analyse	
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
50	0	50	1 hour

End Semester Examination Pattern: Objective Questions with multiple choice (Four). Question paper includes fifty questions of one mark each covering the five identified courses.

Syllabus

Full Syllabus of all Five selected Courses.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Logic Circuit Design**	
1.1	Mock Test on Module 1 and Module 2	1
1.2	Mock Test on Module 3, Module 4 and Module 5	1
1.3	Feedback and Remedial	1
2	**Network Theory**	
2.1	Mock Test on Module 1, Module 2 and Module 3	1
2.2	Mock Test on Module 4 and Module 5	1
2.3	Feedback and Remedial	1
3	**Signals & Systems**	
3.1	Mock Test on Module 1 and Module 2	1
3.2	Mock Test on Module 3, Module 4 and Module 5	1
3.3	Feedback and Remedial	1
4	**Measurements & Instrumentation**	
4.1	Mock Test on Module 1, Module 2 and Module 3	1
4.2	Mock Test on Module 4 and Module 5	1
4.3	Mock Test on Module 1, Module 2 and Module 3	1

5	**Control Systems**	
5.1	Mock Test on Module 1, Module 2 and Module 3	1
5.2	Mock Test on Module 4 and Module 5	1
5.3	Feedback and Remedial	1

AEL332	POWER ELECTRONICS LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This course aims to

i. Familiarize the students with different types of power electronics circuits and application
ii. Familiarize students with simulation of basic power electronics circuits

Prerequisite: ECL202 - ANALOG CIRCUITS AND SIMULATION LAB

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

CO 1	Design and demonstrate the functioning of basic power electronics circuits.
CO 2	Design and simulate the functioning of basic power electronics circuits using simulation tools.
CO 3	Function effectively as an individual and in a team to accomplish the given task.

Mapping of course outcomes with program outcomes

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

Assessment

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15marks
ContinuousAssessment : 30 marks
Internal Test (Immediately before the second series test : 30marks

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

(a) Preliminary work : 15 Marks

(b) Implementing the work/Conducting the experiment : 10 Marks
(c) Performance, result and inference (usage of equipments and troubleshooting) : 25 Marks
(d) Vivavoce : 20 Marks
(e) Record : 5 Marks

General instructions: End-semester practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the examination only on submitting the duly certified record. The external examiner shall endorse the record.

Part A (At least 8 experiments are mandatory)

1 Power BJT drive circuits

2. Power MOSFET drive circuits

3 Snubber circuits

4. Three phase diode bridge rectifier

5 Single phase Controlled rectifiers with R, RL loads

6 Realization of basic Buck, Boost and Buck-Boost converters

7 Realization of half bridge converter

8. Application of PWM IC TL 494

9. DC to AC inverter using MOSFET & IC

10. Realization of simple SMPS

Part B (At least 8 experiments are mandatory)

Experiments shall be done using SPICE/ MATLAB

1 Drive circuitsfor Power BJT

2. Drive circuits for Power MOSFET

3 Snubber circuits – shunt and series

4. Three phase diode bridge rectifier

5 Single phase Controlled rectifiers with R, RL loads

6 Realization of Buck, Boost and Buck-Boost converters. Study its Continuous and discontinuous conduction mode

7 Realization of Isolated Converters : Push-Pull, Half bridgeand Full bridge configurations

8. DC to AC inverter using MOSFET

9. Realization of simple SMPS

10. DC motor speed control

* Manual has to be prepared by the college

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
AED 334	MINIPROJECT	PWS	0	0	3	2

Objectives

- For enabling the students to apply the knowledge to address the real-world situations/problems and find solutions.
- To estimate the ability of the students in transforming the theoretical knowledge studied in to a working model of an electronic system.
- Design and development of Small electronic project based on hardware or a combination of hardware and software for electronics systems.

Course Plan

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

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

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

Expected outcome

1. Students will be able to practice acquired knowledge within the selected area of technology for project development.
2. Identify, discuss and justify the technical aspects and design aspects of the project with a systematic approach.
3. Reproduce, improve and refine technical aspects for engineering projects.
4. Work as a team in development of technical projects.
5. Communicate and report effectively project related activities and findings.

Evaluation

The internal evaluation will be made based on the product, the report and a viva- voce examination, conducted by a 3-member committee appointed by Head of the Department comprising HoD or a senior faculty member, Academic coordinator for that program, project guide/coordinator.

The Committee will be evaluating the level of completion and demonstration of functionality/specifications, presentation, oral examination, work knowledge and involvement.

Total Marks	150
CIE	75
ESE	75

Split up for CIE	
Attendance	10
Marks awarded by Guide	15
Project Report	10
Evaluation by the Committee	40

Split up for ESE	
Demonstration	50
Project Report	10
Viva-Voce	15

SEMESTER VI

PROGRAM ELECTIVE I

ECT312	DIGITAL SYSTEM DESIGN	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to design hazard free synchronous and asynchronous sequential circuits and implement the same in the appropriate hardware device

Prerequisite: ECT203 Logic Circuit Design

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

CO 1 K4	Analyze clocked synchronous sequential circuits
CO 2 K4	Analyze asynchronous sequential circuits
CO 3 K3	Design hazard free circuits
CO 4 K3	Diagnose faults in digital circuits
CO 5 K2	Summarize the architecture of FPGA and CPLDs

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	3		2				2	2		3
CO2	3	3			2				2	2		3
CO3	3	3	3	3					2	2		3
CO4	3	2		1					2	2		3
CO5	2								2	2		3

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	15
Understand	K2	10	20	30
Apply	K3	20	20	35
Analyse	K4	10		20
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Test (2 numbers) : 25 marks

Assignment/Quiz/Course project : 15 marks

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

Course Level Assessment Questions

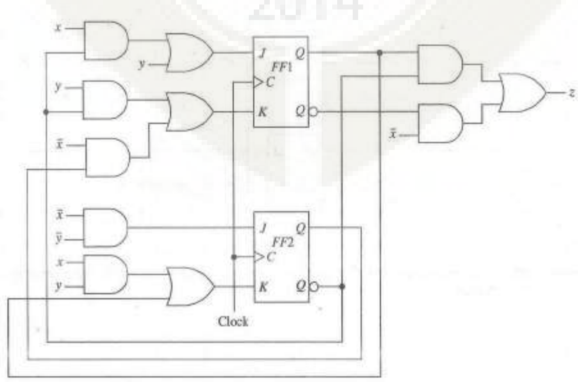
Course Outcome 1 (CO1): Analyze clocked synchronous sequential circuits (K4)

1. Construct an ASM chart for a sequence recognizer to recognize the input sequence of pairs x1x2= 01, 01, 11, 00. The output variable, 'z' is asserted when x1x2= 00 if and only if the three preceding pairs of inputs are x1x2= 01, 01 and 11, in that order.

2. Obtain a minimal state table for a clocked synchronous sequential network having a single input line 'x' in which the symbols 0 and 1 are applied and a single output line 'z'. An outputof 1 is to be produced if and only if the 3 input symbols following two consecutive input 0's consist of at least one 1. An example of input/output sequences that satisfy the conditions of the network specifications is:

   x=01000100100100100000000011
   z=00000010000001000000000001

3. Analyse the following clocked synchronous sequential network. Derive the next state and output equations. Obtain the excitation table, transition table, state table and state diagram.

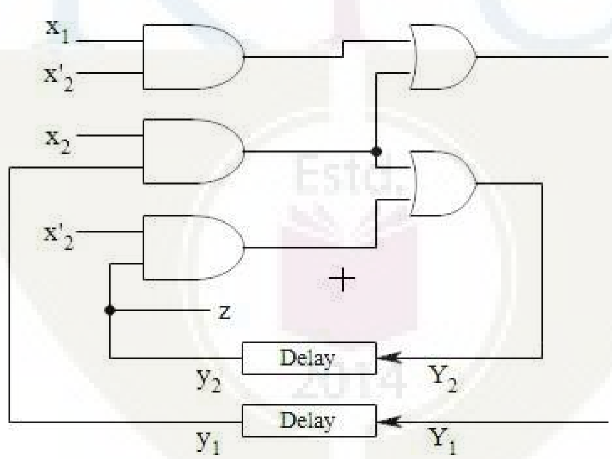


Course Outcome 2 (CO2): Analyze asynchronous sequential circuits (K4)

1. A reduced flow table for a fundamental-mode asynchronous sequential network is given below. Using the universal multiple-row state assignment, construct the corresponding expanded flow table and transition table. Assign outputs where necessary such that there is at most a single output change during the time the network is unstable. Assume that the inputs x1 and x2 never change simultaneously.

Present state	Next state				Output (z)			
	Input state (x_1x_2)				Input state (x_1x_2)			
	00	01	10	11	00	01	10	11
A	(A)	B	(A)	D	1	-	0	-
B	D	(B)	(B)	C	-	0	1	-
C	A	(C)	(C)	(C)	-	1	1	0
D	(D)	C	A	(D)	0	-	-	1

2. Analyze the asynchronous sequential network by forming the excitation/transition table, state table, flow table and flow diagram. The network operates in the fundamental mode with the restriction that only one input variable can change at a time.



3. Describe races in ASN with example.

Course Outcome 3 (CO3): Design hazard free circuits (K3)

1. Differentiate between static and dynamic hazard.

2. Examine the possibility of hazards in the (i) OR-AND logic circuit whose Boolean function is given by $f = \sum(0,2,6,7)$ (ii) AND-OR logic circuit whose Boolean function is given by $f = \sum(3,4,5,7)$. Show how the hazard can be detected and eliminated in each circuit.

3. Investigate the problem of clock skew in practical sequential circuits and suggest solutions with justification to minimize or eliminate it.

Course Outcome 4 (CO4): Diagnose faults in digital circuits (K3)

1. Illustrate the fault table method used for effective test set generation for the circuit whose Boolean function is $z = \overline{x_1}x_2 + x_3$
2. Find the test vectors of all SA0 and SA1 faults of the circuit whose Boolean function is $f = \bar{x}_1 x_2 + x_1 x_2 x_3$ by the Kohavi algorithm.
3. Write a note on BIST techniques.

Course Outcome 5 (CO5): Summarize the architecture of FPGA and CPLDs (K2)

1. Draw and explain the architecture of Xilinx XC4000 configurable logic block.
2. Draw and explain the architecture of Xilinx 9500 CPLD family.
3. Explain the internal structure of XC4000 input/output block.

SYLLABUS

Module 1: Clocked Synchronous Networks

Analysis of clocked Synchronous Sequential Networks (CSSN), Modelling of CSSN – State assignment and reduction, Design of CSSN, ASM Chart and its realization

Module 2: Asynchronous Sequential Circuits

Analysis of Asynchronous Sequential Circuits (ASC), Flow table reduction- Races in ASC, State assignment problem and the transition table- Design of AS, Design of ALU

Module 3: Hazards

Hazards – static and dynamic hazards – essential, Design of Hazard free circuits – Data synchronizers, Mixed operating mode asynchronous circuits, Practical issues- clock skew and jitter, Synchronous and asynchronous inputs – switch bouncing

Module 4: Faults

Fault table method – path sensitization method – Boolean difference method, Kohavi algorithm, Automatic test pattern generation – Built in Self Test (BIST)

Module 5: CPLDs and FPGA

CPLDs and FPGAs - Xilinx XC 9500 CPLD family, functional block diagram– input output block architecture - switch matrix, FPGAs – Xilinx XC 4000 FPGA family – configurable logic block - input output block, Programmable interconnect

Text Books

1. Donald G Givone, Digital Principles & Design, Tata McGraw Hill, 2003
2. John F Wakerly, Digital Design, Pearson Education, Delhi 2002
3. John M Yarbrough, Digital Logic Applications and Design, Thomson Learning

Reference Books

1. Miron Abramovici, Melvin A. Breuer and Arthur D. Friedman, Digital Systems Testing and Testable Design, John Wiley & Sons Inc.
2. Morris Mano, M.D.Ciletti, Digital Design, 5th Edition, PHI.
3. N. N. Biswas, Logic Design Theory, PHI
4. Richard E. Haskell, Darrin M. Hanna , Introduction to Digital Design Using Digilent FPGA Boards, LBE Books- LLC
5. Samuel C. Lee, Digital Circuits and Logic Design, PHI
6. Z. Kohavi, Switching and Finite Automata Theory, 2nd ed., 2001, TMH

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Clocked Synchronous Networks**	
1.1	Analysis of clocked Synchronous Sequential Networks(CSSN)	2
1.2	Modelling of CSSN – State assignment and reduction	2
1.3	Design of CSSN	2
1.4	ASM Chart and its realization	1
2	**Asynchronous Sequential Circuits**	
2.1	Analysis of Asynchronous Sequential Circuits (ASC)	2
2.2	Flow table reduction- Races in ASC	2
2.3	State assignment problem and the transition table- Design of AS	2
2.4	Design of ALU	2
3	**Hazards**	
3.1	Hazards – static and dynamic hazards – essential	1
3.2	Design of Hazard free circuits – Data synchronizers	1
3.3	Mixed operating mode asynchronous circuits	1
3.4	Practical issues- clock skew and jitter	1
3.5	Synchronous and asynchronous inputs – switch bouncing	2
4	**Faults**	
4.1	Fault table method – path sensitization method – Boolean difference method	2
4.2	Kohavi algorithm	2
4.3	Automatic test pattern generation – Built in Self Test(BIST)	3
5	**CPLDs and FPGA**	
5.1	CPLDs and FPGAs - Xilinx XC 9500 CPLD family, functional block diagram– input output block architecture - switch matrix	3
5.2	FPGAs – Xilinx XC 4000 FPGA family – configurable logic block - input output block, Programmable interconnect	3

Simulation Assignments:

At least one assignment should be design of digital circuits that can be used in day today life. This has to be done in a phased manner. The first phase involves the design in HDL (VHDL/ Verilog) and the second phase implementing the same in a hardware device. Some of the assignments are as listed below:

1. Design of vending machine
2. Design of ALU
3. Architecture of different FPGAs
4. Architecture of different CPLDs
5. Fault detection methods other than those mentioned in the syllabus
6. Metastability condition and methods to avoid it

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: ECT312

Course Name: DIGITAL SYSTEM DESIGN

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each carries 3 marks.

1	Differentiate Mealy and Moore models.	K1
2	What are the elements in an ASM chart?	K1
3	Describe one-hot assignment technique.	K2
4	Define critical and non-critical races.	K1
5	What is jitter? List the sources of clock jitter.	K2
6	Differentiate positive skew and negative skew.	K2
7	List the different types of faults in digital circuits.	K1
8	Differentiate between fault and defect.	K2
9	What are FPGA? What are the advantages of FPGA?	K1
10	Differentiate between FPGA and CPLD	K2

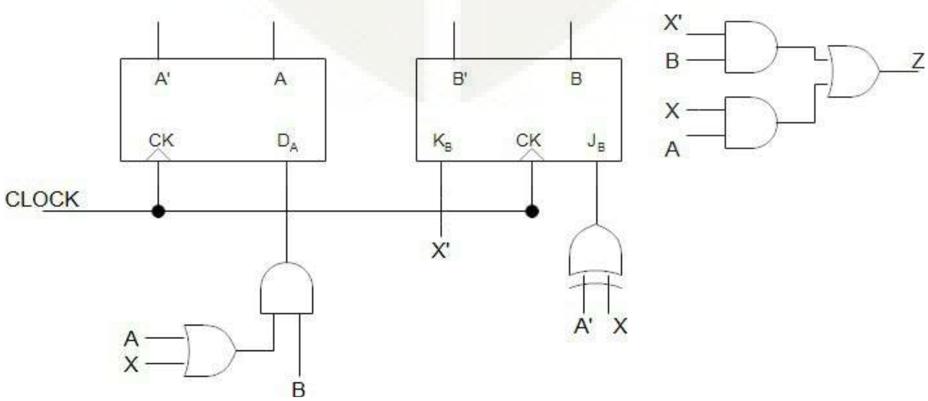
PART – B

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

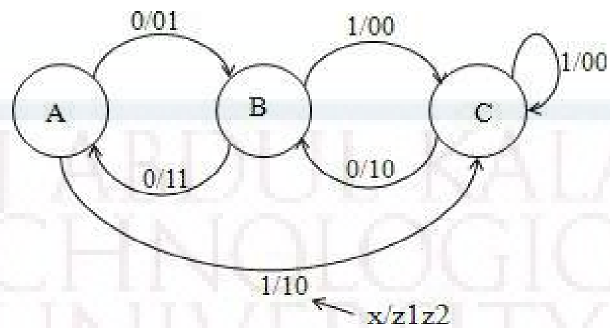
Module - I

11 a Analyze the following sequential network. Derive the next state and output equations. Obtain its transition table and state table. 8

CO1 K4

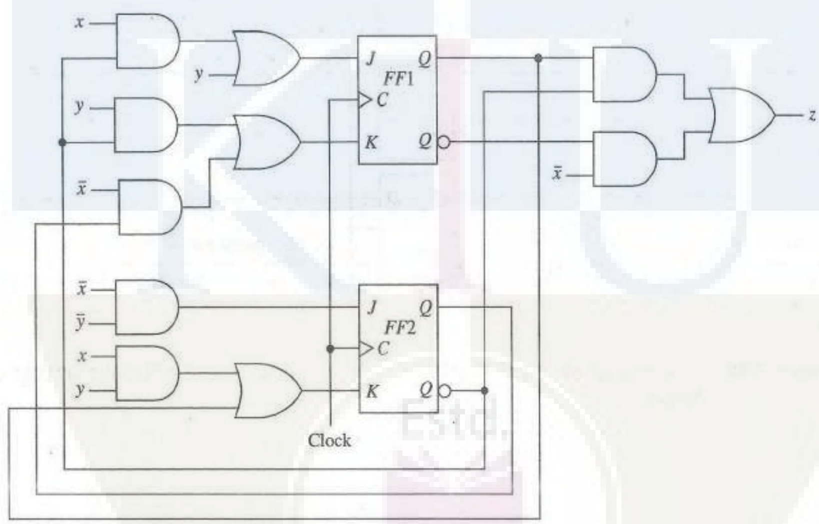


b. Construct an ASM chart for the following state diagram shown. Determine the model of CSSN that this system conforms to with proper justification. 6 CO1 K3



OR

12 For the clocked synchronous sequential network, construct the excitation table, transition table, state table and state diagram. 8 CO1 K4



b. Obtain a minimal state table for a clocked synchronous sequential network having a single input line 'x' in which the symbols 0 and 1 are applied and a single output line 'z'. An output of 1 is to be produced if and only if the 3 input symbols following two consecutive input 0's consist of at least one 1. An example of input/output sequences that satisfy the conditions of the network specifications is: 6

x= 01000100100100100000000011

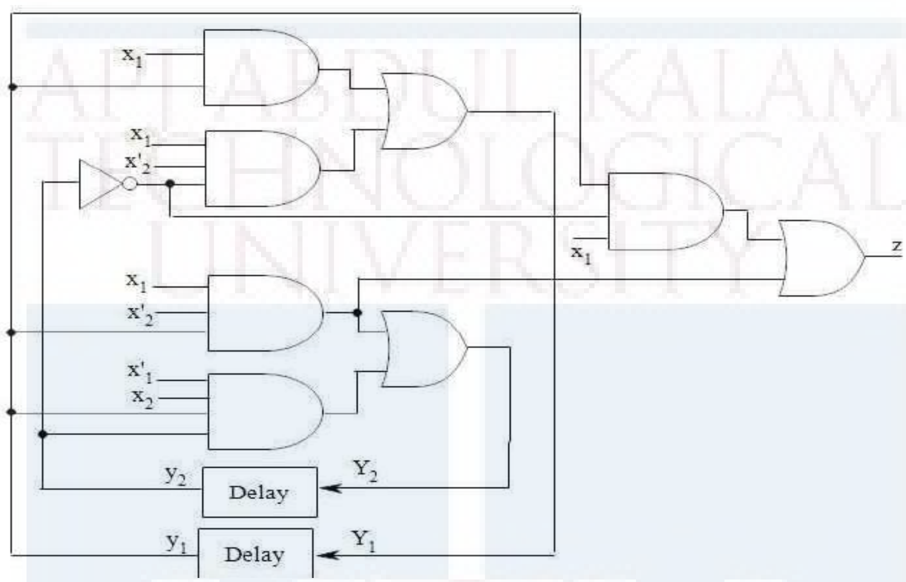
z= 00000010000000100000000001

CO1 K3

Module - II

13a Analyze the asynchronous sequential network by forming the excitation/transition table, state table, flow table and flow diagram. The network operates in the fundamental mode with the restriction that only one input variable can change at a time. 14

CO2
K4



OR

x_1 x_2

14a A reduced flow table for a fundamental-mode asynchronous sequential network is given below. Using the universal multiple-row state assignment, construct the corresponding expanded flow table and transition table. Assign outputs where necessary such that there is at most a single output change during the time the network is unstable. Assume that the inputs and never change simultaneously. 14

CO2
K4

Present state	Next state				Output (z)			
	Input state (x_1x_2)				Input state (x_1x_2)			
	00	01	10	11	00	01	10	11
A	(A)	B	(A)	D	1	-	0	-
B	D	(B)	(B)	C	-	0	1	-
C	A	(C)	(C)	(C)	-	1	1	0
D	(D)	C	A	(D)	0	-	-	1

Module - III

15a. Examine the possibility of hazard in the OR-AND logic circuit whose Boolean function is given by $f = \sum(0,2,6,7)$. Show how the hazard can be detected and eliminated. 8 CO3 K3

b. Explain essential hazards in asynchronous sequential networks. What are the constraints to be satisfied to avoid essential hazards? 6 CO3 K3

OR

16a Draw the logic diagram of the POS expression Y= (x1+x2') (x2+x3). Show that there is a static-0 hazard when x1 and x3 are equal to 0 and x2 goes from 0 to 1. Find a way to remove the hazard by adding one or more gates. 9 CO3 K3

b Discuss the concept of switch bouncing and suggest a suitable solution. 5 K3

Module - IV

17a Illustrate the fault table method used for effective test set generation for the circuit whose Boolean function is $z = \overline{x_1}x_2 + x_3$ 8 CO 4 K3

b How can the timing problems in asynchronous sequential circuits be solved using mixed operating mode circuits? 6 K3

OR

18 a. Find the test vectors of all SA0 and SA1 faults of the circuit whose Boolean function is $f = \bar{x}_1 x_2 + x_1x_2x_3$ by the Kohavi algorithm. 8 CO4 K3

b. Identify different test pattern generation for BIST 6 CO4 K3

Module - V

19 Explain the architecture of XC 4000 FPGA family. 14 CO5 K2

OR

20 Draw and explain the architecture of Xilinx 9500 CPLD family. Also explain the function block architecture. 14 CO5 K2

AET322	DIGITAL IMAGE PROCESSING	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to develop a strong understanding of the basic image processing operations.

Prerequisite: ECT204 Signals and Systems

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

CO 1	Explain the fundamental concepts related to digital image processing and generation of digital images.
CO 2	Apply the principles of various 2D transforms in digital image processing.
CO 3	Implement spatial and frequency domain image enhancement techniques using mathematical principles.
CO4	Interpret the techniques involved in image segmentation and image restoration algorithms.
CO5	Compare different techniques involved in image compression and implement the fundamental image processing algorithms on computers.

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				3	3						3
CO 2	3	3			3	3						3
CO 3	3	3			3	3						3
CO 4	3	3			3	3						3
CO5	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 fundamental concepts related to digital image processing and generation of digital images.

1. Explain the fundamental steps in image processing.
2. Explain image digitization.

Course Outcome 2 (CO2): Apply the principles of various 2D transforms in digital image processing.

1. Explain the properties of 2D DFT.
2. Find the KL transform for the given image patch.

Course Outcome 3 (CO3): Implement spatial and frequency domain image enhancement techniques using mathematical principles.

1. Explain the various spatial domain image enhancement techniques.
2. Compare smoothening and sharpening filters.

Course Outcome 4 (CO4): Interpret the techniques involved in image segmentation and image restoration algorithms.

1. Explain region based segmentation.
2. What is image restoration? Give the model of image degradation/restoration process.

Course Outcome 5 (CO5): Compare different techniques involved in image compression and implement the fundamental image processing algorithms on computers.

1. Explain an image compression model.
2. Obtain the Huffman code for the word 'SEGMENTATION'

SYLLABUS

Module 1:

Image fundamentals: Fundamental Steps in Image Processing, Elements of a Digital Image Processing System, Elements of Visual Perception, A Simple Image Model. Digital Image representation- 2D Sampling and Quantization. Two dimensional systems - 2D convolution. Colour image fundamentals-RGB, CMY, HIS models

Module 2:

Image transforms: Introduction to Fourier Transform, 2D Discrete Fourier Transform and Properties. Hadamard Transform, Walsh transform, Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) , KL transform and Singular Value Decomposition.

Module 3:

Image Enhancement in spatial domain: Point operations and Neighbourhood Operations, Gray-Level Transformation, Bit plane slicing , Histogram Processing. Spatial filtering- smoothing filters, sharpening filters. Image Enhancement in frequency domain: Low pass and high pass filters, homomorphic filtering.

Module 4:

Image Restoration: Image Degradation model, Classification of image restoration Techniques, Estimation of degradation function. Inverse filtering, Weiner filtering.

Image segmentation: Classification of Image segmentation techniques, Type of edges, Edge detection, Segmentation based on thresholding, Region based segmentation.

Module 5:

Image Compression: Types of redundancy, Image Compression Model, Lossless Compression methods: Arithmetic Coding, Huffman Coding, Vector quantization.

Image compression standards - JPEG &MPEG, Wavelet based image compression.

Text Books

1. Gonzalez Rafel C, Digital Image Processing, Pearson Education, 2009
2. S Jayaraman, S Esakkirajan, T Veerakumar, Digital image processing , Tata Mc Graw Hill, 2015.

Reference Books

1. Anil K Jain , Fundamentals of digital image processing: , PHI,1988
2. Kenneth R Castleman , Digital image processing:, Pearson Education,2/e,2003
3. Pratt William K, Digital Image Processing: , John Wiley,4/e,2007.
4. Milan Sonka et. al., 'Image Processing, Analysis and Machine Vision', Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Image Fundamentals**	
1.1	Fundamental Steps in Image Processing, Elements of a Digital Image Processing System	1
1.2	Elements of Visual Perception, A Simple Image Model.	1
1.3	Digital Image representation- 2D Sampling and Quantization	2
1.4	Two dimensional systems - 2D convolution	1
1.5	Colour image fundamentals-RGB, CMY, HIS models	2
2	**Image transforms**	
2.1	Introduction to Fourier Transform, 2D Discrete Fourier Transform and Properties.	2
2.2	Hadamard Transform, Walsh transform, Discrete Cosine Transform (DCT),	2
2.3	Discrete Wavelet Transform (DWT)	1
2.4	KL transform and Singular Value Decomposition.	2
3	**Image Enhancement**	
3.1	Point operations and Neighbourhood Operations , Gray-Level Transformation, Bit plane slicing	2
3.2	Histogram Processing	2
3.3	Spatial filtering- smoothing filters, sharpening filters	1
3.4	Image Enhancement in frequency domain: Low pass and high pass filters, homomorphic filtering.	2
4	**Image Restoration**	
4.1	Estimation of degradation function, Image Degradation model, Classification of image restoration Techniques.	2
4.2	Inverse filtering, Weiner filtering	1
4.3	**Image segmentation**: Classification of Image segmentation techniques, Type of edges, Edge detection	2
4.4	Segmentation based on thresholding, Region based segmentation.	2
5	**Image Compression**	
5.1	Types of redundancy, Image Compression Model	2
5.2	Lossless Compression methods : Arithmetic Coding, Huffman Coding	2
5.3	Vector quantization. Image compression standards -JPEG &MPEG	2
5.4	Wavelet based image compression.	1

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AE322

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

Course Name: Digital Image Processing

Max. Marks : 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	Explain the fundamental steps in image processing.		CO1
2	What is image digitization?		CO1
3	For the image segment I $=\begin{bmatrix} 2 & 2 \\ 1 & 3 \end{bmatrix}$, compute the transform coefficients using DFT.		CO2
4	What are orthogonal transforms?		CO2
5	Distinguish between unsharp masking and high boost filtering.		CO3
6	What is histogram equalization?		CO3
7	Give the model of image degradation/restoration process and explain.		CO4
8	Mention the different types of edges in an image.		CO4
9	State and explain the state of redundancies in images.		CO5
10	Draw the block diagram of an image compression model.		CO5

PART – B

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

Module – I

11. a)	State and explain 2D sampling theorem for band limited images.	8	CO1	K1

11. b)	Explain how colour images are represented using HSI colour space model.	6	CO1	K2
	OR			
12.a)	An image $f(x, y) = 2 \cos 2\pi (3x + 4y)$ is sampled with sampling intervals $\Delta x = 0.2$ and $\Delta y = 0.2$ in x and y direction respectively. Determine the i) Sampled image spectrum ii) Fourier transform of image after it has been low pass filtered iii) Reconstructed image. Will the system produce aliasing error?	7	CO1	K3
12.b)	Explain the basic elements in a digital image processing system.	7	CO1	K2

Module – II

13. a)	State and prove any two properties of 2D DFT.	8	CO2	K2
13. b)	Find the DCT of the sequence x(n) = {11,22,33,44}	6	CO2	K2
	OR			
14.a)	Perform KL transform of the following matrix $X = \begin{matrix} 4 & -1 \\ -2 & 3 \end{matrix}$	10	CO2	K2
14.b)	Define the energy compaction property of a unitary transform.	4	CO2	K1

MODULE III

15. a)	Given an image in which the stars are barely visible, owing to superimposed illumination resulting from atmospheric dispersion. Give an enhancement procedure based on homomorphic filtering to bring out the image components due to the stars themselves.	6	CO3	K3
15. b)	Briefly explain the various image enhancement operations in spatial domain.	8	CO3	K2
	OR			

16.a)	What are the advantages of filtering in frequency domain?	4	CO3	K1
16.b)	A 4 x 4 image patch (4 bits/pixel) is given by I= $\begin{bmatrix} 12 & 9 & 12 & 10 \\ 12 & 14 & 8 & 10 \\ 9 & 13 & 12 & 10 \\ 12 & 14 & 12 & 10 \end{bmatrix}$ Apply histogram equalization to the image by rounding the resulting image pixels to integers. Sketch the histograms of original image and histogram equalised image.	10	CO3	K3

MODULE IV

17. a)	Explain the Wiener filter for image restoration. State the advantages and disadvantages of wiener filter.	8	CO4	K2
17. b)	Explain split and merge procedure in image segmentation.	6	CO4	K2
	OR			
18.a)	Explain how a degraded image can be restored using an inverse filter. Explain its limitations.	7	CO4	K2
18.b)	How edge detection is performed in images?	7	CO4	K2

Module – V

19.a)	With the help of a block diagram, explain DCT based JPEG compression standard.	8	CO5	K2
19.b)	Explain the analytics of Arithmetic Coding based Compression.	6	CO5	K2
	OR			
20.a)	Obtain the Huffman code for the word ‘SEGMENTATION’	7	CO5	K3
20.b)	Discuss Vector quantization.	7	CO5	K2

AET332	COMPUTER NETWORKS	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to impart the basics of computer networking, various functional layers and their functions and the associated protocols.

Prerequisite: Nil.

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

CO1	Summarize the functions of each layer in the reference models.
CO2	Explain the addressing at the data link layer, and various media access control methods
CO3	Explain various services and addressing schemes at the network layer
CO4	Review the transport layer services, TCP and UDP
CO5	Summarize the application layer protocols and the concept of flow control for improving QOS.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	30	30	60
Understand	K2	20	20	40
Apply	K3			
Analyse	K4			
Evaluate				
Create				

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Summarize the functions of each layer in thereference models.

1. Explain the function of data link layer.
2. Compare the characteristics of guided and unguided transmission media.
3. Compare circuit switching with packet switching.
4. Explain TCP/IP protocol suite.

Course Outcome 2 (CO2): Explain the addressing at the data link layer, and various media access control methods.

1. Explain transparent routing of bridges.
2. Compare various multiple access protocols.
3. Explain Selective Repeat ARQ protocol.
4. Compare Standard Ethernet, Fast Ethernet and Gigabit Ethernet.

Course Outcome 3 (CO3): Explain the addressing schemes at the network layer, and various routing algorithms.

1. Explain classless interdomain routing.
2. What is the use of extension header in IPv6?
3. Explain IPv6 header format.
4. Explain ARP with the format of a packet.

Course Outcome 4 (CO4): Describe the transport layer services, and TCP and UDP.

1. Compare connection oriented and connectionless protocols.
2. Compare TCP and UDP services.
3. Explain implicit and explicit signaling for congestion control.
4. TCP is a reliable data protocol. Justify the statement.

Course Outcome 5 (CO5): Summarize the application layer protocols and the concept of flow control for improving QOS.

1. Explain the flow control mechanism in TCP.
2. Explain WWW and HTTP.
3. Write notes on SNMP.
4. Explain how an email is sent using SMTP.

SYLLABUS

MODULE I

Networks: Network types, Topology, Protocol layering, TCP/ IP protocol suite, The OSI model.

Physical layer: Guided and unguided transmission media, Circuit switched networks, Packet switched networks

MODULE II

Data-Link Layer: Link-Layer addressing, Peer-to-peer protocols, Stop-and-wait ARQ protocol, Go-back-N ARQ protocol, Selective-repeat ARQ protocol.

Media Access Control (MAC): Random access: ALOHA, CSMA, Controlled access, Channelization.

Wired LAN (Ethernet): Ethernet protocol, Standard Ethernet, Fast Ethernet (100 Mbps), Gigabit Ethernet, LAN bridges and Ethernet switches,

MODULE III

Network layer: Network layer services, Packet switching, IPv4 header, IPv4 addressing, subnet addressing, IP routing, Classless Interdomain Routing, Address resolution, fragmentation and reassembly, IPv6 header format, IPv6 addressing, extension headers.

MODULE IV

Transport layer: Transport layer services, Connectionless and connection-oriented protocols.

User Datagram Protocol (UDP): User datagram, UDP services, UDP applications.

Transmission Control Protocol (TCP): TCP Services, TCP features, Segment, TCP connection establishment and connection termination, Congestion Control.

MODULE V

Application Layer: HTTP, World Wide Web, FTP, Domain Name System, Electronic Mail, SNMP.

Quality of Service: Data-flow characteristics, Flow control to improve QOS.

Text Books

1. Forouzan, Data Communications and Networking, 5/e, Mc Graw Hill, 2013.
2. Leon Garcia and Indra Widjaja, Communication Networks, 2/e, Mc Graw Hill, 2013.

Reference Books

1. Larry L. Peterson & Bruce S. Dave, Computer Networks-A Systems Approach, 5/e, Morgan Kaufmann, 2011.
2. William Stallings, Data and Computer Communications, 9/e, Pearson, 2014.
3. Dimitri Bertsekas and Robert Gallager, 2/e, Pearson, 2015.
4. Andrew S Tanenbaum, Computer Networks, 4/e, Pearson, 2003.

Course Contents and Lecture Schedule

No.	Topic	No. of lecture hours
1	**Networks**	
1.1	Network types, Topology	1
1.2	Protocol layering	1
1.3	TCP/ IP protocol suite	1
1.4	The OSI model	1
	Physical layer	
1.5	Guided and unguided transmission media	1
1.6	Circuit switched networks	1
1.7	Packet switched networks	1
2	**Data-Link Layer**	
2.1	Link-Layer addressing	1
2.2	Peer-to-peer protocols	1
2.3	Stop-and-wait ARQ protocol, Go-back-N ARQ protocol, Selective-repeat ARQ protocol	1
	Media Access Control (MAC)	
2.4	Random access: ALOHA, CSMA	1
2.5	Controlled access, Channelization	1
	Wired LAN (Ethernet)	
2.6	Ethernet protocol, Standard Ethernet, Fast Ethernet (100 Mbps), Gigabit Ethernet,	1
2.7	LAN bridges and Ethernet switches	1
3	**Network layer**	
3.1	Network layer services, Packet switching	1
3.2	IPv4 header, IPv4 addressing, subnet addressing	1

3.3	IP routing,	1
3.4	Classless Interdomain Routing	1
3.5	Address resolution	1
3.6	fragmentation and reassembly	1
3.7	IPv6 header format, IPv6 addressing, extension headers	1
4	**Transport layer**	
4.1	Transport layer services, Connectionless and connection-oriented protocols	1
	User Datagram Protocol (UDP)	
4.2	User datagram	1
4.3	UDP services, UDP applications	1
	Transmission Control Protocol (TCP)	
4.4	TCP Services, TCP features	1
4.5	Segment	1
4.6	TCP connection establishment and connection termination,	1
4.7	Congestion Control	1
5	**Application Layer**	
5.1	World Wide Web, FTP	1
5.2	Domain Name System	1
5.3	Electronic Mail	1
5.4	SNMP	1
	Quality of Service	
5.5	Data-flow characteristics	1
5.6	Flow control to improve QOS	2

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET 332

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

Course Name: Computer Networks

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 marks.

1.	Mention different types of computer networks.	CO1	K1
2.	Compare guided and unguided transmission media.	CO1	K2
3.	What are the functions of a LAN bridge?	CO2	K1
4.	Name and discuss about the switching devices at different functional layers.	CO2	K2
5.	What is meant by fragmentation and reassembly?	CO3	K1
6.	Explain the concept of subnet addressing.	CO3	K1
7.	Compare congestion control and flow control.	CO4	K2
8.	Discuss about UDP services.	CO4	K1
9.	Which are the messages sent between the client and server during the mail transfer phases?	CO5	K2
10.	Explain one of the scheduling techniques used to improve QOS.	CO5	K1

PART – B

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

Module – I

11.	Explain OSI reference model.	14	CO1	K1
	OR			
12 a).	Compare circuit-switched and packet-switched networks.	5	CO1	K2
12 b).	Explain different phases involved in circuit switching.	9	CO1	K1

Module – II

13.	Explain various ARQ protocols and compare them.	14	CO2	K2
	OR			
14.	Explain the characteristics, frame format and addressing of standard	14	CO2	K1

	Ethernet.			

Module – III

15 a).	Draw IPV4 header format and explain various fields.	9	CO3	K1
15 b).	Explain the major changes in IPv6 compared to IPv4.	5	CO3	K2
OR				
16 a).	Draw IPV6 header format and explain various fields.	9	CO3	K1
16 b).	Compare classful and classless addressing in IPv4.	5	CO3	K2

Module – IV

17 a).	Draw TCP header format and explain various fields.	9	CO4	K1
17 b).	Explain send window and receive window in TCP	5	CO4	K2
OR				
18 a).	Explain the slow start algorithm for congestion control.	9	CO4	K1
18 b).	Explain congestion avoidance with a suitable algorithm.	5	CO4	K2

Module – V

19 a).	Explain FTP with some examples of FTP commands.	9	CO5	K1
19 b).	List the identifiers used to define a web page. Give examples for URL.	5	CO5	K2
OR				
20 a).	Explain traffic shaping or policing to improve QOS.	9	CO5	K1
20 b).	Compare persistent and nonpersistent connections in HTTP.	5	CO5	K2

AET342	BIOMEDICAL INSTRUMENTATION	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to familiarize principles of various biomedical instrumentation systems.

Prerequisite: AET206 Measurements & Instrumentation

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

CO 1	Describe the basic principles of physiological systems of human body.
CO 2	Illustrate the design principles and development of various biomedical instruments.
CO 3	Explain the principle of patient monitoring systems and identify safety issues related to biomedical instrumentation.
CO4	Describe the applications of medical imaging techniques in biomedical instrumentation.

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
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	20
Understand	K2	40	40	80
Apply	K3			
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): Describe the basic principles of physiological systems of human body.

1. What is resting potential and action potential? Explain the propagation of action potential in a nerve fibre.
2. Explain psychological transducers with necessary diagrams.
3. Explain cardiovascular dynamics.

Course Outcome 2 (CO2): Illustrate the design and development of various biomedical instruments**.**

1. Describe the working of ultrasonic diathermy unit.
2. What are hearing aids? Explain the principle operation of hearing aids.
3. Explain the working of synchronous and asynchronous pace maker with block diagram.

Course Outcome 3 (CO3): Explain the principle of patient monitoring systems and identify safety issues related to biomedical instrumentation.

1. What is biotelemetry? How patient monitoring can be realized using bio telemetry?
2. Explain the causes of electric shock hazards in hospitals. What are the precautions to minimize electric shock hazards?
3. Explain the elements of intensive cardiac unit.

Course Outcome 4 (CO4): Describe the applications of medical imaging techniques in biomedical instrumentation.

1. Describe Holter monitoring technique.
2. Explain with neat diagram the working of X-ray machine. Describe the application of X-rays in medical field.
3. Explain computer tomography with a necessary diagrams.

SYLLABUS

Module 1:

Development of biomedical instrumentation, man instrument system components- block diagram, problems encountered in biomedical measurements. Physiological systems of the body (brief discussion on Heart and cardio vascular system, Anatomy of nervous system, Physiology of respiratory systems).

Sources of bioelectric potentials- resting potential, action potential, bioelectric potentials, electrode theory, bipolar and unipolar electrodes, surface electrodes, physiological transducers. Bio electric potentials example (ECG, EEG, EMG, ERG etc.)

Module 2:

Electro-conduction system of the heart. Electro cardiography – electrodes and leads – Einthoven triangle, ECG machine– block diagram. Measurement of blood pressure – direct and indirect measurement–oscillometric measurement–ultrasonic method, blood flow cardiac output, plethysmography, cardiac arrhythmia, pace makers, defibrillators.

Module 3:

Electroencephalogram–neuronal communication– EEG measurement. Muscle response–Electromyogram (EMG)– Nerve Conduction velocity measurements- Electromyogram Measurements. Respiratory parameters – Spiro meter, pneumograph. Artificial respirator, nerve stimulator, artificial kidney machine, hearing aids, diathermy.

Module 4:

Patient monitoring systems: Intensive cardiac care, bedside and central monitoring systems, patient monitoring through bio-telemetry, implanted transmitters, telemetering multiple information. Sources of electrical hazards and safety techniques

Module 5:

Recent trends: Medical imaging, X-rays, laser applications. Basic principle of computed tomography, magnetic resonance imaging system and nuclear medicine system – radiation therapy. Ultrasonic imaging system - introduction and basic principle, colour doppler systems. Holter monitoring, endoscopy.

Text Books

John. G. Webster, "Medical Instrumentation, Application and Design" John Wiley, New York, 1998

Cromwell, F. J. Weibell and L. A. Pfeiffer, Biomedical Instrumentation Measurements, Pearson education, Delhi, 1990.

Reference Books

Arumugam M. "Biomedical Instrumentation", Anuradha Agencies Publishers, Kumbakonam, 2006.

R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata Mc Graw Hill ",

J. Carr and J. M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education

R Geddes L. A. and Baker L. E., "Principles of Applied Biomedical Instrumentation", 3rd Edition, John Wiley, New York, 1989

Richard Aston, "Principles of Bio-medical Instrumentation and Measurement", Merril Publishing Company, New York, 1990.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1		
1.1	Development of biomedical instrumentation- need and significance Man instrumentation system-Block diagram. Problems encountered in biomedical measurements.	1
1.2	Brief introduction on physiological systems of the body-Nervous, cardio-vascular and respiratory systems.	2
1.3	Sources of bioelectric potentials- resting potential, action potential	1
1.4	Electrode theory, Nernst equation and various types of electrodes.	1
	Bio electric potentials example (ECG, EEG, EMG, ERG, etc.)	1
2		
2.1	Electro-conduction system of the heart. Electrocardiography, electrodes and leads – Einthoven triangle, ECG machine– block diagram.	3
2.2	Measurement of blood pressure– direct and indirect measurement– oscillometric measurement–ultrasonic method	2
2.2	Blood flow cardiac output, plethysmography, cardiac arrhythmia.	2
2.3	Pace makers, defibrillators.	1
3		
3.1	Electro encephalogram— EEG instrumentation, electrode placement, EEG patterns.	2
3.2	Muscle response– Electromyogram (EMG)– Nerve Conduction velocity measurements	1
3.3	Respiratory parameters – Spiro meter, pneumograph.	2
3.3	Artificial respirators, artificial kidney machine, hearing aids.	2
3.4	Diathermy-Types	1
4		
4.1	Patient monitoring systems: Intensive cardiac care, bedside and central monitoring systems.	2
4.2	Patient monitoring through bio-telemetry, implanted transmitters, telemetering multiple information.	2
4.3	Sources of electrical hazards and safety techniques	1

5		
5.1	X-rays, laser applications	1
5.2	Basic principle of computed tomography.	1
5.3	Magnetic resonance imaging system and nuclear medicine system	2
5.4	Ultrasonic imaging system - introduction and basic principle	2
5.5	Colour doppler systems, Holter monitoring, Endoscopy.	2

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET342

Program: Applied Electronics and Instrumentation Engineering

Course Name: Biomedical Instrumentation

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	Draw the block diagram of man instrument system and explain various components present in it.	CO2	K1
2	What are the major problems encountered while measuring a biological variable from an instrument.	CO1	K2
3	Explain the electrical conduction system of the heart.	CO1	K2
4	Write notes on plethysmography.	CO2	K1
5	Discuss on various EEG patterns.	CO2	K2
6	Explain the working principle of spirometer.	CO2	K2
7	Explain different methods of electric accident prevention.	CO3	K2
8	Identify the situation to use diathermy? Mention its applications?	CO3	K2
9	With the help of a block diagram explain the basic principle of Computer tomography.	CO4	K2
10	Explain the biomedical applications of X-Ray	CO4	K2

PART – B

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

Module – I

11. a)	Write a short note on Resting potential, Action potential and Propagation of Action potential with Action potential waveform..	9	CO1	K2
11. b)	Enumerate various skin surface electrodes. Write principle of operation of any THREE electrodes	5	CO1	K2
	OR			
12.a)	Explain equivalent circuit of bio-potential electrode interface.	7	CO1	K2
12.b)	Identify the various types of transducers used in Biomedical engineering? Write principle of operation of any 5 transducers.	7	CO1	K2

Module – II

13 a)	What is cardiac vector? Explain ECG leads with necessary figures.	9	CO2	K2
13 b)	What is plethysmography? Explain impedance plethysmograph with necessary diagram	5	CO2	K1
	OR			
14 a)	With help of neat diagram write how the oscillometric method helps to measure Blood Pressure.	9	CO2	K2
14 b)	Describe the working of electronic pacemaker with necessary diagram.	5	CO2	K1

Module – III

15 a)	With neat diagram write how we can measure velocity of conduction in nerve.	5	CO2	K2
15 b)	What are hearing aids? Differentiate between conventional and digital type of hearing aids with suitable sketches?:-	9	CO2	K2
	OR			
16 a)	Write a short note on tidal volume and vital capacity in breathing mechanism with neat diagram.	7	CO2	K2
16 b)	What is an artificial kidney machine? Explain any one method of dialysis with suitable sketches	7	CO2	K2

Module – IV

17 a)	Describe the bedside monitoring system with a suitable block diagram.	9	CO3	K2
17 b)	What is diathermy? Explain any one type of diathermy unit.	5	CO3	K2
	OR			
18 a)	Discuss on single channel telemetry system with a suitable block diagram.	9	CO3	K2
18 b)	Explain the physiological effects of electric current, specifying important susceptibility parameters with necessary figures..	5	CO3	K2

Module – V

19 a)	With neat diagram explain the working of X-ray machine. Enumerate the uses of X-rays in medicine?	10	CO4	K2
19 b)	Explain the principle of operation of endoscopy	4	CO4	K2
	OR			
20 a)	Explain the principle of operation of Holter monitoring.	7	CO4	K2
20 b)	With a block diagram, explain the components of an NMR system	7	CO4	K2

AET352	REAL TIME OPERATING SYSTEMS	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to impart the basics of operating systems tasks and basic OS architectures and develop these to RTOS.

Prerequisite: AET305 Computer Architecture and Embedded Systems

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

CO1	Summarize the basics of operating systems tasks and basic OS architectures.
CO2	Explain the concepts of different task scheduling schemes.
CO3	Identify the problems and issues related with multitasking.
CO4	Interpret the strategies in interfacing the memory.
CO5	Illustrate various I/O Management and Disk Scheduling algorithms.
CO6	Apply software development to embedded computer systems using RTOS.

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	2										3
CO 3	3	2	2				2					3
CO 4	3											3
CO 5	3	2					2					3
CO 6	3	2	2		2	2	2	3				3

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	15	15	30
Understand	K2	25	25	50
Apply	K3	10	10	20
Analyse	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): Summarize the basics of operating systems and basic OS architectures.

1. What are the two main functions of operating systems? Briefly explain each function.
2. What are the differences between monolithic and microkernel architectures of OS?
3. What is the advantage of Microkernel OS?
4. Explain different types of OS architectures.

Course Outcome 2 (CO2): Explain the concepts of different task scheduling schemes.

1. Discuss the problems associated with multiprocessor scheduling. How they can be solved?
2. Compare FCFS and Round Robin Scheduling algorithms..
3. Explain Priority Scheduling algorithm.
4. Explain Scheduling algorithms.

Course Outcome 3 (CO3): Summarize the problems and issues related with multitasking.

1. Describe the principles of Deadlock.
2. With proper code write in detail about producer-consumer problem and suggest a suitable solution.
3. State and explain the dining philosopher problem.
4. What conditions are generally associated with the reader/writers problem?.

Course Outcome 4 (CO4): Describe the strategies to interface memory.

1. Using a suitable example, illustrate dynamic partitioning.
2. What are the design issues in OS?
3. Explain the I/O management.
4. Discuss the fixed and dynamic memory partitioning techniques.

Course Outcome 5 (CO5): Explain to develop software for embedded computer systems using a real-time operating systems.

1. Compare Vxworks and µCOS
2. Explain the interprocess communication techniques supported vy VxWorks.
3. Describe the architecture of µCOS.
4. Design a RTOS control system for an avionics system.

SYLLABUS

MODULE I

Introduction to RTOS: Concept-Operating system objectives and functions-Comparison of RTOS and General Purpose Operating Systems.
RTOS Architectures: (Monolithic, Microkernel, Layered, Exo-kernel and Hybrid kernel structures)
Task- Defining a Task, Task States and Scheduling

MODULE II

Uniprocessor Scheduling: Types of scheduling algorithms: FCFS, SJF, Priority, Round Robin Multi-level feedback queue scheduling, Multiprocessor Scheduling concept

MODULE III

Concurrency: Principles of Concurrency, Mutual Exclusion H/W Support, software approaches, Semaphores and Mutex, Message Passing techniques.
Classical Problems of Synchronization: Readers-Writers Problem, Dining Philosopher problem. Deadlock.

MODULE IV

Memory Management requirements, Memory partitioning: Fixed, dynamic, partitioning
Memory allocation Strategies (First Fit, Best Fit, Worst Fit, Next Fit), Paging, Demand paging
Page Replacement Policies, I/O Management and Disk Scheduling, Operating System Design issues, I/O Buffering.

MODULE V

Comparison and study of RTOS: Vxworks and µCOS, Case studies: RTOS for embedded Systems.

Text Books

1. C.M. Krishna and G.Shin, Real Time Systems, McGraw-Hill International Edition, 1997.
2. Jean J Labrosse, Embedded Systems Building Blocks Complete and Ready-to-use Modules in C, CMP books, 2/e, 1999

Reference Books

1. Philip A Laplante, “Real-Time Systems Design and Analysis: An Engineer's Handbook”, 4 th Edition, Wiley

2. BorkoFurht, Dan Grostick, David Gluch, Guy Rabbat, John Parker, Meg McRoberts, "Real-Time UNIX® Systems: Design and Application Guide" Springer, 2012
3. Jean J Labrosse , Micro C/OS-II, The Real Time Kernel, CMP Books, 2011
4. Sam Siewert, V, Real-Time Embedded Components and Systems: With Linux and RTOS (Engineering), 2015

Course Contents and Lecture Schedule

No.	**Topic**	**No. of lecture hours**
1	**Introduction to RTOS**	
1.1	Concept-Operating system objectives and functions	1
1.2	Comparison of RTOS and General Purpose Operating Systems	1
1.3	**RTOS Architectures**: (Monolithic, Microkernel, Layered, Exo-kernel and Hybrid kernel structures)	2
1.4	**Task**-Defining a Task, Task States and Scheduling.	2
2	**Scheduling**	
2.1	Uniprocessor Scheduling: Types of scheduling	2
2.2	Scheduling algorithms: FCFS, SJF, Priority, Round Robin	2
2.2	Multi-level feedback queue scheduling, Multiprocessor Scheduling concept	3
3	**Multitasking**	
3.1	Concurrency: Principles of Concurrency, software approaches, Semaphores and Mutex, Message Passing techniques.	4
3.2	Classical Problems of Synchronization: Readers-Writers Problem, Dining Philosopher problem. Deadlock	3
4	**Memory Management**	
4.1	Memory Management requirements, Memory partitioning: Fixed, dynamic, partitioning	2
4.2	Memory allocation Strategies (First Fit, Best Fit, Worst Fit,Next Fit), Paging, Demand paging, Page Replacement Policies	3
4.3	I/O Management and Disk Scheduling, Operating System Design issues, I/O Buffering.	3
5	**Case studies**	
5.1	Comparison and study of RTOS: Vxworks and µCOS	3
5.2	Case studies: RTOS for embedded Systems	4

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET 352

Program: Applied Electronics and Instrumentation Engineering

Course Name: Real Time Operating Systems

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each carries 3 marks.

1.	Differentiate Pre-emptive and Non Pre-emptive Scheduling schemes. Give examples.	CO1	K2
2.	Explain the monolithic and layered architecture of operating systems.	CO1	K2
3.	Explain the concept of multi-level feedback queue scheduling.	CO2	K2
4.	Discuss the problems associated with multiprocessor scheduling. How they can be solved?	CO2	K3
5.	Describe the principles of Deadlock.	CO3	K1
6.	State and explain the dining philosopher problem.	CO3	K2
7.	Explain disk management in OS	CO4	K2
8.	Using a suitable example, illustrate dynamic partitioning.	CO4	K2
9.	Compare Vxworks and µCOS	CO5	K2
10.	Explain the interprocess communication techniques	CO5	K2

PART – B

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

Module – I

11.	Explain the operating system functions and services in detail.	14	CO1	K2
	OR			
12	Explain different types of OS architectures and Mention the advantage of Microkernel OS?	14	CO1	K2

Module – II

13.	Describe the virtual machine structure of operating system design.	14	CO2	K2
	OR			
14.	Explain and Compare FCFS and Round Robin Scheduling algorithms.	14	CO2	K2

Module – III

15 a)	Discuss the different methods of preventing deadlock.	10	CO3	K1
15 b)	What conditions are generally associated with the reader/writers problem?	4	CO3	K2
OR				
16 a)	State and explain the Dining Philosopher problem. Give a suitable solution (with code) to the problem using semaphore.	14	CO3	K3

Module – IV

17 a)	Explain the basic concepts of demand paging.	6	CO4	K2
17 b)	Give a detailed description about the different I/O buffering schemes.	8	CO4	K1
OR				
18	Write in detail about any three disk scheduling algorithms.	14	CO4	K2

Module – V

19	Explain the various inter-process communication techniques supported by VxWorks and MicroC/OS.	14	CO5	K2
OR				
20	Using a block diagram explain how a real time system is implemented. Describe a real life example of an RTOS control system	14	CO5	K3

AET362	OPTOELECTRONIC DEVICES	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to understand various photonic materials and devices.

Prerequisite: ECT201 Solid State devices

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

CO 1	Explain the physics of absorption, recombination and photoemission from semiconductors.	K2
CO 2	Discuss different LED structures with material properties.	K2
CO 3	Explain different types of lasers with distinct properties.	K2
CO4	Analyze different types of photo detectors based on their performance parameters	K3
CO5	Explain optical modulators and optical components.	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
CO 2	3	3			2							2
CO 3	3	3			2							2
CO 4	3	3			2							2
CO 5	3	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	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): Explain the physics of absorption, recombination and photoemission from semiconductors.

1. Briefly explain radiative and non radiative recombination in semiconductors.
2. Describe the absorption in Quantum wells and the Quantum Confined Stark effect.
3. What is Auger Recombination? Derive the equation for absorption coefficient of a semiconductor

Course Outcome 2 (CO2): Discuss different LED structures with material properties.

1. What is quantum efficiency and reponsivity of LED?
2. Explain the construction, principle of operation, of a hetero junction LED.
3. What is meant by Lambartian source?

Course Outcome 3 (CO3): Explain different types of lasers with distinct properties.

1. Explain the principle of operation of FP laser.
2. Explain the characteristics of a semiconductor laser.
3. Explain the construction of VCSEL laser.

Course Outcome 4 (CO4): Analyze different types of photo detectors based on their performance parameters.

1. Explain the construction and operation of PIN diode and APD.
2. Discuss the term responsivity with respect to a photo detector.

Course Outcome 5 (CO5): Explain optical modulators and optical components

1. Discuss the principle of operation of different electro-optic modulators
2. With suitable diagrams discuss an AWG, FBG and other optical components

SYLLABUS

Module 1:

Optical processes in semiconductors – electron hole recombination, absorption, Franz-Keldysh effect, Stark effect, quantum confined Stark effect, deep level transitions, Auger recombination.

Module 2:

Light-Emitting Diodes: Surface-emitting and edge-emitting LEDs, heterostructure, Lambertian

source InGaN/GaN LED, structure and working, performance parameters, White-light LEDs, generation of white light with LEDs, generation of white light by dichromatic sources, and trichromatic sources, white-light sources based on wavelength converters.

Module 3:

Lasers – threshold condition for lasing, line broadening mechanisms, axial and transverse laser modes, heterojunction lasers, distributed feedback lasers, quantum well lasers, Vertical-Cavity Surface-Emitting Lasers, Tuneable Semiconductor Lasers, modulation of lasers, nitride light emitters.

Module 4 :

Optical detection – PIN, APD, modulated barrier photodiode, Schottky barrier photodiode, wavelength selective detection, micro cavity photodiodes.
Optical modulators using pn junction, electro-optical modulators, acousto-optical modulators, Raman-Nath modulators.

Module 5:

OIC and Optical Components: Optoelectronic ICs, advantages, integrated transmitters and receivers, guided wave devices. Introduction to optical components, directional couplers, multiplexers, AWG, attenuators, isolators, circulators, tunable filters, fixed filters, add drop multiplexers, optical cross connects, wavelength convertors,

Text Books

1. Pallab Bhattacharya: *Semiconductor Optoelectronic Devices*, 2/e; Pearson Education, 2002.
2. Yariv, *Photonics Optical Electronics in Modern Communication*, 6/e, Oxford Univ Press, 2006.

Reference Books

1. S.C Gupta: *Optoelectronic Devices and Systems*, PHI,2008
2. Khare, *Fiber optics and Optoelectronics*, Oxford University press, 2006

3. Saleh and Teich, *Fundamentals Of Photonics*, Wiley interscience, 2007
4. Simmon and Potter, *Optical materials*, Elsevier, 2006

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Optical processes in semiconductors**	
1.1	Electron hole recombination.	1
1.2	Direct and Indirect band gap semiconductors	1
1.3	Absorption,	1
1.4	Franz-Keldysh effect	1
1.5	Stark effect, quantum confined Stark effect	2
1.6	Deep level transitions, Auger recombination	1
2	**Light-Emitting Diodes**	
2.1	Surface-emitting and edge-emitting LEDs, Lambertian source	2
2.2	Heterostructure, InGaN/GaN LED, structure and working, performance parameters	2
2.3	White-light LEDs, generation of white light with LEDs**,**	1
2.4	Generation of white light by dichromatic sources, and trichromatic sources,	1
2.5	White-light sources based on wavelength converters.	1
3	**Lasers**	
3.1	Threshold condition for lasing, line broadening mechanisms	1
3.2	Axial and transverse laser modes	1
3.3	Heterojunction lasers, distributed feedback lasers,	1
3.4	Quantum well lasers, Vertical-Cavity Surface-Emitting Lasers,	2
3.5	Tuneable Semiconductor Lasers	1
3.6	Modulation of lasers	1
3.7	Nitride light emitters	1
4	**Optical detection**	
4.1	PIN, APD, modulated barrier photodiode, Schottky barrier photodiode	2
4.2	Wavelength selective detection, micro cavity photodiodes.	2
4.3	Optical modulators using pn junction, electro-optical modulators	1
4.4	Acousto-optical modulators, Raman-Nath modulators	2
5	Optoelectronic ICs and optical components	
5.1	Optoelectronic ICs ,integrated transmitters and receivers Advantages	2
5.2	Guided wave devices, directional couplers	1
5.3	Multiplexers, AWG, attenuators, isolators, circulators, add drop multiplexers	2
5.4	Tunable filters, fixed filters, optical cross connects, wavelength convertors	2

Assignment:

At least one assignment should be simulation of optical components or devices on Matlab or any optical simulation software.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET362

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

Course Name: Optoelectronic Devices

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	Differentiate between photons and phonons.	K3	
2	What is a lambartian source?	K2	
3	Calculate momentum change due to phonon absorption in InP having band gap energy of 1.35eV.	K2	
4	Explain the working of White LED.	K2	
5	What is meant by characteristic temperature of LASER?	K3	
6	Explain Quantum wells in semiconductor energy bands. How they are formed?	K2	
7	Explain the term responsivity of a photo detector.	K3	
8	Explain the working principle of electro absorption modulator.	K3	
9	What are the features of Optical ICs?	K2	
10	Explain the construction of Tunable optical filters.	K2	

PART – B

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

Module – I

11. a)	With the help of energy band diagrams explain direct and indirect band gap semiconductors and also describe the process of	10	CO1	K3

	radiative recombination.			
11. b)	The band gap energy GaAs is 1.43eV. Find the peak emission wave length	4	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 $1.1x10^{16}cm^{-3}$. Find the intrinsic concentration n_i for the semi conductor at this temperature. Find the equilibrium electron concentration n in the N region at this temperature.	9	CO2	K3
	Module – II			
13.a)	With necessary diagrams explain the construction and operation of an edge emitting LED.	7	CO2	K2
13.b)	A hetrojunction LED emitting at peak wavelength of 850 nm has radiative and non radiative recombination times of 25ns and 90ns respectively. If the drive current is 35mA find the internal quantum efficiency and internal power level.	7	CO2	K3
	OR			
14.a)	Explain the design features of white-light LED. Describe how white light is obtained from trichromatic sources.	10	CO2	K2
b)	Explain the application of wave length converters in white light generation.	4	CO2	K2
	Module – III			
15.a)	Explain the lasing action in semiconductor lasers. Discuss the light output against current characteristics.	7	CO3	K2
15.b)	Calculate the mirror reflectiveness needed in GaAs-AlGaAs double hetro structure laser in which the FP cavity length is 20mico meter and the cavity loss is 10 cm^{-1}. The optical confinement factor is unity and the threshold gain in the medium is 10^3 $cm.^{-1}$	7	CO3	K3
	OR			
16.a)	With the aid of suitable diagrams, discuss the principles of operation of VCSEL laser.	9	CO3	K2
16.b)	Briefly explain about nitride light emitters.	5	CO3	K2
	Module – IV			

17.a)	Draw the layer diagram and explain the operation of a p-i-n diode.	8	CO4	K2
b)	An APD has a quantum efficiency of 40% at 1300nm. When illuminated with optical power of 0.3W, it produces an output current of 6μA, after avalanche gain. Calculate the multiplication factor of the diode.	6	CO4	K3
	OR			
18.a)	With suitable diagrams explain the structure of a Mach-Zhender modulator. Also describe how an applied electric field affects the optical signal.	9	CO5	K2
b)	Explain the operation of Raman-Nath modulators	5	CO5	K2
	Module – V			
19.a)	With a schematic explain the working of Array waveguide grating (AWG)	7	CO5	K3
	Design an add drop multiplexer using circulator and FBG.	7	CO5	K3
	OR			
20.a)	With necessary figures explain integrated optical transmitter and receiver.	8	CO5	K2
20.b)	Write short notes on (i) Optical Cross Connects (ii) wavelength Converters.	6	CO5	K2

AET372	INTERNET OF THINGS	CATEGORY	L	T	P	CREDITS
		PEC	2	1	0	3

Preamble: This course aims to develop an understanding on IOT

Prerequisite: NIL

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

CO 1	Explain in a concise manner the architecture of IOT	K2
CO 2	Identify various hardware components used in IOT	K3
CO 3	Discuss the various connectivity technologies and interfaces in IOT	K2
CO4	Compare and appreciate the usage of modern technologies like cloud computing for data management in IOT	K2
CO5	Illustrate application of IOT with typical case studies in various fields and protocols	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	2											
CO 2	3	2	2									
CO 3	2											
CO 4	2				2							
CO 5	3	2	2									

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	20
Understand	K2	30	30	60
Apply	K3	10	10	20
Analyse	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 in a concise manner the architecture of IOT

1. With a diagram, explain the function overview of IOT
2. Explain how embedded systems are a part of IOT
3. Illustrate with a neat block diagram, middle ware based architecture
4. List the 7 design principles of IOT

COURSE OUTCOME 2 (CO2): Identify various hardware components used in IOT

1. List few prototyping boards used for IOT design
2. A network connected mobile robot is to be designed as a part of home automation system. Choose any one sensor and its working principle, that will prevent the robot from colliding with other objects at home.
3. Illustrate with neat sketches, the working of stepper motor to get accurate positioning
4. With the help of conceptual diagrams, explain any 3 wireless sensor network topologies

COURSE OUTCOME 3 (CO3): Discuss the various connectivity technologies and interfaces in IOT

1. How does RFID help in connecting various devices in IOT.
2. Explain in detail about CAN.
3. Compare and contrast Bluetooth and Zigbee.
4. How are various IOT devices uniquely identified in a network? Explain in detail.

COURSE OUTCOME 4 (CO4) : Compare and appreciate the usage of modern technologies like cloud computing for data management in IOT

1. Elaborate on the flash memory
2. List the advantages of cloud computing
3. Explain any one method used to analyse the data acquired by IOT
4. How is data management made possible in IOT

COURSE OUTCOME 5 (CO5) : Illustrate application of IOT with typical case studies in various fields and protocols

1. Explain your idea on how IOT can help in water management/ supply systems in smart cities
2. What technological method could you suggest to a farmer so that he can monitor his live stock round the clock, where ever he is in his farm?
3. With a neat block diagram, explain fog computing enabled IOT system
4. Give a detailed overview on MQTT and CoAP

SYLLABUS

Module 1:

Introduction: Definition, basic IOT block diagram, Characteristics of IoT devices – power, computational constraints, IoT Architectural view – Middle ware based architecture, Service oriented architecture, M2M Communication and IOT, Typical application areas of IoT, Functional overview, Design principles of IOT

Module 2:

IOT hardware: Embedded hardware: Embedded platforms for prototyping- Arduino, ESP32, RaspberryPi (*only overview*), typical CPU's and GPU's used in IoT boards

Sensor technologies *(only operating principles required of each)* - humidity sensor (DHT11/22), Gas Sensor (MQ series), Ultrasonic distance sensor (HC-SR04), temperature sensors

Sensor data communication, Wireless Sensor network Topologies

Actuators – (*working principles only*) Relays, DC motors, stepper motor, Solenoids.

Module 3:

IOT Communication and Connectivity: IOT device gateways, IP addressing in the IoT**,** Electronic Product Codes, RFID, ubiquitous code

Communication Technologies for IoT – Zigbee, Bluetooth, BLE, Wifi, LTE, LoRa, 6LoWPAN (detailed protocol stack not required)

Overview of I/O interfaces - UART, SPI, I2C, CAN

Module 4 :

IOT Data Management: Organization of Data, Big data, Acquiring methods, management techniques, Analytics, Storage technologies – Volatile. Non-volatile, Embedded (MTP/OTP), external flash (NAND/NOR), DRAM, eflash, UFS, eMMC.

Cloud computing and IOT– architecture, advantages of cloud computing, **Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS).**

Module 5:

Internet of Things SMART Applications and protocols:

Applications :- Energy management and Smart grid, IoT for Home (home automation), Cities (lighting, water supply, parking) , Environment monitoring(pollution control) , Agriculture (live stock monitoring, precision farming for irrigation, pesticide spraying), Supply chain and customer monitoring, Industrial IoT and Automotive IoT, Fog Computing

Protocols:- (fundamental concepts only) - Message Queue Telemetry Transport (MQTT), Constrained Application Protocol (CoAP), Extensible Messaging and Presence Protocol (XMPP)

Text Books

1. Rajkamal, "Internet of Things : Architecture and Design Principles", McGraw Hill (India) Private Limited.
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on- Approach)", 1st Edition, VPT, 2014

Reference Books

1. The Internet of Things (The MIT Press Essential Knowledge series) Paperback – March 20, 2015 by Samuel Greengard
2. The Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Ovidu Vermesan and Peter Friess, River Publishers.
3. Internet of Things - From Research and Innovation to Market Deployment -RIVER PUBLISHERS, PETER FRIESS, OVIDIU VERMESAN (Editors)
4. Al-Fuqaha et al. Internet of things: A survey on enabling technologies, protocols, and applications. IEEE Communications Surveys & Tutorials (2015), pp. 2347- 2376.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Introduction to IOT**	**7**
1.1	Definition, basic IOT block diagram, Characteristics of IoT devices – power, computational constraints	1
1.2	IoT Architectural view – Middle ware based architecture, Service oriented architecture,	2
1.3	IoT Technology, M2M Communication and IOT, Typical application areas of IoT	3
1.4	Functional overview, design principles of IOT	1
2	**IOT hardware:**	**7**
2.1	Embedded platforms for prototyping- Arduino, ESP32, RaspberryPi (*only overview*), typical CPU's and GPU's used in IoT boards	2
2.2	Sensor technologies *(only operating principles required of each)* - humidity sensor (DHT11/22), Gas Sensor (MQ series), Ultrasonic distance sensor (HC-SR04), temperature sensors, Sensor data is communication, Wireless Sensor network Topologies	3
2.3	Actuators –(*working principles only*) Relays, DC motors, stepper motor, Solenoids	2
3	**IOT Communication and Connectivity:**	**7**
3.1	IOT device gateways, IP addressing in the IoT**,** Electronic Product Codes, RFID, ubiquitous code	2
3.2	Communication Technologies for IoT – Zigbee, Bluetooth, BLE, Wifi, LTE, LoRa, 6LoWPAN(detailed protocol stack not required)	3
3.3	Overview of I/O interfaces - UART, SPI, I2C, CAN	2
4	**IOT Data Management:**	7
4.1	Organization of Data, Big data, Acquiring methods, management techniques, Analytics	2
4.2	Storage technologies – Volatile. Non-volatile, Embedded (MTP/OTP), external flash (NAND/NOR), DRAM, eflash, UFS, eMMC.	2
4.3	Cloud computing and IOT– architecture, advantages of cloud computing	2
4.4	Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS).	1
5	**Internet of Things SMART Applications and protocols:**	**7**
5.1	Energy management and Smart grid	1
5.2	IoT for Home (home automation), Cities (lighting, water supply,	3

	parking), Environment monitoring, pollution control) , Agriculture (live stock monitoring, precision farming for irrigation, pesticide spraying), Supply chain and customer monitoring	
5.3	Industrial IoT and Automotive IoT, Fog Computing	1
5.4	**Protocols:- (fundamental concepts only)** - Message Queue Telemetry Transport (MQTT), Constrained Application Protocol (CoAP), Extensible Messaging and Presence Protocol (XMPP)	2

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET372

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

Course Name: Internet of Things

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

Q. No	Question	K level	CO
1	Cite few application areas of IOT	2	CO1
2	What is M2M communication	1	CO1
3	Define the term actuator? Give an example.	1	CO2
4	Briefly explain any one sensor for measuring temperature	2	CO2
5	Write short note on Bluetooth technology	1	CO3
6	Define Gateway	1	CO3
7	Elaborate on the term big data?	2	CO4
8	Differentiate Saas, PaaS and IaaS	2	CO4
9	Mention various IOT enabled services in smart cities	2	CO5
10	Describe how customers who carry internet connected devices can be tracked	2	CO5

PART – B

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

MODULE - 1				
11 (a)	Describe the typical characteristics of IOT devices	8	CO1	K2
11(b)	In detail, describe the constraints while designing an IOT system	6	CO1	K2
OR				
12 (a)	With necessary diagrams, describe in detail any 2 architectures of IOT	14	CO1	K2

MODULE - 2				
13(a)	An IOT based home is to be designed with gas leak detection system. Choose a suitable sensor for the same and explain about its working principle	8	CO2	K3
13(b)	Name any GPU. Explain its typical features	6	CO2	K1
OR				
14 (a)	Choose a sensor that would help in detecting moisture content in a go down storage facility for vegetables. Explain its working principle.	8	CO2	K3
14 (b)	List few features of Arduino boards used for prototyping	6	CO2	K1

MODULE - 3				
15(a)	Write short notes on (i) RFID (ii) ubiquitous code	8	CO3	K2
15(b)	Compare and contrast LoRa and 6LoWPAN	6	CO3	K2
OR				
16 (a)	Give a detailed explanation of I2C. Use necessary diagrams	8	CO3	K2
16 (b)	Differentiate IPv4 from IPv6	6	CO3	K2

MODULE - 4				
17(a)	How can we manage large data from various sensors	8	CO4	K2
17(b)	How does cloud computing help in data storage	6	CO4	K2
OR				
18 (a)	Explain about the tools that can be used for data analysis	8	CO4	K2
18 (b)	Write short note on UFS	6	CO4	K2

MODULE - 5				
19 (a)	A smart city is to be designed with smart parking facility. Describe the features necessary for the same.	8	CO5	K3
19 (b)	How pollution monitoring can be done with IOT in the	6	CO5	K3

	premises of industries			
OR				
20 (a)	List few facilities that can be incorporated into a smart home with IOT	6	CO5	K3
20 (b)	Describe how an ordinary irrigation system for agricultural purposes can be made efficient with the help of IOT	8	CO5	K3

SEMESTER VI

MINOR

AET382	SOFT COMPUTING	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

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.
CO 2	Analyze various neural network architectures and Support Vector Machine.
CO 3	Define the fuzzy systems and explain the concepts of genetic algorithm.
CO4	Identify and select a suitable Soft Computing technique to solve the real world problems.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment /Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	20
Understand	K2	25	25	50
Apply	K3	15	15	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 (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.

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

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

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

Course Outcome 3 (CO3): Define the fuzzy systems and explain concepts of the Genetic Algorithm.

1. Explain the basic principles and properties of Fuzzy logic and fuzzy sets.
2. Outline the operations on fuzzy relations, Fuzzy membership functions and fuzzification.
3. Explain the concepts of defuzzification methods.

Course Outcome 4 (CO4): Identify and select a suitable Soft Computing technique to solve the real world problems.

1. Generate 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	2
1.2	Artificial neural networks - biological neurons, Basic models of artificial neural networks – McCulloch and Pitts Neuron	3
1.3	Perceptron networks Learning rule – Training and testing algorithm, Activation Functions	3
	Multi-Layer Perceptrons	
1.4	Multi-layer perceptrons, Back propagation Network – Architecture, Learning algorithm	3
2	**Statistical Learning Models:**	
2.1	Bayesian decision theory- Bayes classifier, Decision regions, significance of covariance matrix.	3
	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 -	2
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.	2
5.2	Implementation of perceptrons- Bayes classifiers-	3
5.3	Implementation of ANNs using software tools.	3
5.4	Implementation of SVMss using software tools.	3

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

Course Code: AET382

Program: Minor in Applied Electronics and Instrumentation Engineering

Course Name: Soft Computing

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each carries 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 parameters such as number of neurons in different layers, initial weights, activation functions etc., are selected.	5	CO1	K2
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

AET384	MEMS	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

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

Prerequisite: Nil

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

CO 1	Explain the Laws 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	: 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 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 of micromotors, microvalves and microgrippers

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 the microfabrication steps of making a MEMS cantilever
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. Microactuators – various types - micropump – micromotors – microvalves – microgrippers

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 – Deposition Epitaxy – Etching process – various types – Photo resists

Module 4:

Microsystem Manufacturing: MEMS Process – Bulk Micromachining – Surface Micromachining -Sacrificial etching process – Micromachined cantilevers – LIGA Process – SLIGA – Microsystem packaging materials – 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	Survey of materials central to micro engineering	1
1.5	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	Interdigitated finger capacitors or comb drive sensors and micro accelerometers	2
2.4	Microactuators – various types - micropump – micromotors	2
2.5	Microvalves – microgrippers	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	Deposition Epitaxy – Etching process – various types – Photo resists	3
4	**Microsystem Manufacturing**	
4.1	MEMS Process – Bulk Micromachining – Surface Micromachining	2
4.2	-Sacrificial etching process – Micromachined cantilevers	2
4.3	LIGA Process – process steps , example , SLIGA	2
4.4	Microsystem packaging materials – die level – device level – System level	2
4.5	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

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET384

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

Course Name: MEMS

Max. Marks: 100 Duration: 3 Hours

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

AET386	PROCESS CONTROL	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble: This course aims to understand the principles of process dynamics and to analyze the various types of process control systems.

Prerequisite: Fundamentals of differential equations and Laplace transform

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

CO 1	Explain the characteristics and elements of process dynamics
CO 2	Analyze a process control loop
CO 3	Model and tune a feedback controller
CO4	Analyze multi-loop and multi variable controllers

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		**Continuous Assessment Tests**		**End Semester Examination**
		1	**2**	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
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): Explain the characteristic principles and different elements involved in process dynamics

1. For a given physical system with resistive or capacitive characteristics, find the period of oscillation and damping.
2. Distinguish between the following processes - (i) Regulating and non-regulating, (ii) Interacting and non-interacting and (iii) Linear and non linear
3. What are the criteria used for selecting the process variables?

Course Outcome 2 (CO2): Analyze a process control loop.

1. For a given control loop, derive the expression for steady state gain and process gain.
2. Find the expression for the transfer function of a temperature control system.
3. Compare SLPC and MLPC.

Course Outcome 3 (CO3): Model and tune various control systems such as feedback control systems, multi loop as well as nonlinear systems

1. Design aspects for a feedback -feedforward control system?
2. How can we model a liquid level control system?
3. What can you infer from dead band velocity limiting?

Course Outcome 4 (CO4): Analyze multi variable control systems and model-based controllers

1. Derive the transfer function of a multi variable control system.
2. What is the importance of relative Gain Array?

SYLLABUS

Module 1:

Process characteristics: Incentives for process control, Process Variables types and selection criteria, Process degree of freedom, The period of Oscillation and Damping, Characteristics of physical System: Resistance, Capacitive and Combination of both. Elements of Process Dynamics, Types of processes- Dead time, Single /multi capacity, self-Regulating /non self-regulating, Interacting /non interacting, Linear/non-linear, and Selection of control action for them. Study of Liquid Processes, Gas Processes, Flow Processes, Thermal Processes in respect to above concepts.

Module 2:

Elements of Process Control Loop: Pneumatic and electric actuators, control valves - characteristics of control valves, valve positioner - I/P and P/I converters- Electronic Controllers. Analysis of Control Loop: Steady state gain, Process gain, Valve gain, Process time constant, Variable time Constant, Transmitter gain, linearizing an equal percentage valve, Variable pressure drop. Analysis of Liquid level Control, Temperature control. SLPC and MLPC features, faceplate, functions, SLPC and MLPC comparison. Scaling: types of scaling, examples of scaling.

Module 3:

Feedback Control: Basic principles, Elements of the feedback Loop, Block Diagram, Control Performance Measures for Common Input Changes, Selection of Variables for Control Approach to Process Control. Controller modes (P, PI, PD and PID) and tuning parameters. Tuning of feedback controllers: Process step testing, tuning for - Quarter Decay ratio response, minimal error integral criteria, sampled data controllers. Controller tuning for integrating processes – model of liquid level control system.

Module 4:

Multi Loop & Nonlinear Systems: Cascade control, Feed forward control, feedback-feed forward control, Ratio control, Selective Control, Split range control- Basic principles, Design Criteria, Performance, Implementation issues, Examples and any special features of the individual loop and industrial applications. Nonlinear Elements in Loop: Limiters, Dead Zones, Backlash, Dead Band Velocity Limiting, Negative Resistance.

Module 5:

Multivariable Control: Concept of Multivariable Control: Interactions and its effects, Modelling and transfer functions, Influence of Interaction on the possibility of feedback control, important effects on Multivariable system behaviour Relative Gain Array, effect of Interaction on stability and tuning of Multi Loop Control system. Model Based controllers: Internal Model control, Model Predictive controller, Dynamic matrix controller (DMC), Self-Tuning Controller.

Text Books

1. B.Wayne Bequette, Process Control: Modeling, Design and Simulation, PHI.
2. Donald Eckman – Automatic Process Control, Wiley Eastern Limited.
3. F.G.Shinskey, Process control Systems ,TMH.
4. Carlos A. Smith, Armando B. Corripio - Principles and practice of Automatic Process Control, John Wiley & Sons, 2nd edition.
5. Curtis D Johnson, Process Control Instrumentation Technology, Eighth Edition.

Reference Books

1. B.G.Liptak ,Handbook of Instrumentation -Process control , Chilton.
2. Considine, Process Instrumentation and control Handbook, 5th Ed., McGraw Hill.
3. Krishna Kant, Computer Based Industrial Control, PHI.
4. Murrill , Applications concepts of Process control, ISA.
5. Murrill, Fundamentals of Process Control, ISA.
6. Stephanopoulos George, Chemical Process Control, PHI.
7. T.J.Ross Fuzzy Logic with Engineering Applications, John Wiley & Sons, 2004.
8. Thomas E Marlin - *Process Control- Designing processes and Control Systems for Dynamic performance,* McGraw-Hill International Editions.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Process characteristics:**	
1.1	Incentives for process control, Process Variables types and selection criteria.	1
1.2	Process degree of freedom, The period of Oscillation and Damping.	1
1.3	Characteristics of physical System: Resistance, Capacitive and Combination of both.	1
1.4	Elements of Process Dynamics, Types of processes- Dead time, Single /multi capacity, self-Regulating /non self-regulating, Interacting /non interacting, Linear/non-linear, and Selection of control action for them.	3
1.5	Study of Liquid Processes, Gas Processes, Flow Processes, Thermal Processes in respect to above concepts.	3

2	**Elements of Process Control Loop:**	
2.1	Pneumatic and electric actuators	1
2.2	Control valves - characteristics of control valves, Valve Positioner	2
2.3	I/P and P/I converters, Electronic Controllers	1
	Analysis of Control Loop	
2.4	Steady state gain, Process gain, Valve gain, Process time constant, Variable time Constant, Transmitter gain.	2
2.5	Linearizing an equal percentage valve, Variable pressure drop.	2
2.6	Analysis of Liquid level Control, Temperature control.	2
2.7	SLPC and MLPC features, faceplate, functions, SLPC and MLPC comparison.	1
2.8	Scaling: types of scaling, examples of scaling.	1
3	**Feedback Control:**	
3.1	Basic principles, Elements of the feedback Loop, Block Diagram,	1
3.2	Control Performance Measures for Common Input Changes, Selection of Variables for Control Approach to Process Control.	1
3.3	Controller modes and tuning parameters.	2
	Tuning of feedback controllers:	
3.4	Process step testing, tuning for - Quarter Decay ratio response, minimal error integral criteria, sampled data controllers.	2
3.5	Controller tuning for integrating processes – model of liquid level control system.	1
4	**Multi Loop & Nonlinear Systems:**	
	Basic principles, Design Criteria and Implementation issues of:	
4.1	Cascade control	1
4.2	Feed forward control	1
4.3	Feedback-feed forward control	1
4.4	Ratio control	1
4.5	Selective Control	1
4.6	Split range control	1

4.7	Examples and any special features of the individual loop and industrial applications	1
4.8	Nonlinear Elements in Loop: Limiters, Dead Zones, Backlash, Dead Band Velocity Limiting, Negative Resistance.	2

5	**Multivariable Control:**	
5.1	Concept of Multivariable Control: Interactions and its effects, Modelling and transfer functions, Influence of Interaction on the possibility of feedback control	2
5.2	Important effects on Multivariable system behaviour Relative Gain Array, effect of Interaction on stability and tuning of Multi Loop Control system.	2
5.3	Model Based controllers: Internal Model control	1
5.4	Model Predictive controller	1
5.5	Dynamic matrix controller (DMC)	1
5.6	Self-Tuning Controller.	1

Assignment:

Atleast one assignment should be simulation of any one type of controller using MATLAB or SIMULINK.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B. TECH DEGREE EXAMINATION

Course Code: AET386

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

Course Name: Process Control

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1.	Mention the various criteria that is taken into account while selecting variables to control a given process.	K2
2	Define degrees of freedom of a process.	K2
3	Draw the block diagram of a liquid level control loop.	K2
4	What is scaling? What are the different types of scaling?	K2
5	How will you select the best tuning constants for a feedback controller?	K3
6	What do you mean by minimal error integral criteria?	K2
7	Define dead band velocity limiting in non linear systems.	K2
8	Mention few characteristics of cascade control.	K2
9	What is Relative Gain Array? How is it useful in predicting the intertaction on stability in a multivariable control system.	K2
10	List a few features of Internal model control.	K2

PART – B

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

Module – I

11. a)	Draw the block diagram of a general process control system and explain its elements.	6	CO1	K2
11. b)	Derive the period of oscillation and damping for a second order resistive-capacitive system	8	CO1	K3
	OR			
12.a)	Compare the following systems with suitable examples (a) self-regulating and non self-regulating systems (b) Interacting and non-interacting systems	14	CO1	K3

Module – II

13 a)	Derive the expression for process gain, valve gain and steady state gain for a flow control system.	8	CO2	K3
13 b)	Compare SLPC and MLPC features.	6	CO2	K2
	OR			
14 a)	Explain linearization of an equal percentage valve into a linear valve.	8	CO2	K2
14 b)	With a neat sketch, explain a temperature control system. Also derive the expression for process time constant.	6	CO2	K3

Module – III

15 a)	Derive the tuning parameters for a PID controller for a second order process.	5	CO3	K4
15 b)	Explain a technique for fine tuning of controller with suitable example.	5	CO3	K3
15 c)	What are the various control performance measures for common input changes for a feedback system?	4	CO3	K2
	OR			
16 a)	Explain the steps involved in tuning a process with feedback controller using step testing procedure.	8	CO3	K2
16 b)	How will you tune a process using feedback controller with Quarter Decay ratio response?	6	CO3	K3

Module – IV

17 a)	Explain the multi loop control performance through decoupling	9	CO4	K2
17 b)	Explain in detail about the various tuning techniques used in multi loop control system.	5	CO4	K3
	OR			
18	Write neat sketches explain the following control loops: (a) Ratio control (b) Split range control	14	CO4	K2

Module – V

19	Write notes on: (a) Dynamic matrix controllers (b) Model predictive controller	14	CO4	K3
	OR			
20 a)	Explain the influence on interaction on the possibility of feedback control using a 2x2 system.	8	CO4	K3
20 b)	A multivariable system has the following state-space model dx/dt = [-3 2; 1 -4]x +[2 0;0 1]u and y=***I***x Obtain the transfer function model matrix for this system.	6	CO4	K3

SEMESTER VI

HONOURS

AET 394	PWM SCHEME FOR POWER CONVERTERS	CATEGORY	L	T	P	CREDIT
		VAC	3	1	0	4

Preamble: This course aims to develop the skill to design PWM based power converters.

Prerequisite: AET306 Power Electronics

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

CO 1 K2	Explain the principle of Sinusoidal and space vector pulse width modulation in three phase inverters
CO 2 K3	Apply the principle of sinusoidal and space vector modulation in multilevel inverters
CO 3 K2	Explain the principle of current source inverters
CO 4 K2	Discuss the principle of voltage source inverter fed drives
CO 5 K2	Explain the principle of current source inverter fed drives

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): Explain the principle of sinusoidal and space vector pulse width modulation in three phase inverters

1. Illustrate the principle of two-level, three phase voltage source inverters
2. Explain the principle of third harmonic injection in sinusoidal PWM
3. Explain the principle of overmodulation in sinusoidal and space vector PWM
4. Model and simulate two-level three phase voltage source inverter using sinusoidal and space vector PWM

Course Outcome 2 (CO2): Explain the principle of sinusoidal and space vector modulation in multilevel inverters

1. Explain three-level inverter topology of Neutral Point Clamped, Cascaded H-bridge and Flying capacitor inverters
2. Apply the principle of sinusoidal and space vector PWM in Neutral Point Clamped, Cascaded H-bridge and Flying capacitor inverters
3. Illustrate the adverse effect of common mode voltage in multilevel inverters and its elimination techniques (any 2 methods)
4. Model and simulate three level inverters.

Course Outcome 3 (CO3): Explain the principle of current source inverters.

1. Explain the principle of trapezoidal, selective harmonic elimination and space vector modulation in current source inverters
2. Explain the topology and space vector modulation technique of parallel current source inverter.
3. Model and simulate a PWM GCT CSI

Course Outcome 4 (CO4): Discuss the principle of voltage source inverter fed drives

1. Illustrate the principle of two-level inverter fed medium voltage drives
2. Illustrate the principle of three-level NPC inverter fed drive

3. Explain the principle of cascaded H-bridge and NPC-H bridge inverter fed drives
4. Model and simulate IGBT based three-level NPC and cascaded H-bridge inverter fed drives

Course Outcome 5 (CO5): Explain the principle of Current source inverter fed drives

1. Illustrate the principle of single bridge and dual bridge PWM rectifiers
2. Explain the principle of transformerless CSI Drive for Standard AC motors
3. Illustrate the principle of CSI drive with multipulse SCR rectifier
4. Explain the principle of LCI drives for synchronous motors
5. Model and simulate a low-cost CSI drive with 6-pulse SCR rectifier

SYLLABUS

Module 1 : Two-level Voltage Source Inverters (10)

Pulse width modulation – Sinusoidal PWM and Space vector modulation

Module 2 : Multilevel Inverters and Modulation Schemes 10

Neutral Point Clamped, Cascaded H-bridge and Flying capacitor multilevel inverters – Modulation Schemes – Common mode voltage and elimination schemes

Module 3 : PWM Current Source Inverters 9

Current source inverters – Trapezoidal Modulation-Selective Harmonic Elimination-Parallel current source inverters

Module 4 : Voltage Source Inverter-Fed Drives 8

Voltage source inverter based medium voltage drives- NPC and CHB inverter fed drives

Module 5 : Current Source Inverter-Fed Drives 8

Current source inverter drives with PWM rectifier-Trasnformerless CSI drive-CSI drive with multipulse SCR rectifier-LCI drives for Synchronous motors

Text Books

1. Bin Wu, "High - Power Converters and AC Drives", Wiley Interscience

Reference Books

1. G.Holmes & T.A. Lipo, "Pulse width Modulation for Power Converters, Principle and practice", IEEE Press, 2003

2. M.P.Kazmierkowski , ”Control of Power Converters : Selected Problems”, Academic Press, 2003

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Two-level Voltage Source Inverters**	
1.1	Two-level three phase voltage source inverters - Sinusoidal PWM-Modulation Scheme-Harmonic Content-Over modulation	3
1.2	Third Harmonic Injection PWM	1
1.3	Space vector modulation-Switching states-Space vectors-Space vector diagram	2
1.4	Dwell time calculation, modulation index, switching sequence	2
1.5	Overmodulation	1
1.6	Comparison of Sinusoidal PWM and Space vector modulation	1
2	**Multilevel Inverters and Modulation Schemes**	
2.1	Neutral point clamped three level inverter- converter configuration	1
2.2	Cascaded H-bridge three level Inverter –converter configuration	1
2.3	Flying capacitor three level inverter – converter configuration	1
2.4	Switching States and Space vector diagram of three-level inverter	2
2.5	Modulation Schemes- Sinusoidal PWM and Space vector PWM in three level inverters (basic principles only)	2
2.6	Optimum switching in Space vector PWM	1
2.7	Common mode voltage and its adverse effects in multilevel inverters–elimination techniques	2
3	**PWM Current Source Inverters**	
3.1	PWM Current source inverter-Trapezoidal modulation-basic principle only	2
3.2	Selective Harmonic Elimination – basic principle only	2
3.3	Space vector modulation in current source inverters	2
3.4	Parallel current source inverters – inverter topology	2
3.5	Space vector modulation in parallel current source inverters	1
4	**Voltage Source Inverter-Fed Drives**	
4.1	Two-level VBSI based medium voltage drives-power converter building block	2
4.2	Two-Level VSI with Passive Front End	1
4.3	GCT-Based NPC Inverter drives	1
4.4	IGBT-Based NPC Inverter drives	1
4.5	Multilevel CHB Inverter fed drives	2
4.6	NPC/H-bridge Inverter fed drives	1
5	**Current Source Inverter-Fed Drives**	
5.1	CSI drives with single-bridge PWM rectifier	1
5.2	CSI drives with Dual bridge PWM rectifier	1
5.3	Transformerless CSI Drive for Standard AC Motors - CSI Drive Configuration	1
5.4	Integrated dc Choke for Common-Mode Voltage Suppression	1

5.5	CSI Drive with 18 pulse SCR Rectifier - Low-Cost CSI Drive with 6-Pulse SCR Rectifier	2
5.6	LCI Drives for Synchronous Motors - LCI Drives with 12-Pulse Input and 6-Pulse Output - LCI Drives with 12-Pulse Input and 12-Pulse Output	2

Assignment:

At least one assignment should be simulation of power electronic circuits using any circuit simulation software.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: AET 394

Program: B Tech Honours in Applied Electronics and Instrumentation Engineering/ Electronics and Instrumentation Engineering

Course Name: PWM Scheme for Power Converters

Max. Marks: 100 Duration: 3Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	What is the principle of sinusoidal PWM?	CO1	K2
2	What is redundant switching state in space vector PWM?	CO1	K2
3	Discuss the advantages and drawbacks of cascaded H-bridge inverters	CO2	K1
4	Explain the importance of optimum switching in space vector PWM	CO2	K2
5	Compare SVM, TPWM and SHE for current source inverters	CO3	K1
6	Explain the principle of load commutated inverters	CO3	K2
7	Draw the schematic of power converter building block used in medium voltage drives. What is the function of the snubber circuit?	CO4	K2
8	What is meant by N+1 redundancy in medium voltage drives?	CO4	K2
9	List the features of CSI medium voltage drives	CO5	K1
10	Discuss the use of an integrated dc choke for common mode voltage suppression in CSI drives.	CO5	K2

PART – B

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

	Module – I			
11(a)	Derive expression for dwell times for a 2-level voltage source inverter	8	CO1	K3

	employing space vector modulation			
11(b)	Illustrate the principle of third harmonic injection PWM	6	CO1	K3
	OR			
12(a)	Explain overmodulation in sinusoidal and space vector modulation	8	CO1	K3
12(b)	Compare sinusoidal PWM and space vector PWM	6	CO1	K2
	Module – II			
13(a)	Draw and explain the topology of 3-level neutral point clamped inverter with space vector diagram	8	CO2	K2
13(b)	Explain the importance of optimum switching in space vector PWM	6	CO2	K2
	OR			
14(a)	Draw and explain the topology of three-level cascaded H-bridge inverter	6	CO3	K2
14(b)	Define common mode voltage in three level inverters. What are its adverse effects? Discuss any one method for eliminating CMV.	8	CO3	K2
	Module – III			
15(a)	With schematic explain PWM GCT current source inverter	8	CO4	K2
15(b)	Explain the principle of trapezoidal modulation in current source inverters	6	CO4	K2
	OR			
16(a)	Illustrate the principle of parallel current source inverters for high-power MV drives	8	CO4	K2
16(b)	Discuss selective harmonic elimination technique in current source inverters	6	CO4	K2
	Module – IV			
17(a)	With schematic explain a typical two-level VSI drive with a passive front end.	8	CO5	K2
17(b)	List the advantages and drawbacks of CHB inverter drives	6	CO5	K2
	OR			
18(a)	With schematic explain GCT based three-level NPC inverter-fed drive	7	CO5	K2
18(b)	Draw and explain NPC/H-bridge inverter fed drive	7	CO5	K2
	Module – V			
19(a)	With schematic explain a CSI drive with single bridge PWM rectifier and inverter.	7	CO6	K2

19(b)	With circuit schematic explain the operation of LCI drive system with 12-pulse input and 6-pulse output.	7	CO6	K2
	OR			
20 (a)	Draw and explain the operation of transformerless CSI drive with an integrated dc choke	7	CO6	K2
20(b)	With schematic explain a CSI drive with 18 pulse SCR rectifier	7	CO6	K3

Simulation Assignments (AET 394)

The following simulations can be done in MATLAB software.

1. Sine triangle PWM generation for three phase, two-level inverter
2. Sine triangle PWM generation for three phase, three-level inverter
3. Space vector PWM for three phase, two-level inverter
4. Space vector PWM for three phase, three-level inverter
5. PWM GCT CSI

AET396	MIXED CIRCUIT DESIGN	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

Preamble: This course aims to develop the skill of the design of various analog and digital circuits.

Prerequisite: Basic understanding of Analog and Digital circuits

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

CO 1	Analyze MOS amplifier circuits in CS, CD, CG and cascode configurations	K3
CO 2	Build current mirror and differential amplifier circuits	K3
CO 3	Develop operational amplifier circuits using differential amplifier stages.	K3
CO4	Explain concepts of PLL and Develop dynamic analog circuits using MOS switches	K2
CO5	Explain the working concepts of data convertors and develop circuits for D/A and A/D conversions.	K3

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Analyze MOS amplifier circuits in CS, CD, CG and cascode configurations.

1. Derive the output impedance and voltage gain of MOS amplifiers.
2. Design single stage MOS amplifiers for a given specification
3. Explain the working of Cascode configuration and the calculation of voltage gain

Course Outcome 2 (CO2): Build current mirror and differential amplifier circuits.

1. For the given power consumption and input CM level design a basic NMOS differential pair .
2. Explain the principle of operation of current mirror
3. Design a current copying circuit

Course Outcome 3 (CO3): Develop operational amplifier circuits using differential amplifier stages.

1. Design a single stage opamp amplifier for a specific gain.
2. Design a 2 stage opamp amplifier for an output swing.
3. Explain frequency compensation in opamp.

Course Outcome 4 (CO4): Explain concepts of PLL and Develop dynamic analog circuits using MOS switches

1. Explain the use of PLL as a frequency multiplier.
2. Design a low pass switched integrated circuit for a given cut off frequency
3. Explain the charge injection effect in series MOS switches.

Course Outcome 5 (CO5): Explain the working concepts of data convertors develop circuits for D/A and A/D conversions.

1. Design a 3 bit R-2R DAC circuit with R = 1Kohm and R_f = 2Kohm
2. Explain the working concepts of cyclic DAC with an example
3. Design 3 bit Flash ADC and draw the transfer curve for Vin = 0 to 5V.

SYLLABUS

Module 1:

MOS Amplifiers: Common Source with resistive load, diode connected loads and current source load, CS stage with source degeneration, Source follower and CG stage (Derivation of Voltage Gain and Output impedance of circuits)

Cascoded stages : Cascoded amplifier, Cascoded amplifier with cascoded loads, Folded cascode Amplifier. Comparison of Cascode and folded cascode configuration.

Module 2:

MOS Current Mirror: Operation principle of basic current mirror. PMOS and NMOS current

Mirrors, Current mirror copying circuits, MOSFET cascode current mirror circuits

Differential Amplifiers: Need of Differential Amplifier. Basic MOS differential pair, Differential mode and Common mode gain. Differential Amplifier with diode connected load**.** Differential Amplifier with current source Load and current mirror load, MOS telescopic cascode amplifier. (Only Voltage Gain and Output impedance of circuits)

Module 3:

CMOS OP AMPS: Performance parameters in an opamp, Comparison of ideal and practical opamp, Single stage Folded cascode opamp. Two Stage Operational Amplifiers -Frequency compensation of OPAMPS - miller compensation**,** Design of classical two stage OP AMP

Comparator: Characterization of a comparator-static and dynamic, A two stage open loop comparator (analysis not required)

Module 4 :

Phase Locked Loop : Voltage controlled oscillators, Simple PLL, Basic PLL Topology, Charge Pump PLL, Basic Charge Pump PLL, Applications of PLL.

Switched Capacitor Circuits: Charge injection and clock feed through in MOS switches. Sample and hold circuits, Switched Capacitor Integrator, Ladder filters

Module 5:

Data Converters: DAC Specifications-DNL, INL, latency, SNR, Dynamic Range ADC Specifications-Quantization error, Aliasing, SNR, Aperture error

DAC Architecture: Resistor String, Charge Scaling, Cyclic and Pipeline types.

ADC Architecture: Flash, Pipe line and successive approximation ADC

Text Books

1. Razavi B., Design of Analog CMOS Integrated Circuits, Mc Graw Hill, 2001
2. Phillip E. Allen, Douglas R. Holbery, CMOS Analog Circuit Design, Oxford, 2004.

Reference Books

1. Baker, Li, Boyce, CMOS: Circuits Design, Layout and Simulation, Prentice Hall India, 2000
2. Razavi B., Fundamentals of Microelectronics, Wiley student Edition 2014.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**MOS Amplifiers**	
1.1	Common Source with resistive load, diode connected loads and current source load, CS stage with source degeneration. Calculation of Voltage gain and Output impedance .	3
1.2	Source follower circuit working. Calculation of Voltage gain and Output impedance.	1
1.3	CG stage, Calculation of Voltage Gain and Output impedance of circuits in CG configuration	1
	Cascoded stages	
1.4	Cascoded amplifier, Cascoded amplifier with cascoded loads. Calculation of Voltage Gain and Output impedance	2
1.5	Folded cascode Amplifier : Fold up and fold down cascode. Calculation of Voltage Gain and Output impedance. Comparison with Cascode configuration.	2
2	**MOS Current Mirror**	
2.1	Operation principle of basic current mirror. PMOS and NMOS current Mirrors, Current mirror copying circuits, MOSFET cascode current mirror circuits	2
	Differential Amplifiers	
2.2	Need of Differential Amplifier. Basic MOS differential pair, Differential mode and Common mode gain. Differential Amplifier with	4

	diode connected load	
2.3	Differential Amplifier with current source Load and current mirror load, MOS telescopic cascode amplifier. (Only Voltage Gain and Output impedance of circuits)	3
3	**CMOS OP AMPS**	
3.1	Performance parameters in an opamp, Comparison of ideal and practical opamp Single stage Folded cascode opamp.	2
3.2	Two Stage Operational Amplifiers -Frequency compensation of OPAMPS - miller compensation, Design of classical two stage OP AMP	4
	Comparator	
3.3	Characterization of a comparator-static and dynamic, A two stage open loop comparator (analysis not required)	3
4	**Phase Locked Loop**	
4.1	Voltage controlled oscillators, Simple PLL, Basic PLL Topology, Charge Pump PLL, Basic Charge Pump PLL, Applications of PLL	4
4.2	**Switched Capacitor Circuits**	
	Charge injection and clock feed through in MOS switches. Sample and hold circuits, Switched Capacitor Integrator, Ladder filters	5
5	**Data Converters**	
5.1	DAC Specifications-DNL, INL, latency, SNR, Dynamic Range ADC Specifications-Quantization error, Aliasing, SNR, Aperture error	4
5.2	**DAC Architecture -** Resistor String, Charge Scaling , Cyclic and Pipeline types.	3
5.3	**ADC Architecture-** Flash, Pipe line and successive approximation ADC	2

Assignment:

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

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET396

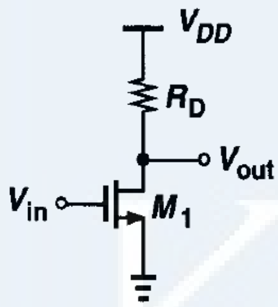
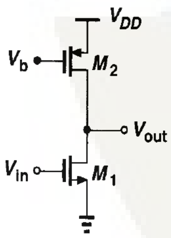
Program: Honours in Applied Electronics and Instrumentation Engineering/ Electronics and Instrumentation Engineering

Course Name: Mixed Circuit Design

Max. Marks: 100 Duration: 3 Hours

PART A

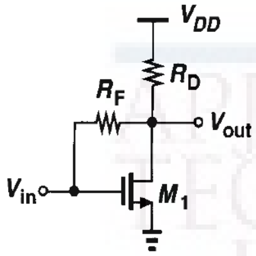
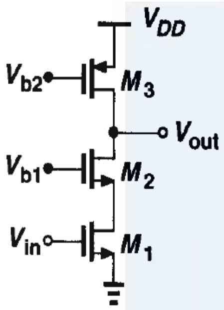
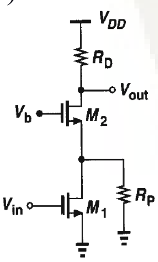
Answer ALL Questions. Each Carries 3 mark.

1.	Obtain the transfer characteristics of the circuit shown in the Figure 	K3	
2	Calculate the small signal voltage gain of the circuit. 	K2	
3	Explain the need of differential amplifier circuits.	K1	
4	With relevant circuit diagram explain the working of a MOS current mirror circuit	K2	
5	Compare the characteristics of ideal and non ideal operational amplifier	K1	
6	Draw the general block diagram of a 2 stage opamp circuit and list the ideal characteristics.	K2	
7	Write notes on Charge injection	K1	
8	Briefly explain the working of PLL	K2	
9	Describe the working of a 3 bit Flash type A/D Converter, with a circuit diagram.	K2	
10	Explain Quantization error in the data convertors.	K1	

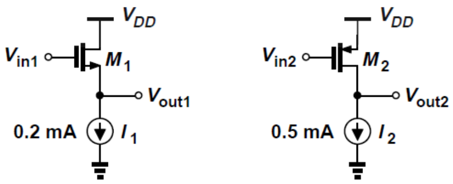
PART – B

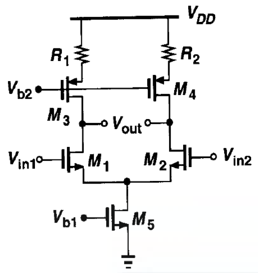
Answer one question from each module; each question carries 14 marks.

Module – I

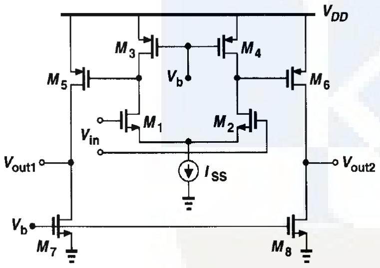
11. a)	Consider the circuit shown in Figure, Calculate the small signal voltage gain A_v. (Assume all MOSFETs in sat $\lambda\neq0$, $\gamma=0$)  	5	CO1	K2
11. b)	Sketch V_{out} vs V_{in} for the circuit shown in Figure  	9	CO1	K3
	OR			
12.a)	Compare the features of folded cascode configuration and cascode configuration	5	CO1	K2
12.b)	Calculate the small signal voltage gain of the circuit. (Assume $\lambda=0$)  	9	CO1	K3

Module – II

13 a)	Prove that in an NMOS differential pair amplifier:- $(V_{out1} - V_{out2})/(V_{in1} - V_{in2}) = -g_m R_D$	5	CO2	K2
13 b)	A designed system employs the circuit stages shown in Figure. Design a circuit that produces I_1 and I_2 from a 0.4-mA reference.  	9	CO2	K3
	OR			

14 a)	Obtain the differential gain of the circuit shown in Figure 	9	CO2	K3
14 b)	Estimate CMRR due to transistor mismatch in an NMOS differential pair circuit with resistive load	5	CO2	K2

Module - III

15 a)	Draw the circuit of a 2stage comparator circuit and explain the working.	4	CO3	K2
15 b)	Explain any two frequency compensation techniques in the opamp circuits.	10	CO3	K2
	OR			
16 a)	Explain the need of a 2 stage opamp circuit with appropriate circuit diagram.	4	CO2	K2
16 b)	Design the 2 stage opamp shown in the figure for a power budget = 6mW and maximum differential swing = 4V,Iss = 0.5mA.(Assume typical circuit parameters) 	10	CO3	K2

Module – IV

17 a)	Discuss the usage of PLL in frequency multiplication and synthesis	6	CO4	K2
17 b)	Design a switched capacitor implementation of a summing integrator with the relationship $V_o = \frac{v_1}{j\omega(\frac{C_F}{C_A f})} + \frac{v_2}{j\omega(\frac{C_F}{C_B f})}$	9	CO4	K2
	OR			
18 a)	Explain the non ideal effects in PLL	6	CO4	K2
18 b)	Explain the working of sample and hold circuits .	4	CO4	K2
18 c)	Write notes on Capacitive feed through in Dynamic circuits	4	CO4	K2

Module - V

19a)	Explain the working of R-2R ladder type DAC. In a 10 bit DAC, reference voltage is given as 10V. Find analog output for digital input of 1000011001.	8	CO3	K3
19 b)	With neat diagram explain the working of cyclic DAC	6	CO4	K2
	OR			

20 a)	A 4-bit R-2R ladder type DAC having R= 5 kΩ and V_R= 5 V. Find its resolution and output voltage for inputs 1)1101 and 2) 1001	8	CO4	K3
20 b)	With neat diagram explain the working of pipeline ADC	6	CO4	K2

Simulation Assignments

The following simulations can be done in LTSPICE.

1. Design single stage MOS amplifier stages in CS CD and CG configurations . Observe the input and output signals. Plot the AC frequency response and understand the variation of gain at high frequencies.
2. Design and simulate current mirror circuit for various reference currents and verify the W/L requirements of the devices .
3. Design MOS amplifier stages in cascode configurations . Observe the input and output signals. Plot the AC frequency response and understand the tradeoffs.
4. Design and implement differential amplifier and measure its CMRR. Plot its transfer characteristics.
5. Design and simulate a 3 bit flash type ADC. Observe the output bit patterns and transfer characteristics
6. Design and simulate R − 2R DAC circuit.
7. Observe the effect of clock feed through on the voltage across the load capacitors(C_L) in dynamic analog circuits. See the changes with the load capacitor(C_L) values

AET398	COMPUTER VISION	CATEGORY	L	T	P	CREDITS
		VAC	4	0	0	4

Preamble: This course aims to develop skills to implement solutions for computer vision challenges.

Prerequisite: AET322 Digital Image Processing.

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

CO 1	Explain the fundamentals of imaging systems, camera and derive its parameters.
CO 2	Apply various image processing and feature extraction techniques in computer vision applications.
CO 3	Demonstrate 3D modeling from 2D images.
CO4	Make use of motion analysis and detection methods in computer vision applications.
CO5	Apply deep neural network systems for computer vision challenges.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	2								3
CO 2	3	3	3	2	3							3
CO 3	3	3	3	2	3							3
CO 4	3	3	3	2	3							3
CO 5	3	3	3	2	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): Explain the fundamentals of imaging systems, camera and derive its parameters.

1. Explain pin hole camera model.
2. Differentiate intrinsic and extrinsic parameters.
3. Explain the concept of disparity and its relationship with depth

Course Outcome 2 (CO2): Apply various image processing and feature extraction techniques in computer vision applications.

1. For a given task, identify a method for feature extraction.
2. Find suitable application of SURF features.
3. Choose suitable technique for medical image segmentation.
4. Explore different applications of dimensionality reduction techniques.

Course Outcome 3 (CO3): Demonstrate 3D modeling from 2D images.

1. Given single image and reflectance map obtain its shape.
2. Derivation of Fundamental matrix.
3. Demonstrate the idea of obtaining structure from motion.

Course Outcome 4 (CO4): Make use of motion analysis and detection methods in computer vision applications.

1. Obtain optical flow for a given video.
2. Face detection using Viola Jones algorithm.
3. Pedestrian detection using HOG.

Course Outcome 5 (CO5): Apply deep neural network systems for computer vision challenges

1. Explain different layers in CNN.

2. Identify a CNN architecture for specific task.

SYLLABUS

Module 1

Fundamentals of Image Formation: Pinhole camera. Perspective Projection, Homogeneous Coordinates. Camera: Intrinsic and extrinsic parameters. Transformation- Orthogonal, Euclidean and Affine. Orthographic projection; Parallel Projection. Camera Calibration, Stereo vision: introduction, concept of disparity and its relationship with depth.

Module 2

Feature Extraction: Edges - Canny, LOG, DOG. Line detection-Hough Transform. Corners - Harris and Hessian. SIFT, SURF, HOG. Image Segmentation and Pattern Analysis: Image Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs. Clustering: K-Means, Mixture of Gaussians, Dimensionality Reduction: PCA

Module 3

Depth estimation: Binocular Stereopsis, Reflectance Map, Albedo estimation Photometric Stereo. Shape from shading- Propagation and Optimization Method, Frankot Chellappa Algorithm. Two view geometry- Epipolar geometry, Fundamental matrix, Essential Matrix. Structure from Motion: Triangulation, Two frame structure from motion.

Module 4

Motion Analysis- Regularization theory, Background Subtraction and Modeling, Optical Flow: brightness constancy equation, aperture problem, Horn-Shunck method, Lucas Kanade method, Depth from optical flow.

Object detection: Sliding window method, Detecting deformable objects. Face detection using Viola Jones algorithm. Face recognition using Eigen faces. Pedestrian Detection using HOG.

Module 5

Introduction to Neural Networks: Model of a biological neuron, activation functions, Back propagation, Learning XOR, Gradient-Based Learning. Convolutional Neural Networks, CNN Architectures - AlexNet, VGG 16, GoogLeNet, ResNet.

Text Books

1. Computer Vision: Algorithms and Applications, Richard Szeliski, Springer 2010.
2. Computer vision: A modern approach, by Forsyth and Ponce. Prentice Hall, 2002.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.

Reference Books

1. Multiple View Geometry in Computer Vision, Richard Hartley and Andrew Zisserman,Second Edition, Cambridge University Press, March 2004.
2. B K P Horn , Robot Vision, McGraw-Hill,1986

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Fundamentals of Image Formation**	
1.1	Pinhole camera. Perspective Projection, Homogeneous Coordinates.	2
1.2	Camera: Intrinsic and extrinsic parameters	2
1.3	Transformation- Orthogonal, Euclidean and Affine. Orthographic projection; Parallel Projection	2
1.4	Camera Calibration	1
1.5	Stereo vision: introduction; concept of disparity and its relationship with depth.	2
2	**Feature Extraction**	
2.1	Edges - Canny, LOG, DOG	1
	Line detection-Hough Transform	1
2.2	Corners - Harris and Hessian	1
2.3	SIFT, SURF, HOG	2
2.4	Image Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs.	2
2.5	Clustering: K-Means, Mixture of Gaussians,	1
2.6	Dimensionality Reduction: PCA	1
3	**Depth estimation**	
3.1	Binocular Stereopsis; Reflectance Map; Albedo estimation Photometric Stereo	2
3.2	Shape from shading- Propagation and Optimization Method, Frankot Chellappa Algorithm	2
	Two view geometry	
3.3	Epipolar geometry, Fundamental matrix, Essential Matrix	3
3.4	Structure from Motion: Triangulation, Two frame structure from motion.	2
4	**Motion Analysis**	
4.1	Regularization theory, Background Subtraction and Modeling	2
4.2	Optical Flow: brightness constancy equation, aperture problem, Horn-Shunck method, Lucas Kanade method, Depth from optical flow.	3
	Object detection	
4.3	Sliding window method, Detecting deformable objects.	1
4.4	Face detection using Viola Jones algorithm.	1
4.5	Face recognition using Eigen faces	1
4.6	Pedestrian Detection using HOG	1
5	**Introduction to Neural Networks**	
5.1	Model of a biological neuron, activation functions	1

5.2	Back propagation, Learning XOR	1
5.3	Gradient-Based Learning	2
5.4	Convolutional Neural Networks	2
	CNN Architectures	
5.5	AlexNet, VGG 16, GoogLeNet, ResNet.	3

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET398

Program: B Tech. Honours in Applied Electronics and Instrumentation Engineering / Electronics and Instrumentation Engineering

Course Name: Computer Vision

Max. Marks:100 Duration: 3 Hours

PART A

Answer ALL Questions. Each question carries 3 marks.

1	Find linear transformation matrix that represent perspective projection and orthogonal projection?	CO1	K2
2	Explain the concept of disparity and its relationship with depth.	CO1	K2
3	Explain K-means clustering algorithm.	CO2	K2
4	Explain HOG algorithm.	CO2	K2
5	Explain the concept of obtaining shape from shading.	CO3	K2
6	Explain triangulation method.	CO3	K2
7	Prove that optical flow obtained using Lucas-Kanade algorithm is the least squared solution of optical flow constraint equation.	CO4	K3
8	What is aperture problem in optical flow.	CO4	K1
9	What do you mean by a learning algorithm?	CO5	K1
10	What are problems with SGD?	CO5	K2

PART – B

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

Module – I

11. a)	Derive the camera calibration matrix. What are cameras intrinsic and extrinsic (calibration) parameters?	9	CO1	K2
11. b)	Obtain affine transformation matrix.	5	CO1	K2
	OR			

12.a)	Discuss on camera calibration.	9	CO1	K1
12.b)	Derive the perspective projection equation for a virtual image located at a distance d in front of the pinhole.	5	CO1	K2

Module – II

13 a)	Explain Harris corner detection.	5	CO2	K2
13 b)	Briefly explain the principles of PCA. Explain the steps involved in determining principal components	9	CO2	K2
	OR			
14 a)	Explain how Hough transform can be used to detect lines.	5	CO2	K2
14 b)	Explain the steps for constructing SIFT feature.	9	CO2	K2

Module – III

15 a)	Let M1 and M2 be two camera matrices. Assume that M1 = [I|0] and M2 = [A|a], where A is a 3x3 matrix. Prove that fundamental matrix corresponding to these camera matrices is of the form $F = [a]_x A$, where $[a]_x$ represents linear transformation matrix of cross product.	10	CO3	K4
15 b)	Explain photometric stereo for image reconstruction.	4	CO3	K2
	OR			
16 a)	Given reflectance map and a single image, explain how to obtain surface normals corresponding to real 3D scene that is imaged.	9	CO3	K3
16 b)	Explain the steps in obtaining structure from motion.	5	CO3	K2

Module – IV

17 a)	Explain in detail the computation of optical flow using Horn Schunk algorithm.	9	CO4	K2
17 b)	Explain Sliding window method for object detection.	5	CO4	K2
	OR			
18 a)	Explain face detection using Viola Jones algorithm.	9	CO4	K2
18 b)	Discuss on background Subtraction methods.	5	CO4	K2

Module – V

19 a)	Explain the role of optimization in machine learning algorithms.	4	CO5	K2
b)	Compare AlexNet and VGG 16 architectures.	5	CO5	K2
c)	Differentiate between RMS prop and ADAM.	5		K3
	OR			
20 a)	Explain the structure of Convolutional Neural Network.	10	CO5	K2
(b)	Explain the concept of back propagation.	4	CO5	K2