SEMESTER I

Discipline : ELECTRONICS & INSTRUMENTATION
Stream : EC1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221TEC100	ADVANCED ENGINEERING MATHEMATICS	DISCIPLINE CORE	3	0	0	3

Preamble: The purpose of this course is to expose students to the basic theory of linear algebra and probability.

Course Outcomes: The COs shown are only indicative. For each course, there can be 4 to 6 COs. After the completion of the course the student will be able to

CO 1	To analyze distributions of random variables and make computations based on that
CO 2	evaluate average behaviour of random variables, and analyze their converging behviours
CO 3	To analyze behaviour of random processes and explain basis of vector spaces.
CO 4	To evaluate properties of linear transformations
CO 5	To evaluate if a linear tranformaion is diagonalizable and decompose it using spectral decomposition theorem.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7
CO 1	3		3		3	3	
CO 2	3		3		3	3	
CO 3	3		3		3	3	
CO 4	3		3		3	3	
CO 5	3		3		3	3	

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Continuous Internal Evaluation: 40 marks

Micro project/Course based project: 20 marks

Course based task/Seminar/Quiz: 10 marks

Test paper, 1 no. : 10 marks

The project shall be done individually. Group projects not permitted. Test paper shall includeminimum 80% of the syllabus.

End Semester Examination Pattern:

End Semester Examination: 60 marks

There will be two parts; Part A and Part B

- Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions.
- Part B will contain 7 questions with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Model Question paper

A P J ABDUL KALAM TECHNOLOGICAL UNIVERSITY
M.TECH DEGREE EXAMINATION
SEMESTER:
Branch:
ADVANCED ENGINEERING MATHEMATICS

Time: 2.5 Hours **Marks: 60**

Part A

Answer ALL Questions. Each question carries 5 marks

1. Given that $ff(x) = \frac{k}{2^x}$ is a probability distribution of a random variable that can take on the values $x = 0,1,2,3,\text{A}\ 4$. Find k. Find the cumulative distribution function.
2. State and prove weak law of large numbers.
3. Show that $(1,3,2,-2), (4,1,-1,3), (1,1,2,0), (0,0,0,1)$ is a basis for R^4.
4. Let $T: V \rightarrow$ Wbe a linear transformation defined by $T(x,y,z) = (x+y, x-y, 2x+z)$. Find the range, null space, rank and nullity of T.
5. Describe an inner product space. If V is an inner product space, then for any vectors α, βin V prove that $\|\alpha+\beta\| \leq \|\alpha\| + \|\beta\|$.

Part B
Answer ANY FIVE Questions, one from each module
(5 x 7 marks = 35marks)

6. If the probability mass function of a RV X is given by $P(\text{X} = x) = kx^3, x = 1,2,3,4$. Find the value of k, $P\left(\frac{1}{2} < \text{X} < \frac{3}{2} / \text{X} > 1\right)$ mean and variance of X.
7. If the moment generating function of a uniform distribution for a random variable X is $\frac{1}{t}(e^{5t} - e^{4t})$.Find E(X).
8. Consider the Markov chain with three states, s={1,2,3} that has the following transition matrix $P = \begin{bmatrix} \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{3} & 0 & \frac{2}{3} \\ \frac{1}{2} & \frac{1}{2} & 0 \end{bmatrix}$ Draw the state diagram for the chain. If $P(\text{X}_1 = 1) = P(\text{X}_2 = 2) = \frac{1}{4}$, find $P(\text{X}_1 = 3, \text{X}_2 = 2, \text{X}_3 = 1)$.

9. Find the eigen values and eigen vectors of $A = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$

10. Find the least square solution to the equation $Ax = b$, where $A = \begin{bmatrix} 1 & 2 \\ 1 & 3 \\ 0 & 0 \end{bmatrix}$ and $b = \begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix}$. Obtain the projection matrix P which projects b on to the column space of A.
11. Let T be the linear transformation from R^3 to R^2 defined by T(x,y,z) =(x+y, 2z-x). Let B_1, B_2 be standard ordered bases of R^3 and R^2 respectively. Compute the matrix of T relative to the pair B_1, B_2.
12. Let V be a finite-dimensional complex inner product space, and let T be any linear operator on V. Show that there is an orthonormal basis for V in which the matrix of T is upper triangular.

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Syllabus

Module 1 Axiomatic definition of probability. Independence. Bayes' theorem and applications. Random variables. Cumulative distribution function, Probability Mass Function, Probability Density function, Conditional and Joint Distributions and densities, Independence of random variables. Functions of Random Variables: Two functions of two random variables. Pdf of functions of random variables using Jacobian.

Module 2 Expectation, Fundamental theorem of expectation, Moment generating functions, Characteristic function. Conditional expectation. Covariance matrix. Uncorrelated random variables. Pdf of Jointly Gaussian random variables, Markov and Chebyshev inequalities, Chernoff bound. Central Limit theorem. Convergence of random variables. Weak law of large numbers, Strong law of large numbers.

Module 3 Random Processes. Poisson Process, Wiener Process, Markov Process, Birth-Death Markov Chains, Chapman- Kolmogorov Equations,

Groups, Rings, homomorphism of rings. Field. Vector Space. Subspaces. direct sum. Linear independence, span. Basis. Dimension. Finite dimensional vector spaces. Coordinate representation of vectors. Row spaces and column spaces of matrices.

Module 4 Linear Transformations. Four fundamental subspaces of a linear transformation. Rank and Rank-nullity theorem. Matrix representation of linear transformation. Change of basis transformation. System of linear equations. Existence and uniqueness of solutions. Linear functionals. Dual, double dual and transpose of a linear transformation.

Module 5 Eigen values, Eigen vectors, Diagonizability.

Inner product. Norm. Projection. Least-squares solution. Cauchy-Schwartz inequality. Orthonormal bases. Orthogonal complement. Spectral decomposition theorem.

Course Plan

No	Topic	No. of Lectures
	Module I	
1.1	Axiomatic definition of probability. Independence. Bayes' theorem and applications.	2
1.2	Random variables. Cumulative distribution function, Probability Mass Function,	1
1.3	Probability Density function, Conditional and Joint Distributions and densities, Independence of random variables.	2
1.4	Functions of Random Variables: Two functions of two random variables. Pdf of functions of random variables using jacobian.	2
	Module II	
2.1	Expectation, Fundamental theorem of expectation, Conditional expectation.	1
2.2	Moment generating functions, Charectristic function.	1
2.3	Covariance matrix. Uncorrelated random variables. Pdf of Jointly Guassian random variables,	2
2.4	Markov and Chebyshev inequalities, Chernoff bound. Central Limit theorem.	2
2.5	Convergence of random variables. Weak law of large numbers, Strong law of large numbers.	2
3	**Module III**	
3.1	Random Processes. Poisson Process, Wiener Process,	2
3.2	Markov Process, Birth-Death Markov Chains, Chapman-Kolmogorov Equations,	2
3.3	Groups, Rings, homomorphism of rings. Field. Vector Space. Subspaces. direct sum.	2
3.4	Linear independence, span. Basis. Dimension. Finite dimensional vector spaces.	2
3.5	Coordinate representation of vectors. Rowspaces and column spaces of matrices.	1
4	**Module IV**	
4.1	Linear Transformations. Four fundamental subspaces of a linear transformation. Rank and Rank-nullity theorem.	2
4.2	Matrix representation of linear transformation. Change of basis transformation.	1
4.3	System of linear equations. Existence and uniqueness of solutions.	2
4.4	Linear functionals. Dual, double dual and transpose of a linear transformation.	2

5	**Module V**	
5.1	Eigen values, Eigen vectors, Diagonizability.	2
5.2	Inner product. Norm. Projection. Least-squares solution. Cauchy-Schwartz inequality.	2
5.3	Orthonormal bases. Orthogonal complement. Spectral decomposition theorem.	2

Reference Books

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

2. Jimmie Gilbert and Linda Gilbert, Linear Algebra and Matrix Theory, Elsevier

3. Henry Stark and John W. Woods "Probability and Random Processes withApplications to Signal Processing", Pearson Education, Third edition.

4. Athanasios Papoulis and S. Unnikrishna Pillai. Probability, Random Variables and Stochastic Processes, TMH

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221TAE001	DISCRETE CONTROL SYSTEMS	PROGRAM CORE 1	3	0	0	3

Preamble: The course introduces the fundamental concepts, principles and application of digital control system analysis and design. This course goes deeper into the various aspects of stability analysis, state space design, state feedback design, state observer design and analysis of the performance of discrete controllers in digital control engineering.

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

CO 1	Familiarize with digital control of dynamic systems using Z-transform techniques
CO 2	Analyse stability of discrete time system and digital controllers
CO 3	Analyse the performance of a discrete controller
CO 4	Design digital controllers in state space domain
CO 5	Analyse the system performance and stability with controller and observer in closed-loop

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2		2	2			
CO 2	3		3	3			
CO 3	3		3	3	3		
CO 4	3		3	3	3		
CO 5	3		3	3			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20%
Analyse	60%
Evaluate	20%

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
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Continuous Internal Evaluation: 40 marks

Micro project/Course based project: 20 marks
Course based task/Seminar/Quiz: 10 marks
Test paper, 1 no. : 10 marks
The project shall be done individually. Group projects not permitted. Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:60 marks

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Syllabus and Course Plan (For 3 credit courses, the content can be for 40 hrs and for 2 credit courses, the content can be for 26 hrs. The audit course in third semester can have content for 30 hours).

Syllabus

MODULE I

Introduction to digital control: Introduction to Discrete time system representation, Mathematical modeling of sampling process , Data reconstruction

Modeling discrete-time systems by pulse transfer function- Revisiting Z-transform,Mapping of s-plane to z-plane , Pulse transfer function , Pulse transfer function of closed loop system , Sampled signal flow graph

MODULE II

Stability analysis of discrete time system: Jury stability test, Stability analysis using bi-linear transformation -Lyapunov stability analysis of discrete time system- Implementation of digital controllers – digital PID controllers-position-velocity algorithms-Tuning methods.

MODULE III

Design of sampled data control systems: Root locus method, Controller design using root locus, Root locus based controller design using MATLAB- Design based on the Frequency response methods- Bode plot, Lead compensator design using Bode plot Lag compensator design using Bode plot Lag-lead compensator design in frequency domain.

MODULE IV

Discrete state space model: Introduction to state variable model Various canonical forms, Characteristic equation, state transition matrix, Solution to discrete state equation - Controllability, Observability of discrete state space models- using MATLAB

MODULE V

State feedback design: Pole placement by state feedback, Set point tracking controller, state Observer- Full order observer, Reduced order observer -Output feedback design.

Course Plan

No	Topic	No. of Lectures
1	**Introduction to digital control**	
1.1	Introduction to Discrete time system representation, Mathematical modeling of sampling process, Data reconstruction	4
1.2	Modeling discrete-time systems by pulse transfer function-Revisiting Z-transform,Mapping of s-plane to z-plane, Pulse transfer function, Pulse transfer function of closed loop system, Sampled signal flow graph	6
2	**Stability analysis of discrete time system**	
2.1	Jury stability test, Stability analysis using bi-linear transformation	4
2.2	Lyapunov stability analysis of discrete time system	2
2.3	Implementation of digital controllers – digital PID controllers-position-velocity algorithms-Tuning methods.	2
3	**Design of sampled data control systems**	
3.1	Root locus method, Controller design using root locus, Root locus based controller design using MATLAB	4
3.2	Design based on the Frequency response methods- Bode plot, Lead compensator design using Bode plot Lag compensator design using Bode plot Lag-lead compensator design in frequency domain	4
4	**Discrete state space model**	
4.1	Introduction to state variable model Various canonical forms, Characteristic equation, state transition matrix, Solution to discrete state equation	4
4.2	Controllability, Observability of discrete state space models-using MATLAB	3
5	**State feedback design**	
5.1	Pole placement by state feedback, Set point tracking controller, state Observer- Full order observer, Reduced order observer	4
5.2	Output feedback design	3

References

1. B. C.Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007.

2. K. Ogata, Discrete Time Control Systems,Prentice Hall, 2/e, 1995.

3. M. Gopal, Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003.

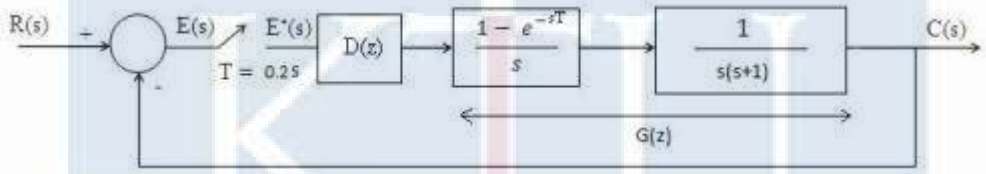
4. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems, Addison Wesley, 1998,PearsonEducation,Asia, 3/e, 2000.K.

5. J. Astroms and B. Wittenmark, Computer Controlled Systems - Theory and Design, Prentice Hall, 3/e, 1997.

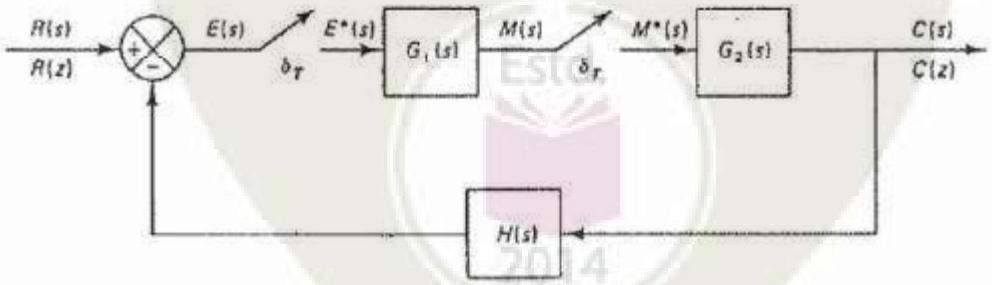
Course Level Assessment questions

Course Outcome 1:

1. Consider the digital control system shown in figure. Design a digital controller D(z) such that the closed loop system has a damping ratio 0.5 and the number of samples per cycle of damped sinusoidal oscillation to be 8.



2. Obtain the closed loop pulse transfer function of



Course Outcome 2:

1. For a unity feedback system, with sampling time T=1sec, open loop pulse transfer function is

$$G(z)=\frac{K(0.3679z+0.2542)}{(z-0.3679)(z-1)}$$

Determine the value of K for stability by use of Jury's stability test. Also determine the frequency of oscillations at the output.

2. Derive position-velocity algorithms of PID controllers

Course Outcome 3:

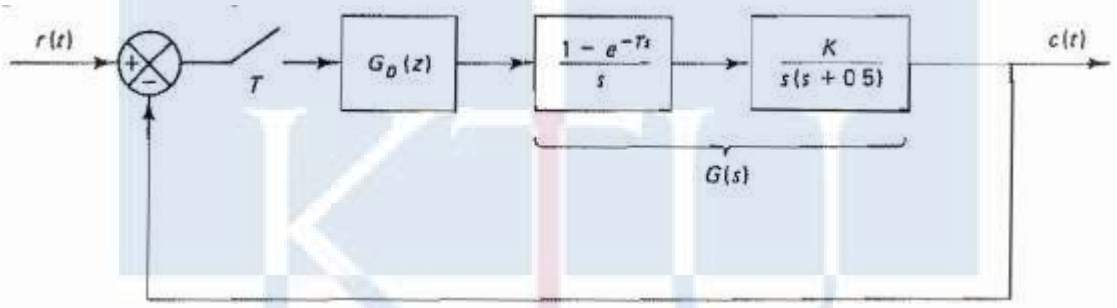
1. Design a controller to place the poles at 0.5± j0.5,0 for the system

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \\ x_3(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -4 & -2 & -1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(k)$$

$$y(k) = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix}$$

Assume any additional data required.

2. Consider the system shown. Design a digital controller for the system in w-plane so that system has PM = 50^0 , GM ≥ 10 dB, K_v =20sec^{-1} , T= 0.1 sec.



Course Outcome 4:

1. Prove that if a discrete system is completely state controllable and observable, then there is no pole zero cancellation in the pulse transfer function.
2. Consider the system

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 1 & -2 \\ -3 & -4 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

$$y(k) = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

Check whether the above system is controllable and observable.

Course Outcome 5:

1. Consider the discrete time system defined by the equation

$$x(k+1) = Gx(k) + Hu(k)$$
$$y(k) = Cx(k)$$

$$\text{where } G = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}, H = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, C = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}.$$

Assuming that the output y(k) is measurable, design a minimum order observer, suchthat the observer poles are placed at 0.3, -0.6.

2. Consider the system

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \\ x_3(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -0.16 & 0.84 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} u(k)$$

$$y(k) = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix}$$

Determine the state feedback gain matrix so that the closed loop system will exhibit the deadbeat response to any initial state x(0).

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER
221TAE001 DISCRETE CONTROL SYSTEMS

Time: 2:30hours **Max. Marks:60**

PART A

Answer ***all*** questions. Each question carries ***5 marks***.

1. Obtain the pulse transfer function of a digital PID controller.
2. What are the necessary and sufficient conditions for a system to be stable in Jury's stability test. Comment on the stability of the system given below
$y(k) - 0.6y(k-1) - 0.81y(k-2) + 0.67y(k-3) - 0.12y(k-4) = x(k)$.
3. Obtain the discrete time equivalent of the system

$$\begin{bmatrix}\dot{x}_1(t)\\ \dot{x}_2(t)\end{bmatrix} = \begin{bmatrix}-2 & 2\\ 1 & -3\end{bmatrix}\begin{bmatrix}x_1(t)\\ x_2(t)\end{bmatrix} + \begin{bmatrix}-1\\ 5\end{bmatrix}u(t)$$

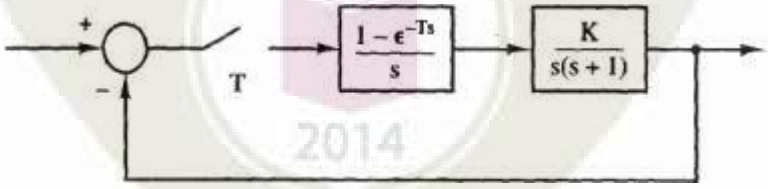
$$y(t) = \begin{bmatrix}2 & -4\end{bmatrix}\begin{bmatrix}x_1(t)\\ x_2(t)\end{bmatrix} + 6u(t)$$

with a sampling interval T=0.2s
4. With the help of a neat block diagram explain design via pole placement technique.
5. Explain briefly the separation principle in observer design.

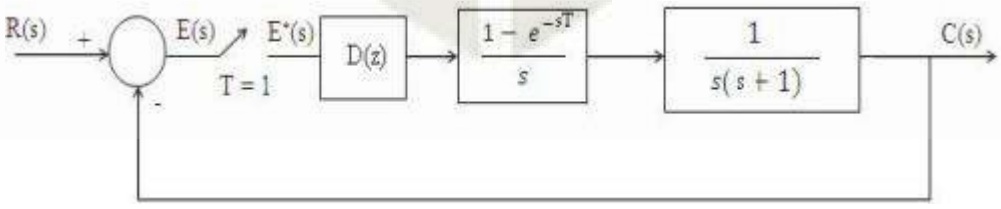
PART B

Answer ***any five*** questions. Each question carries ***7 marks***

6. Consider the system with a sampling time period of T=0.1s, Find the range of the gain for which the system remains stable. Also find the frequency of sustained oscillations.



7. For the system shown, find Phase margin of the system when D(z) =1



8. Consider the discrete time system defined by the equation
$x(k+1) = Gx(k) + Hu(k)$

Where

$$G=\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -0.25 & 0 & 0.5 \end{bmatrix}, H=\begin{bmatrix} 0 & 1 \\ 0 & 0 \\ 1 & 0 \end{bmatrix}$$

Design a state feedback gain matrix so that system will exhibit deadbeat response to any initial state x(0).

9. Consider the system

$x(k+1) = Gx(k) + Hu(k)$

$y(k) = Cx(k) + Du(k)$

Where

$$G=\begin{bmatrix} 0 & 0 & -2 \\ 1 & 0 & -6 \\ 0 & -2 & 0 \end{bmatrix}, H=\begin{bmatrix} 1 & 1 \\ 0 & -1 \\ 0 & 1 \end{bmatrix}, C=\begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix}, D=\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

Check whether the system is controllable.

10. Consider the continuous time system defined by the state and output equations

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Design a state feedback control law for the equivalent discrete time system so that closed loop poles of the system are placed at 0.8±j0.25 for the given system.

11. Consider the discrete time system defined by

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 1 & -2 \\ -3 & -4 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

$$y(k) = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

Obtain the pulse transfer function matrix.

12. Obtain the discrete time state and output equations and pulse transfer function of the following continuous time system: G(s) = 1/(*s*(*s*+2)). which may be represented in state space by the equation

$$\begin{bmatrix} \dot{x1} \\ \dot{x2} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x1 \\ x2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x1 \\ x2 \end{bmatrix}$$

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221TAE002	MEMS	PROGRAM CORE 2	3	0	0	3

Preamble: This course introduces students to the rapidly emerging, multi-disciplinary, and exciting field of Micro Electro Mechanical Systems.

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

CO 1	Describe the working principles of micro sensors and actuators
CO 2	Identify the typical materials used for fabrication of micro systems
CO 3	Explain the principles of standard micro fabrication techniques
CO 4	Describe the challenges in the design and fabrication of Micro systems
CO 5	Describe the working principle of RF MEMS
CO 6	Describe the working principle of MEMS phase shifters

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	2	1				
CO 2	2	2	2	2		1	
CO 3	3	3	1	2		1	
CO 4	2	2	1	2		1	
CO 5	2	3	2	2			
CO 6	2	2	2				

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20%
Analyse	60%
Evaluate	20%
Create	

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
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Micro project/Course based project: 20 marks
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Test paper, 1 no. : 10 marks
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End Semester Examination Pattern:60 marks
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Course Level Assessment Questions

Course Outcome 1 (CO1): Describe the working principles of micro sensors and actuators

1. Explain the working principles of micropumb in MEMS.
2. How a micro accelerometer work? Explain with neat diagram.

Course Outcome 2 (CO2): Identify the typical materials used for fabrication of micro systems

1. Explain how polymers help in MEMS fabrication.
2. What are the different materials used in MEMS fabrication?

Course Outcome 3 (CO3):Explain the principles of standard micro fabrication techniques

1. Explain vapour deposition technique with neat diagram.
2. Explain etching process with neat diagram.

Course Outcome 4 (CO4): Describe the challenges in the design and fabrication of Microsystems

1. Explain LIGA process with neat diagram.
2. Explain the process of packaging technology in MEMS with neat diagram.

Course Outcome 5 (CO5):Describe the working principle of RF MEMS

1. With neat diagram explain the working of RF filter circuit.
2. How a resonator MEMS switch works

Course Outcome 6 (CO6): Describe the working principle of MEMS phase shifters

1. What are the different types of MEMS phase shifters? Explain Switched delay line phase shifters.
2. Explain Distributed MEMS phase shifters Applications of MEMS.

Syllabus

MODULE I:

INTRODUCTION TO MICROSYSTEMS, MICRO SENSORS AND ACTUATORS - Overview of microelectronics manufacture and Microsystems technology. Definition - MEMS materials. The multi-disciplinary nature of MEMS. Survey of materials central to micro engineering. Applications of MEMS in various industries.

Working principle of Microsystems - micro actuation techniques - micro sensors – types – Microactuators – types – micropump – micromotors – micro – valves – microgrippers – microaccelerometers.

MODULE II:

MATERIALS FOR MEMS – Silicon – Silicon compounds – Silicon Nitride, Silicon Dioxide, Silicon carbide, Poly Silicon, GaAs , Silicon Piezo resistors, Polymers in MEMS

FABRICATION PROCESS -Substrates - single crystal silicon wafer formation – Photolithography – Ion implantation – Diffusion – Oxidation – CVD - Physical vapor deposition - etching process.

MODULE III:

MICRO SYSTEM MANUFACTURING- Bulk Micro manufacturing - surface micro machining – LIGA – Micro stereo lithography - Micro system packaging materials - die level - device level - system level - packaging techniques – die preparation – surface bonding - wire bonding - sealing.

MODULE IV:

MICROSYSTEMS DESIGN AND PACKAGING-Design considerations, Mechanical Design, Process design, Realization of MEMS components using intellisuite. Micro system packaging, Packing Technologies, Assembly of Microsystems, Reliability in MEMS.

MODULE V:

Introduction to RF MEMS- MEMS inductors- varactorstuner /filter- Reconfigurable circuit elements- Resonator MEMS switch Tunable CPW resonator- MEMS microswitch arrays.

MEMS phase shifters- Types of phase shifters- Switched delay line phase shifters. Distributed MEMS phase shifters Applications of MEMS in Space-Biomedical and micropumps for continuous flow system

Syllabus and Course Plan

No	Topic	No. of Lectures
1	Introduction to microsystems, microsensors and actuators	
1.1	Overview of microelectronics manufacture and Microsystems technology. Definition	1
1.2	MEMS materials	1
1.3	The multi-disciplinary nature of MEMS	1
1.4	Survey of materials central to micro engineering	1
1.5	Applications of MEMS in various industries	1
1.6	Working principle of Microsystems - micro actuation techniques - microsensors, microactuators	1
1.7	Microgrippers, microaccelerometers.	1
1.8	Micropump, micromotors, microvalves	1
2	FABRICATION PROCESS	
2.1	Materials for MEMS – Silicon – Silicon compounds	1
2.2	Silicon Nitride, Silicon Dioxide, Silicon carbide, Poly Silicon	1
2.3	GaAs, Silicon Piezo resistors, Polymers in MEMS	1
2.4	Substrates - single crystal silicon wafer formation	1
2.5	Photolithography, Ion implantation	1
2.6	Diffusion, Oxidation,CVD	1
2.7	Physical vapor deposition - etching process	2
3	MICROSYSTEM MANUFACTURING	
3.1	Bulk Micro manufacturing	1
3.2	Surface micromachining	1
3.3	LIGA, Micro stereo lithography	2
3.4	Microsystem packaging materials - die level - device level - system level	1
3.5	Packaging techniques – die preparation	1
3.6	Surface bonding - wire bonding - sealing.	1
4	MICROSYSTEMS DESIGN AND PACKAGING	
4.1	Design considerations, Mechanical Design, Process design,	2
4.2	Realization of MEMS components using intellisuite. Micro system packaging	2
4.3	Assembly of Microsystems, Reliability in MEMS.	1
5	Introduction to RF MEMS	
5.1	Introduction to RF MEMS- MEMS inductors- varactorstuner /filter	1
5.2	Reconfigurable circuit elements- Resonator MEMS switch Tunable CPW resonator	1
5.3	MEMS microswitch arrays. MEMS phase shifters- Types of phase shifters	2

5.4	Switched delay line phase shifters.	1
5.5	Distributed MEMS phase shifters	1
5.6	Applications of MEMS in Space-Biomedical and micropumps for continuous flow system	2

References

1. Chang Liu, Foundations of MEMS, Pearson 2012
2. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, TMH, 2002
3. Chang C Y and Sze S. M., VLSI Technology, McGraw-Hill, New York, 2000
4. Julian W Gardner, Microsensors: Principles and Applications, John Wiley & Sons, 1994
5. Mark Madou, Fundamentals of Micro fabrication, CRC Press, New York, 1997
6. Stephen D. Senturia, Microsystem design, Springer (India), 2006
7. Thomas B. Jones, Electromechanics and MEMS, Cambridge University Press, 2001
8. Gregory T.A. Kovacs, Micromachined Transducers Sourcebook, McGraw Hill, 1998

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER
221TAE002MEMS

Time: 2:30hours **Max. Marks:60**

PART A

Answer ***all*** questions. Each question carries ***5 marks***

1. How micro accelerometer works? Explain its principle with neat diagram.
2. What are the different types of vapour deposition scheme in MEMS processing? Explain with neat diagram.
3. Explain the process of LIGA with neat diagram.
4. What are the different types of packaging techniques used in MEMS?
5. Explain about MEMS tunable CPW resonator.

PART B

Answer ***any five*** questions. Each question carries ***7 marks***

6. What are the different applications of MEMS in automobile engineering?
7. Explain the following
   a. Photolithography
   b. Ion implantation
   c. Diffusion
   d. Oxidation
8. Discuss Micro stereo lithographic process. What are the different types? Explain with neat diagram.
9. What are the different types of surface bonding techniques used in MEMS? Explain with neat diagram.
10. What are the different packaging processes used in MEMS? Explain the details.
11. Explain Resonator MEMS switch Tunable CPW resonator. Also explain MEMS microswitch arrays.
12. Explainone application of MEMS in Biomedical System. Explain with neat diagram.

SEMESTER I

PROGRAM ELECTIVE I

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EAE100	NONLINEAR CONTROL SYSTEMS	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: This course aims to provide a strong foundation on advanced control methods to analyse and predict stability of non-linear control system. The course also includes the feedback linearization and backstepping approaches.

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

CO 1	Study the characteristics of a non-linear system
CO 2	Analyse non-linear systems
CO 3	Familiarize with feedback linearisation
CO 4	Analyse and design nonlinear systems
CO 5	Study the concept of back stepping and forwarding approaches

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	2	1	1	1	
CO 2	2	2	1	1	1	1	
CO 3	2	2	1	1	2	1	
CO 4	2	2	1	2	1		
CO 5	2	1	2	1	2		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20%
Analyse	60%
Evaluate	20%
Create	

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred): 15 marks
Course based task/Seminar/Data collection and interpretation: 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Course Level Assessment Questions

Course Outcome 1 (CO1):To study the characteristics of a non-linear system

1. How the nonlinear systems are classified?
2. Discuss the behaviour of nonlinear systems.

Course Outcome 2 (CO2): Make the students to analyse a non-linear system

1. Discuss the nonlinearity behaviour of a relay servo system with necessary diagrams.
2. Find the nonlinearity model of inverted pendulum and analyse the system.

Course Outcome 3 (CO3):Give an introduction to feedback linearisation

1. For the system having a closed loop transfer function $\frac{10}{s^2+2s+5}$, plot the phase trajectory originating from the initial condition (-1,0)
2. Discuss applications of sliding mode control using switched control laws.

Course Outcome 4 (CO4): To study stability analysis of Nonlinear systems -Lyapunov design

1. Discuss the Liapunov stability analysis method. How we can represent graphically stable, unstable and an asymptotic stable system.
2. Explain "stability in the sense of Lyapunov". Write the Lyapunov's stability theorems.

Course Outcome 5 (CO5):To study the concept of backstepping and forwarding approaches

1. Explain the back stepping approach in control systems.
2. How can we model a coupled tank liquid level control system?

SYLLABUS

MODULE I:

Introduction: Nonlinear system behaviour.Nonlinear system analysis: Concepts of phase plane analysis, Phase plane analysis of linear and nonlinear systems, Existence of limit cycles.

MODULE II:

Fundamentals of Liapunov theory: Nonlinear systems and equilibrium points, Concepts of stability, Linearization and local stability, Lyapunov's direct method, Invariant set theorems, Lyapunov analysis of LTI systems, Krasovskii's method, Variable gradient method, Physically motivated Lyapunov functions, Performance analysis. Control design based on Liapunov's direct method.

MODULE III:

Advanced stability theory: Concepts of stability for Non-autonomous systems, Lyapunov analysis of non autonomous systems, instability theorems, Existence of Lyapunov functions, Barbalat's Lemma and stability analysis, Positive real systems: PR and SPR Transfer functions, The Kalman-Yakubovich Lemma, The passivity Formalism: passivity in linear systems, Absolute stability, Establishing boundedness of signals, Existence and Unicity of solutions

MODULE IV:

Nonlinear Control systems design: Feedback Linearization and the canonical form, Input-state Linearization of SISO systems, Input output Linearization of SISO systems, multi input systems Sliding Control: Sliding surfaces,Filippov's construction of the equivalent dynamics.

MODULE V:

Direct implementations of switching controllaws: Continuous approximations of switching control laws, modeling and performance tradeoffs Lie derivative, Lie Bracket, Back stepping method for non-feedback linearizable systems.

Syllabus and Course Plan

No	Topic	No. of Lectures
1	**Introduction:**	
1.1	Nonlinear system behaviour	1
1.2	Nonlinear system analysis: Concepts of phase plane analysis, Phase plane analysis of linear and nonlinear systems	3
1.3	Existence of limit cycles.	2
2	**Fundamentals of Liapunov theory:**	
2.1	Nonlinear systems and equilibrium points, Concepts of stability, Linearization and local stability	2
2.2	Lyapunov's direct method, Invariant set theorems, Lyapunov analysis of LTI systems, Krasovskii's method, Variable gradient method	3
2.3	Physically motivated Lyapunov functions, Performance analysis	3
2.4	Control design based on Liapunov's direct method	2
3	**Advanced stability theory:**	
3.1	Concepts of stability for Non-autonomous systems, Lyapunov analysis of non-autonomous systems	2
3.2	instability theorems, Existence of Lyapunov functions	2
3.3	Existence of Lyapunov functions, Barbalat's Lemma and stability analysis	2
3.4	Positive real systems: PR and SPR Transfer functions, The Kalman-Yakubovich Lemma	3
3.5	The passivity Formalism: passivity in linear systems, Absolute stability, Establishing boundedness of signals, Existence and Unicity of solutions.	3
4	**Nonlinear Control systems design:**	
4.1	Feedback Linearization and the canonical form, Input-state Linearization of SISO systems, Input output Linearization of SISO systems	3
4.2	multi input systems Sliding Control: Sliding surfaces,Filippov's construction of the equivalent dynamics	3
5	**Properties of Adaptive systems:**	
5.1	Continuous approximations of switching control laws	2
5.2	Modelling and performance trade-offs Lie derivative, Lie Bracket,	2

5.3	Back stepping method for non-feedback linearizable systems.	ELECTRONICS & INSTRUMENTATION-EC12

References

1. Jean- Jacques Slotine and Weiping Li, Applied nonlinear Control, Prentice Hall,1991, ISBN:0-13-040890.
2. H.K. Khalil, Nonlinear Systems, 3rd ed., Prentice hall, 2002.
3. D. Elliott, Bilinear Systems, Springer, 2009.
4. Shankar Sastry, Nonlinear Systems; Analysis, Stability and Control, Springer. 1999
5. P. LaSalle, Solomon Lefschetz, Stability by Liapunov's direct method: with applications, Joseph Academic Press, 1961
6. Mathukumalli Vidyasagar, Nonlinear systems analysis, SIAM, 2002.
7. Alberto Isidori, Nonlinear Control Systems - Volume 1, Springer, 1995.
8. Alberto Isidori, Nonlinear Control Systems – Volume 2, Springer, 1999.

Model Question Paper

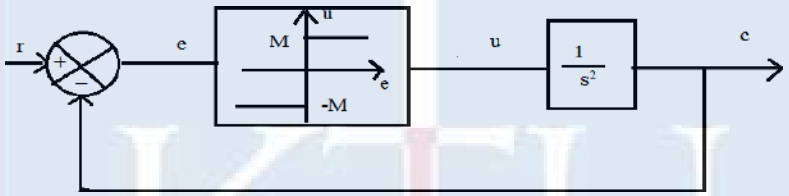
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER
221EAE100NON-LINEAR CONTROL SYSTEMS

Time: 2:30 hours **Max. Marks:60**

PART A

Answer ***all*** questions. Each question carries ***5 marks***.

1. Briefly explain the characteristics of Non Linear Control System.
2. Briefly explain the describing functions of dead zone & saturation nonlinearity.
3. Consider a system with ideal relay as shown in figure. Determine the singular point. Construct the phase trajectory corresponding to initial conditions (i) c(0)= 2 (ii)$c^1(0)$ = 1 and (i) c(0) =2 (ii) $c^1(0)$ = 1.5.Take r =2V & M=1.2V



4. Explain "stability in the sense of Lyapunov". Write the Lyapunov's stability theorems.
5. Discuss applications of sliding mode control using switched control laws.

PART B

Answer ***any five*** questions. Each question carries ***7 marks***

6. Explain the concept of absolute stability in non-linear control system. Also state and explain Popov's criterion of stability.
7. What are the basic concepts of sliding mode control? What is the differential inclusion solution in the sense of Fillippov.
8. Using Variable Gradient method construct the liapunov's function and check the stability of the system described by : a) $XX1$ =X2 b) $XX2 = -XX2 - XX13$
9. Write the modelling and analysis of 2 DoF helicopter systems.
10. Write short note onKrasovskii's method &Variable gradient method.
11. Explain the back stepping approach in control systems.
12. How can we model a coupled tank liquid level control system.

COURSE CODE:	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EAE001	CMOS CIRCUIT DESIGN	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: This course aims to develop skills in the design of CMOS circuits.

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

CO 1	Describe the characteristics of CMOS inverter
CO 2	Describe the operation of MOS logic circuits
CO 3	Design semiconductor memory circuits
CO 4	Apply the concept of current mirrors and differential amplifiers
CO 5	Design a CMOS operational amplifier

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			2	1			
CO 2	1		2	1			
CO 3	1		3	1	1		
CO 4	1		3	1			
CO 5	1		3	1	1		

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation: 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):
1. Derive the expression for V_{IL} of a CMOS inverter.
2. Discuss the switching characteristics of a CMOS inverter.

Course Outcome 2 (CO2):
1. Draw a CMOS JK latch circuit and explain its operation.
2. Design a CMOS D latch using Transmission Gates.

Course Outcome 3 (CO3):
1. Describe the structure of NAND based ROM cell and explain.
2. Describe the operation of a 3T DRAM cell.

Course Outcome 4 (CO4):
1. Draw the schematic of a Widlar MOS current mirror.
2. Draw the structure of a differential pair with current mirror load and write the expression for voltage gain.

Course Outcome 5 (CO5):
1. Draw the structure of a two stage CMOS opamp and discuss the design steps.
2. Compare cascode and folded cascodeopamps.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

First Semester M. Tech. Degree Examination_____, _____

Course Code: 221EAE001

Course Name: CMOS Circuit Design

Time: 2.5 Hours Max. Marks: 60

PART A

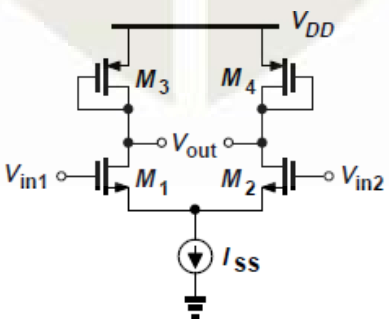
Answer all questions. Each question carries 5 marks.

1. Derive the expression for V_{th} of a CMOS inverter. (K3)
2. Design a CMOS D latch using Transmission Gates. (K5)
3. Discuss the operation of a sense amplifier. (K2)
4. Draw the schematics of the following circuits (i) balanced Wilson MOS current mirror (ii) unbalanced Wilson MOS current mirror. (K2)
5. Compare cascode and folded cascodeopamps. (K4)

PART B

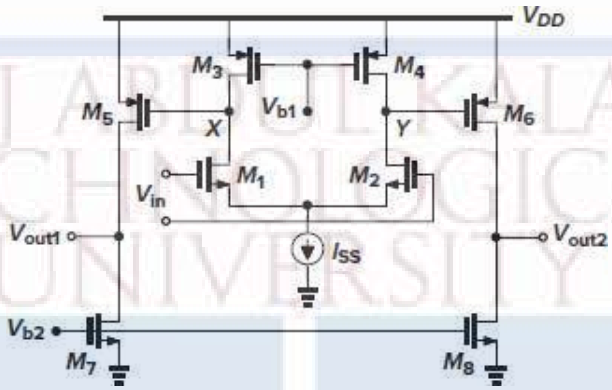
Answer any five questions. Each question carries 7 marks.

6. Derive the expression for T_{PHL} in a CMOS inverter. (K3)
7. Design a CMOS SR latch circuit using NAND2 gates and explain its operation. (K5)
8. Explain the operation of 6T SRAM circuit. (K2)
9. Describe the structure of NOR based ROM cell and explain. (K2)
10. Determine the voltage gain of the circuit shown below. Assume $\lambda \neq 0$. (K5)



11. Explain the working of a MOS current mirror circuit with appropriate circuit diagram. (K2)

12. Design the opamp for the following requirements: Maximum differential swing = 4V, Total power dissipation=6mW, I_{ss}=0.5mA, V_{dd}=3V, μ_n=350cm^2/V-s, μ_p=100cm^2/V-s, C_{ox}=383.6nF/cm^2, λ_n=0.1, λ_p=0.2, $|V_T|$=0.7V. (K5)



Syllabus

Module I - CMOS Inverter

Review of MOS Transistors - CMOS Inverter - Static Characteristics, Derivation for V_{TH}, V_{IL} and V_{IH}, Switching Characteristics, Calculation of propagation delay times.

Module II - MOS Logic Design

Theory of Operation and Circuits of Transmission Gate, Sequential - SR Latch Circuits – NOR based and NAND based, Clocked SR Latch, CMOS D Latch, Clocked JK Latch

Module III - Semiconductor Memory Circuits

Read Only Memory Circuits – NOR based ROM Array, NAND based ROM Array, Design of Row and Column Decoders, SRAM Circuits, Full CMOS SRAM Cell, Fast Sense Amplifiers, DRAM Circuits.

Module IV - Current Mirrors and Differential Amplifiers

Wilson current mirrors, Widlar current mirror, Differential Amplifiers: Basic Differential Pair, Common Mode Response, Differential Amplifiers with MOS Loads : Current Source Load, Current Mirror Load, Cascode Load.

Module V – MOS Operational Amplifiers

One stage Op amp - Simple opamp topology, Cascodeopamp, Folded Cascode op amp, Two stage Op amp, Design of a two stage Op amp, Introduction to BiCMOS

Course Plan

No	Topic	No. of Lectures
1	**CMOS Inverter**	
1.1	CMOS Inverter - Static Characteristics, Derivation for V_{TH}	2
1.2	Derivation for V_{IL} and V_{IH}	2
1.3	Switching Characteristics	2
1.4	Calculation of propagation delay times.	2
2	**MOS Logic Circuits**	
2.1	Theory of Operation and Circuits of Transmission Gate	2
2.2	Sequential - SR Latch Circuits – NOR based and NAND based	2
2.3	Clocked SR Latch	2
2.4	CMOS D Latch, Clocked JK Latch	2
3	**Semiconductor Memory Circuits**	
3.1	Read Only Memory Circuits – NOR based ROM Array, NAND based ROM Array	2
3.2	Design of Row and Column Decoders	2
3.3	SRAM Circuits, Full CMOS SRAM Cell	2
3.4	Fast Sense Amplifiers, DRAM Circuits	2
4	**Current Mirrors and Differential Amplifiers**	
4.1	Wilson current mirrors	2
4.2	Widlar current mirror	1
4.3	Differential Amplifiers: Basic Differential Pair, Common Mode Response	2
4.4	Differential Amplifiers with MOS Loads : Current Source Load, Current Mirror Load, Cascode Load	3
5	**MOS Operational Amplifiers**	
5.1	One stage Op amp - Simple opamp topology	2
5.2	Cascodeopamp	1
5.3	Folded Cascode op amp	1
5.4	Two stage Op amp, Design of a two stage Op amp	2
5.5	Introduction to BiCMOS	2

References

1. BehzadRazavi, “Design of Analog CMOS Integrated Circuits”, Second Edition, McGraw-Hill Education, 2017
2. Sung-Mo Kang,YusufLeblebici , “CMOS Digital Integrated Circuits: Analysis and Design”, Third Edition, Tata McGraw-Hill 2003

3. Baker, Li, Boyce, "CMOS: Circuits Design, Layout and Simulation", Prentice Hall India, 2000
4. Phillip E. Allen, Douglas R. Holbery, "CMOS Analog Circuit Design", Oxford, 2004

COURSE CODE:	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EAE002	ADVANCED BIOMEDICAL INSTRUMENTATION	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: This course introduces the instrumentation and principle of operation of various biomedical devices.

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

CO 1	Interpret the origin of bioelectric signals and examine their role in various electrophysiological measurements.
CO 2	Compare the instrumentation and principle of operation of various medical imaging tools.
CO 3	Describe the various components in a cardiac telemetry system.
CO 4	Explain the role of nuclear medicine in medical diagnosis.
CO 5	Critically analyze the various quality and safety regulations for medical devices in India.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			1	1	1		
CO 2			3	1	1		
CO 3			3	1			
CO 4			2	1	1		
CO 5			2	2			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20%
Analyse	60%
Evaluate	20%
Create	0%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: Evaluation shall only be based on application, analysis or design-based questions (for both internal and end semester examinations).

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are evoked potentials? How can they be used in a BCI system.

2. Explain the electrode placement systems in various electrophysiological measurement techniques such as EEG and ECG.

Course Outcome 2 (CO2)

1. Explain the principle of operation of magnetic resonant imaging (MRI).

2. Compare and contrast fNIRS and fMRI.

3. Distinguish between various modes of ultrasound in medical imaging.

Course Outcome 3(CO3):

1. Explain the function of various components of a teleradiology station.
2. What is the importance of telehome care? Distinguish between WBAN and WPAN.
3. Explain the challenges which are being faced in widespread use of telemedicine.

Course Outcome 4 (CO4):

1. Explain the principle of operation of PET.
2. Compare and contrast SPECT and PET.

Course Outcome 5 (CO5):

1. Explain the significance of Medical Devices (Amendment) Rules, 2020.
2. Explain about the various medical devices used for measuring blood pressure.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

First Semester M. Tech. Degree Examination_____, _____

Course Code: 221EAE002

Course Name: ADVANCED BIOMEDICAL INSTRUMENTATION

Time: 2.5 Hours Max. Marks: 60

PART A

1	EEG is a popular tool for capturing the neural activity for a BCI system. Defend this trend.	5
2	Contrast the following modes of ultrasound in medical imaging: (a) A-mode (b) B-mode (c) M-mode	5
3	Sketch the block diagram of a single channel telemetry system.	5
4	Explain the basic principle of operation of positron emission tomography.	5
5	Pulse oximeters were widely used for health monitoring during the Covid-19 pandemic. Judge the effectiveness of using pulse oximeters to assess the health of a Covid positive person.	5

PART B

6	Explain the AZTEC (Amplitude-Zone-Time-Epoch-Coding) algorithm for data compression and processing of ECG.	7
7	Illustrate the basic principle and working of a magnetic resonance imaging system.	7
8	With a suitable schematic diagram, illustrate the working of an FM-FM modulated radiotelemetry transmitter for detecting and transmitting ECG and respiration activity simultaneously on a single carrier frequency.	7
9	Illustrate working of a gamma camera.	7
10	Critically analyze the various statutory requirements in the development of new medical devices in India.	7
11	What are ultrasonic blood flow meters? With relevant equations, illustrate the working of a time transit flow meter.	7

12 With relevant diagrams, show how a Picture Archiving and Communication 7
System can be used by healthcare organizations to securely store and digitally transmit electronic images and clinically-relevant reports

Syllabus

Module I:

Review of origin of bioelectric signals, Electrocardiography (ECG): Electrode placement-artifacts-QRS Detection and analysis-Power spectrum of ECG-QRS detection algorithm-Data Compression and Processing of the ECG signal by AZTEC (Amplitude-Zone-Time-Epoch-Coding) and its modifications. Electroencephalogram (EEG): Types of EEG electrodes-electrode placement-artifacts-EEG frequency bands. BCI systems using EEG (p300, motor imagery and speech imagery). EMG-ERG-EOG-Lead systems and recording methods

Module II:

Ultrasound generation & detection, types of transducers, diagnostic application- A Scan, B Scan, M Scan, real time ultrasonic imaging, linear array scanners. X-ray computed tomography (CT Scanner)- principle, contrast scale, scanning system, processing Unit, viewing, storage. Magnetic Resonance Imaging- Basic principle, working and construction. Introduction to imaging using NMR, fMRI and fNIRS

Module III:

Single Channel Telemetry Systems, Multi-Channel Wireless Telemetry Systems, Multi-Patient Telemetry, Implantable Telemetry Systems, Biotelemetry Application on WiMAX Networks. Essential Parameters for Telemedicine, Delivery Modes in Telemedicine, Telemedicine System, Clinical Data Interchange/Exchange Standards, Transmission of still images, video images and digital audio, Cyber medicine, Picture Archiving and Communication System.

Module IV:

Radioactive emissions, rectilinear scanner, gamma camera, imaging system. ECT (emission coupled tomography) and its different approaches: positron emission tomography (PET). Introduction to single-photon emission computed tomography (SPECT).

Module V:

Blood pressure and heart sound measurement: Measurement of blood pressure using sphygmomanometer instrument based on Korotkoff sound, indirect measurement of blood pressure, automated indirect measurement, and specific direct measurement techniques. Blood Flow meters: Electromagnetic blood flow meter, ultrasonic blood flow meter, Time transit flow meter, Doppler flow meter, NMR blood flow meter, cardiac output measurement – indicator dilution methods and impedance technique. Pulse oximetry: Principle-limitations-derived measurements. Various processes in the development of medical devices, from conceptualization to post-marketing surveillance (PMS), Medical Devices (Amendment) Rules, 2020- classification of medical devices-licensing process.

Course Plan

No	Topic	No. of Lectures
1	**Basic Electrophysiological Measurements**	
1.1	Review of origin of bioelectric signals	1
1.2	Electrocardiography (ECG): Electrode placement- artifacts-QRS Detection and analysis-Power spectrum of ECG-QRS detection algorithm-Data Compression and Processing of the ECG signal by AZTEC (Amplitude-Zone-Time-Epoch-Coding) and its modifications.	3
1.3	Electroencephalogram (EEG): Types of EEG electrodes-electrode placement-artifacts-EEG frequency bands	2
1.4	BCI systems using EEG (p300, motor imagery and speech imagery)	1
1.5	EMG-ERG-EOG-Lead systems and recording methods	1
2	**Medical Imaging**	
2.1	Ultrasound generation & detection, types of transducers, diagnostic application- A Scan, B Scan, M Scan, real time ultrasonic imaging, linear array scanners	3
2.2	X-ray computed tomography (CT Scanner)- principle, contrast scale, scanning system, processing Unit, viewing, storage	2
2.3	Magnetic Resonance Imaging- Basic principle, working and construction	2
2.4	Introduction to imaging using NMR, fMRI and fNIRS	1
3	**Telemetry and patient monitoring**	
3.1	Single Channel Telemetry Systems, Multi-Channel Wireless Telemetry Systems, Multi-Patient Telemetry, Implantable Telemetry Systems, Biotelemetry Application on WiMAX Networks	4

3.2	Essential Parameters for Telemedicine, Delivery Modes in Telemedicine, Telemedicine System, Clinical Data Interchange/Exchange Standards, Transmission of still images, video images and digital audio, Cyber medicine, Picture Archiving and Communication System	4
4	**Nuclear medicine**	
4.1	Radioactive emissions, rectilinear scanner, gamma camera, imaging system	4
4.2	ECT (emission coupled tomography) and its different approaches: positron emission tomography (PET)	3
4.3	Introduction to single-photon emission computed tomography (SPECT)	1
5	**Cardiovascular Measurements**	
5.1	Blood pressure and heart sound measurement: Measurement of blood pressure using sphygmomanometer instrument based on Korotkoff sound, indirect measurement of blood pressure, automated indirect measurement, and specific direct measurement techniques.	2
5.2	Blood Flow meters: Electromagnetic blood flow meter, ultrasonic blood flow meter, Time transit flow meter, Doppler flow meter, NMR blood flow meter, cardiac output measurement – indicator dilution methods and impedance technique.	3
5.3	Pulse oximetry: Principle-limitations-derived measurements	1
5.4	Various processes in the development of medical devices, from conceptualization to post-marketing surveillance (PMS), Medical Devices (Amendment) Rules, 2020- classification of medical devices-licensing process.	2

References

1.Carr J. J, Brown J. M. Introduction to Biomedical Equipment Technology, Fourth edition, Pearson Education Inc (2001), 4th edition

2.Rao, Rajesh PN. Brain-computer interfacing: an introduction. Cambridge University Press (2013)

3.Khandpur R.S., Handbook of Biomedical Instrumentation, Tata McGrawHill Publishing (2009), 2nd edition

4.Khandpur, R. S. Telemedicine technology and applications (mHealth, TeleHealth and eHealth). PHI Learning Pvt. Ltd. (2017)

5. Mandeep Singh, Introduction to Biomedical Instrumentation, PHI learning private limited (2010), 1st edition.

6. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Prentice Hall of India, New Delhi. (1973)

7. Manu, Manas, and Gaurav Anand. "A review of medical device regulations in India, comparison with European Union and way-ahead." Perspectives in Clinical Research 13, no. 1 (2022)

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EAE003	OPTIMIZATION TECHNIQUES	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: The course takes a unified view of optimization and covers the main techniques and algorithms. This envision to create a passion for identifying and solving complex optimization problems that are ubiquitous around us, and thus opening up new frontiers of innovative and intuitive research.

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

CO 1	Outline the mathematical building blocks of optimization.
CO 2	Model and solve linear programming problems
CO 3	Apply principles and techniques for solving nonlinear programming models
CO 4	Investigate and assess constrained convex optimization problems
CO 5	Appreciate prominent heuristic optimization algorithms
CO6	Solve optimization problem through optimization software

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3		2	3	3	1	
CO 2	3	1	2	3	3	1	1
CO 3	3	1	2	3	3	1	1
CO 4	3	1	2	3	3	1	1
CO 5	3		2	3	3	1	1
CO 6	3	1	2	3	3	1	1

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	30
Analyse	20
Evaluate	10
Create	-

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern

Students shall be encouraged to submit programming assignments in Python / MATLAB®(Reference text – 4). Optimization tool box of MATLAB®shall be used to implement advanced engineering optimization problems (collaborative works shall be allowed for such assignments)/ Preparing a review article based on peer reviewed original publications: 15 marks

Course based task/Seminar: 15 marks

Internal exams shall be mostly on problems and proofs of various theorems.

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example, if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

First Semester M. Tech. Degree Examination_____, _____

Course Code: CODE221EAE003
Course Name: Optimization Techniques
Time: 2.5 Hours, Marks: 60

PARTA

Answer ALL Questions. Each Carries 5 marks.

1. Define the gradient of the function. Demonstrate its importance in the multi-variable optimization.
2. State and prove complementary slackness theorem.
3. Using Newton's method minimize $f=(3x_1-1)^3 + 4x_1x_2 + 2x_2^2$ by taking initial point as (1,2).
4. State and prove Kuhn – Tucker conditions in non-linear programming.
5. Differentiate supervised and supervised learning.

PART–B

Answer any FIVE full questions; each question carries 7 marks.

6.a) Given, $\Psi_1^{-1} = \begin{bmatrix} 0.5000 & 0.5000 & 0.5000 & 0.5000 \\ 0.6533 & 0.2706 & -0.2706 & -0.6533 \\ 0.5000 & -0.5000 & -0.5000 & 0.5000 \\ 0.2706 & -0.6533 & 0.6533 & -0.2706 \end{bmatrix}$

$\Psi_2^{-1} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -\square\square & -1 & \square\square \\ 1 & -1 & 1 & -1 \\ 1 & \square\square & -1 & -\square\square \end{bmatrix}$ and $\square\square = \begin{bmatrix} 4 \\ 5 \\ 5 \\ 4 \end{bmatrix}$ 4 marks

Let Ψ_1 and Ψ_2 be two change of basis matrices. Obtain the representation of the given vector $\square\square$ in terms of Ψ_1 and Ψ_2. Calculate l_0, l_1 and l_∞ norms of there presentation.

6.b) Discuss the convexity and concavity of the following functions

a) $\square\square(\square\square) = (\square\square_1 + \square\square_2)\square\square^{(\square\square_1+\square\square_2)}\square\square_1 > 0, \square\square_2 > 0$

b) $\square\square(\square\square) = \square\square_1\square\square_1(\square\square) + \square\square_2\square\square_2(\square\square)\square\square_1 \geq 0, \square\square_2 \geq 0$ and both $\square\square_1(\square\square)$ and $\square\square_2(\square\square)$ are convex functions 3 marks

7.a) Congratulations! Upon graduating from college, you have immediately been offered a high-paying position as president of the Lego Furniture Company. Your company produces chairs (each requiring 2 square blocks and 1 rectangular block) as well as tables (each requiring 2 square blocks and 2 rectangular blocks) and has available resources consisting of 8 rectangular blocks and 6 square ones. Assume chairs and tables each sell for 5 and 7 respectively, and that your company sells all of what it produces. 3 marks

(i) Set up an LP whose objective is to maximize your company's revenue.

(ii) Represent it in the standard form and matrix form.

7.b) Solve the following LPP using dual simplex method

min z = $3x_1+2x_2$

subject to $2x_1+ 3x_2 \geq 30$

$-x_1+2x_2 \leq 6$ 4 marks

$x_1+3x_2> 20$

$x_1, x_2 \geq 0$

8a) Solve the following optimization problem using Simplex algorithm. 3 marks

$$\max_{x_1,\, x_2,\, x_3} \; 15x_1 + 4x_2 - 5x_3$$
$$s.\,t. \quad x_1 + x_2 - x_3 \leq 21$$
$$3x_1 + 2x_2 + 2x_3 \leq 42$$
$$2x_1 + 3x_3 \leq 42$$
$$x_1 \geq 0,\; x_2 \geq 0, x_3 \geq 0$$

8 b) Consider an LPP 4 marks

max z = $-x_1 - x_2$

subject to $-x_1+ x_2 \geq 1$

$2x_1- x_2 \leq 2$

$x_1, x_2 \geq 0$

Find the dual to the problem. Solve the primal and the dual graphically, and verify that the results of the strong duality theorem hold.

9a) Prove that in Fibonacci search algorithm, at the end of (n-1) iterations, the length of the interval of uncertainty is reduced from (b_1-a_1) to $(b_1-a_1) / F_n$. Moreover, show that Fibonacci method is more efficient than Golden section search algorithm. 4 marks

9 b) Use Newton's method to solve, 3 marks

minimize $(x_1,x_2) = 5x_1^4+6x_2^4-6x_1^2+2x_1x_2+5x_2^2+15x_1-7x_2+13$

Use the initial guess $(1, 1)^T$.

10a) Use the steepest descent method to solve 4 marks

minimize $f(x_1, x_2) = 4x_1^2 + 4x_1x_2 + 2x_2^2 - 3x_1$, starting from the point $(2, 2)^T$. Perform three iterations.

10 b) Describe Grid search method with a suitable example. 3 marks

11a) Consider the problem 4 marks

$\min f(x_1,x_2,x_3,x_4) = x_1^2 + x_2^2 + x_3^2 + x_4^2$

subject to $g_1(x_1,x_2,x_3,x_4) = x_1+2x_2+3x_3+5x_4-10 = 0$

$g_2(x_1,x_2,x_3,x_4) = x_1+2x_2+5x_3+6x_4-15 = 0$

Solve the problem using Lagrangian method and compute the Lagrange multipliers.

11 b) Formulate the Karush-Kuhn-Tucker (KKT) necessary conditions for the following optimization problem 3 marks

$$\begin{aligned} &\min && z = x_1 + x_2 \\ &\text{subject to} && g_1(x_1,x_2) = x_1^3 - x_2 \geq 0 \\ & && g_2(x_1,x_2) = x_1 \geq 0 \\ & && g_3(x_1,x_2) = x_2 \geq 0 \end{aligned}$$

12 a) Explain Ant Colony Optimization algorithm in detail. 4 marks

12 b) Describe Particle Swam Optimization algorithm. List out its advantages, disadvantages and applications. 3 marks

SYLLABUS

Module1:

Mathematical Background:

Vector norm, Matrix norm, Inner product, Norm ball, Interior point, Closure and boundary, Complement, scaled sets, and sum of sets, Supremum and infimum, Vector subspace, Function, Continuity of function, Derivative and gradient, Hessian, Convex sets and convex functions. Introduction to optimization - Optimal problem formulation, Engineering applications of optimization, Optimization techniques - Classification.

Module2:

Linear Programming:

Linear Programming - Formulation of the problem, Graphical method, Simplex method, Artificial variable techniques, Duality Principle, Dual simplex method.

Module3:

Non-linear programming:

Unimodal Function, Elimination methods – Fibonacci method, Golden section method, Direct search methods – Random walk, Grid search method, Indirect search methods – Steepest descent method, Newton's method.

Module4:

Convex optimization:

Standard form of convex optimization problems, Global optimality, An optimality criterion for differentiable convex function, Lagrange dual function and conjugate function, Lagrange dual problem, Karush–Kuhn–Tucker (KKT) optimality conditions, Lagrange dual optimization.

Module5:

Optimization algorithms:

Genetic algorithm, Neural network-based optimization, Ant colony optimization, Particle swarm optimization. Optimization Libraries in Python: scipy.optimize, CVXPY, CVXOPT.

Course Plan

No	Topic	No. of Lectures
1	**Mathematical Background:**	
1.1	Vector norm, Matrix norm, Inner product, Norm ball	1
1.2	Interior point, Closure and boundary	1
1.3	Complement, scaled sets, and sum of sets, Supremum and infimum	1
1.4	Vector subspace, Function, Continuity of function,	1
1.5	Derivative, gradient and Hessian	1
1.6	Convex sets and convex functions	1
1.7	Introduction to optimization - Optimal problem formulation	1
1.8	Engineering applications of optimization, Optimization techniques Classification	1
2	**Linear Programming:**	

2.1	Linear Programming - Formulation of the problem, Graphical method	2
2.2	Simplex method	2
2.3	Artificial variable techniques, Duality Principle	2
2.4	Dual simplex method	2
3	**Non-linear programming:**	
3.1	Uni-modal Function	1
3.2	Elimination Methods: (1) Fibonacci Method	1
3.3	Elimination Methods: (2) Golden Section Method	1
3.4	Direct Search Methods: (1) Random Walk	1
3.5	Direct Search Methods: (2) Grid Search Method	1
3.6	Indirect Search Method: (1) Steepest Descent Method	1
3.7	Indirect Search Method: (2) Newton's Method	2
4	**Convex optimization:**	
4.1	Standard form of convex optimization problems	1
4.2	Global optimality, An optimality criterion for differentiable convex function	2
4.3	Lagrange dual function and conjugate function	1
4.4	Lagrange dual problem	2
4.5	Karush–Kuhn–Tucker (KKT) optimality conditions	2
5	**Optimization algorithms:**	
5.1	Genetic algorithm	1
5.2	Neural network-based optimization	2
5.3	Ant colony optimization	2
5.4	Particle swarm optimization.	1
5.5	Optimization Libraries in Python: scipy.optimize, CVXPY, CVXOPT	2

Text Books

1. Chong-Yung-Chi, Wei-Chiang Li, Chia-Hsiang Lin, Convex Optimization for Signal Processing and Communications – From fundamentals to applications, CRC press.
2. Sukanta Nayak, Fundamentals of Optimization Techniques with Algorithms, Academic press.
3. Singiresu S. Rao, Engineering Optimization: Theory and Practice, John Wiley and Sons.

Reference Books

1. Igor Griva, ArielaSofer, Stephen G Nash,Linear and Nonlinear Optimization, Second edition, SIAM.
2. Kalyanmoy Deb,Optimization for Engineering: Design Algorithms and Examples, Second edition,Prentice Hall.
3. David G Luenberger, Linear and Nonlinear Programming, Second edition, Addison-Wesley.

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EAE004	INDUSTRIAL DRIVES AND CONTROL	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: This course provides a detailed study of different components present in an electric drive system and equips students with detailed knowledge about a DC/AC motor drive system. This course also provides an introduction to various vector control schemes.

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

CO 1	Familiarize about different types of drives and its components.
CO 2	Analyze different types of Power converters
CO 3	Analyze DC motor drive system
CO 4	Describe various types of Inverters and PWM schemes
CO 5	Describe AC motor drive systems and fundamental principles of various Vector control schemes.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3						
CO 2			3				
CO 3			3				
CO 4	3						
CO 5	3						

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	50%
Analyse	50%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern (40 Marks):
Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation: 15 marks
Test paper, 1 no.: 10 marks.

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern(60 Marks):
Part A: 5×5 Marks
Part B: 5×7 Marks

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain different types of components present in an electric drive system

2. Explain the dynamics of an electric drive system.

3. List some of the industrial application applications of drives

Course Outcome 2 (CO2)

1.Describe the four quadrant operation of drives.

2. Analyse Phase controlled converters, Choppers and Cyclo Converters

Course Outcome 3(CO3):

1. Analyse Speed-torquecharacteristics of differenttypes of DC Motors.
2. Describe various types of breaking and control schemes

Course Outcome 4 (CO4):

1. Design various types of voltage source inverters

2. Explain various types of PWM schemes

3. Describe the concept of PDM

Course Outcome 5 (CO5):

1. Describe induction motor drives and various speed control methods

2. Analyse *d-q*modelofinductionmotor

3. Briefly describe different types of vector control schemes.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

First Semester M. Tech. Degree Examination_____, _____

Course Code: CODE221EAE004
Course Name: INDUSTRIAL DRIVES AND CONTROL
Time: 2.5 Hours, Marks: 60

PART A (Answer ***all*** questions)

1	Obtain the load torque equation and briefly describe different components of load torque.	5
2	Explain four quadrant operation of an electric drive system	5
3	Draw and explain Speed-torquecharacteristics ofDCshunt motor.	5
4	Draw the space vector diagram of a three-level Voltage Source Inverter and explain the switching vectors	5
5	Describe the principle of operation of Field Oriented vector control scheme.	5

PART B (Answer any ***FIVE*** questions)

6	Explain different elements in an industrial drive system in detail. Mention the factors influencing the selection of drives	7
7	Explain Chopper controlled drives with suitable diagrams in detail.	7
8	A dc motor takes an armature current of 110A at 480V. The armature circuit resistance is 0.2ohm. The machine has 6 poles and armature is lap connected with 864 conductors. The flux per pole is 0.05 wb. Calculate (i). Speed (ii). Armature torque.	7
9	What are different types of armature and field control techniques used with dc motors? Explain in detail.	7
10	(i). Draw switching vector diagram of a 2-level inverter and derive the expression for switching times T_1, T_2 and T_0. (ii). Compare SPWM and SVPWM, explain the importance of Zero vectors.	7
11	Explain different types of speed control techniques used with an induction motor drive.	7
12	A 6-pole, 50Hz, 3-phase slip-ring induction motor has resistance and reactance of 0.5 and 5 ohm respectively. Calculate (i) at what speed the torque is maximum. (ii) the ratio of max. torque to starting torque. (iii) what must be the value of external resistance to be added so that the starting torque is half of the max. torque?	7

Syllabus

Module 1: Introduction (8 Hours)

Classification of Electric Drives, Components of Electric Drives, Dynamics of Electric Drives, Equivalent Drive parameters, Drives for Industrial applications.

Module 2: Converters and control (8 Hours)

Phase controlled converters, Four quadrant operation, DC Choppers, AC-AC converters: Cyclo converters

Module 3: DC motor drives (8 Hours)

Speed-torque characteristics of DC shunt, Separately excited motor, Permanent Magnet motors and series motors, Dynamic model, Speed and position control methods, Breaking methods.

Module 4: Inverters and PWM techniques (8 Hours)

Inverters: Voltage source inverters, Current source inverters, PWM techniques: Sine-triangle comparison, Harmonic elimination, Hysteresis current controllers, Space vector PWM, Introduction to PDM schemes.

Module 5:AC motor drives (8 Hours)

Induction motor drives, Speed control methods, d-qmodel of induction motor, constant flux speed control structure, Vector control of induction motor: Field Oriented Control(FOC), Direct Torque Control(DTC).

Course Plan

No	Topic	No. of Lectures (40 hrs)
1	**Introduction to Electric Drives**	
1.1	Classification of Electric Drives	1
1.2	Components of Electric Drives	2
1.3	Dynamics of Electric Drives	2
1.4	Equivalent Drive parameters	1
1.5	Drives for Industrial applications	2
2	**Converters and control**	
2.1	Phase controlled converters	2

2.2	Four quadrant operation	2
2.3	DC Choppers	2
2.4	AC-AC converters: Cyclo Converters	2
3	**DC motor drives**	
3.1	Speed-torque characteristics of DC shunt, separately excited motor, Permanent Magnet motors and series motors	4
3.2	Dynamic model	1
3.3	Speed and position control methods	2
3.4	Breaking methods	1
4	**Inverters and PWM techniques**	
4.1	Inverters: Voltage source inverters, Current source inverters	2
4.2	PWM techniques: Sine-triangle comparison	1
4.3	Harmonic elimination	1
4.4	Hysteresis current controllers	1
4.5	Space vector PWM	2
4.6	Introduction to PDM schemes	1
5	**AC motor drives**	
5.1	Induction motor drives	1
5.2	Speed control methods	2
5.3	d-q model of induction motor	2
5.4	Constant flux speed control structure	1
5.5	Vector control of induction motor: 1. Field Oriented Control (FOC) 2. Direct Torque Control (DTC)	2

References

1. "Fundamentals of Electric Drives", Gopal K Dubey, Narosa

2. "Electric Motor Drives – Modeling, Analysis and Control," R. Krishnan, Prentice -Hall of India.

3. "Electric Drives – Concepts and Applications", Vedam Subrahmanyam, Tata McGraw Hill.

4. "Power Electronics – Principles and Applications", Joseph Vithayathil, Tata McGraw Hill.

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EAE005	SYSTEM RELIABILITY	PROGRAM ELECTIVE 1	3	0	0	3

Preamble: System Reliability engineering consists of the systematic application of time-honored engineering principles and techniques throughout a product life cycle and is thus an essential component of a good Product Lifecycle Management program. The goal of reliability engineering is to evaluate the inherent reliability of a product or process and pinpoint potential areas for reliability improvement. Realistically, all failures cannot be eliminated from a design, so another goal of reliability engineering is to identify the most likely failures and then identify appropriate actions to mitigate the effects of those failures.

Course Outcomes: The COs shown are only indicative. For each course, there can be 4 to 6 COs.

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

CO 1	Attain the basic techniques of quality improvement, fundamental knowledge of statistics and probability
CO 2	Apply techniques to analyse the reliability of systems
CO 3	Familiarize the concepts of reliability and maintainability.
CO 4	Describe the modelling methods of failure of systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	1	1	0	0	0
CO 2	2	3	2	2	3	0	0
CO 3	2	1	3	0	1	0	0
CO 4	0	0	3	0	2	0	0

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	40%
Analyse	60%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

The end semester examination will be conducted by the college. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. How the Weibull 2 parameter model can be used for assessing the reliability?

2. Give the failure modelling concept with respect to the bathtub curve.

3. How the conditional probability concepts can be applied to predict the future failure behaviour of systems?

Course Outcome 2 (CO2)

1. Why engineering systems fails ? How can improve the reliability?

2. How the reliability can be improved for the non-repairable systems?

3. How normal and exponential distributions can be used in failure rate prediction.

Course Outcome 3(CO3):

1. Give the principle of RAM engineering.
2. Compare electronic, mechanical and software reliability.
3. What is FMEA and FMECA?

Course Outcome 4 (CO4):

1. Distinguish between HALT and HASS
2. Why ESS is required for components and devices?
3. Distinguish between scale and shape parameter.

Syllabus

MODULE I:

Basic concepts, Rules for combining Probabilities of events, Failure Density and Distribution functions – Bernoulli's trials – Binomial distribution. Expected value and standard deviation for binomial distribution, Network Modeling and Reliability Evaluation Basic concepts, Evaluation of network Reliability / Unreliability – Series systems, Parallel systems, Series - Parallel systems, partially redundant systems.

MODULE II:

Evaluation of network Reliability, Unreliability using conditional probability method, Paths based and Cut setbased approach – complete event tree and reduced event tree methods – Examples, Time Dependent Probability Basic concepts – Reliability functions f(t), F(t), R(t), h(t) – Relationship between these functions – Baths tubs curve.

MODULE III:

Failure density and distribution functions, Exponential failure density and distribution functions - Expected value and standard deviation of Exponential distribution, Measures of reliability – MTTF, MTTR, MTBF. Evaluation of network reliability / Unreliability of simple Series, Parallel, Series-Parallel systems, Partially redundant systems - Evaluation of reliability measure – MTTF for series and parallel systems.

MODULE IV:

Component reliability, Examples of geometry, strength and loads, Fatigue strength, Time dependent reliability of components, Failure rate versus time, Reliability and hazard functions and different distributions, Estimation of failure rate, Expected residual life, Series, parallel and mixed systems, complex systems.

MODULE V:

Reliability enhancement and Failure modes and effect analysis, Event tree and fault tree analysis, Reliability testing, Reliability data and analysis, measurement of reliability, Monte Carlo Simulation, Computation of reliability.

Course Plan

No	Topic	No. of Lectures
1	**Basic concepts**	
1.1	Rules for combining Probabilities of events	1
1.2	Failure Density and Distribution functions – Bernoulli's trials – Binomial distribution. Expected value and standard deviation for binomial distribution	2
1.3	Network Modeling and Reliability Evaluation Basic concepts	2
1.4	Evaluation of network Reliability / Unreliability – Series systems, Parallel systems, Series - Parallel systems, partially redundant systems.	3
2	**Evaluation of network Reliability.**	
2.1	Unreliability using conditional probability method.	2
2.2	Paths based and Cut set based approach – complete event tree and reduced event tree methods - Examples.	2
2.3	Time Dependent Probability Basic concepts – Reliability functions f(t), F(t), R(t), h(t) – Relationship between these functions – Baths tubs curve.	2
3	**Failure density and distribution functions**	
3.1	Exponential failure density and distribution functions - Expected value and standard deviation of Exponential distribution.	2
3.2	Measures of reliability – MTTF, MTTR, MTBF. Evaluation of network reliability / Unreliability of simple Series, Parallel, Series-Parallel systems	3
3.3	Partially redundant systems - Evaluation of reliability measure – MTTF for series and parallel systems.	3
4	**Component reliability**	2
4.1	Examples of geometry, strength and loads, Fatigue strength, Time dependent reliability of components, Failure rate versus time.	3
4.2	Reliability and hazard functions and different distributions, Estimation of failure rate, Expected residual life, Series, parallel and mixed systems, complex systems.	3

5	**Reliability enhancement and Failure modes and effect analysis**	
5.1	Reliability based design, Optimization problems, Failure modes and effect analysis	3
5.2	Event tree and fault tree analysis, Reliability testing.	3
5.3	Reliability data and analysis, measurement of reliability, Monte Carlo Simulation, Computation of reliability.	4

Reference Books

1. Reliability Evaluation of Engineering Systems by Roy Billinton and Ronald N. Allan, Reprinted in India B. S. Publications, 2007.

2. Reliability Engineering by E. Balagurusamy, Tata McGraw Hill, 2003.

3. Reliability and Maintainability Engineering by Charles E. Ebeling, Tata McGraw Hill, 2000.

4. Probability concepts in Electric Power system – G.J.Anders- 1 st edition –1990 – John wiley& sons.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER
221EAE005 SYSTEM RELIABILITY

Time: 2:30hours **Max. Marks:60**

PART A

Answer ***all*** questions. Each question carries ***5 marks***.

1. Define failure density and distribution function.
2. Define reliability function and hazard function.
3. Explain the MTTF and MTBF.
4. Explain the term component reliability ?
5. Give the use of fault tree analysis in reliability assessment.

PART B

Answer ***any five*** questions. Each question carries ***7 marks***

6. Explain the Binomial distribution, Expected value and standard deviation for binomial distribution.
7. Describe the terms Time Dependent Probability, Reliability functions f(t), F(t), R(t), h(t). Give the relationship between these functions.
8. Explain the evaluation of network reliability, Unreliability of simple Series, Parallel, Series-Parallel Systems.
9.
    a. Describe the Reliability and hazard functions and different distributions.
    b. Give the estimation of failure rate, Expected residual life, Series, parallel and mixed systems, complex systems.
10.
    a. Narrate the role of Event tree and fault tree analysis in reliability engineering.
    b. Give the details of Reliability data and analysis, Monte Carlo Simulation and computation of reliability.
11.
    a. Narrate the role of Event tree and fault tree analysis in reliability engineering.
    b. Give the details of Reliability data and analysis, Monte Carlo Simulation and computation of reliability.
12.
    a. What is the survival function and hazard function of an exponential R V?
    b. Define Maintainability and availability.Compare it with reliability.

SEMESTER I

PROGRAM ELECTIVE II

COURSE CODE	COURSE NAME	ELEC RONICS & INS CATEGORY	RI L	MI T	NI P	ATION-EC1 CREDIT
221EAE006	ADAPTIVE CONTROL SYSTEM	PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This course aims to develop the skills for mathematical modelling and stability analysis of adaptive control systems

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

CO 1	Inculcate conceptual understanding of adaptive control
CO 2	Provide knowledge on various adaptive schemes, with a basic understanding on closed loop system stability and implementation issues
CO 3	Develop ability to design suitable stable adaptive scheme to meet the performance objectives even in the presence of disturbances and changing operating conditions
CO 4	Design model reference adaptive control system considering matched structured uncertainties
CO 5	Identify the need and apply appropriate adaptive control design technique to real-time systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	2	2	2	1	1	
CO 2	2	2	2	2	1	1	
CO 3	3	2	3	2	2	1	
CO 4	3	2	2	3	2		
CO 5	2	1	2	2	1		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20%
Analyse	60%
Evaluate	20%
Create	

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Course Level Assessment Questions

Course Outcome 1 (CO1): Inculcate conceptual understanding of adaptive control

1. With suitable block diagram explain adaptive control system
2. Write the classification of adaptive control systems with examples.

Course Outcome 2 (CO2): Provide knowledge on various adaptive schemes, with a basic understanding on closed loop system stability and implementation issues.

1. Draw the block diagram of an IP measurement scheme and explain its importance inan Adaptive Control System.
2. Explain in detail the process of Parametric Identification by Recursive Least square estimation. Differentiate between ARMAX and ARIMAX.

Course Outcome 3 (CO3): Develop ability to design suitable stable adaptive scheme to meet the performance objectives even in the presence of disturbances and changing operating conditions

1. Why the regressive methods are more important in adaptive schemes?
2. Briefly discuss about stability problem of sinusoidal perturbation adaptive controller. Discuss the applications of gain scheduling with suitable example.

Course Outcome 4 (CO4): Design model reference adaptive control system considering matched structured uncertainties

1. State the salient features of Model Reference Adaptive Systems (MRAS)
2. Define MIT Rule.

Course Outcome 5 (CO5): Identify the need and apply appropriate adaptive control design technique to real-time systems.

1. Mention the features of self-tuning regulators.
2. Give notes on stochasticself-tuning regulators.

SYLLABUS

MODULE I:

Introduction: Parametric models of dynamical systems, Adaptive control problem

Real time parameter estimation: Least squares and regression models, Estimating parameters in Dynamical Systems, Experimental conditions, Prior information, MLE, RLS,Instrument variable method.

MODULE II:

Deterministic Self tuning regulators (STR): Pole placement design, Indirect self tuning regulators, Continuous time self-tuners, Direct self-tuning regulators, disturbances with known characteristics.

MODULE III:

Stochastic and Predictive Self tuning regulators: Design of Minimum variance and Moving average controllers, Stochastic self tuning regulators, Unification of direct self tuning regulators.Linear quadratic STR, adaptive predictive control.

MODULE IV:

Model reference adaptive control (MRAS): The MIT Rule, Determination of adaptation gain, Lyapunov theory, Design of MRAS using Lyapunov theory, BIBO stability, Output feedback, Relations between MRAS and STR.

MODULE V:

Properties of Adaptive systems: Nonlinear dynamics, Analysis of Indirect discrete time self tuners, Stability of direct discrete time algorithms, Averaging, Application of averaging techniques, Averaging in stochastic systems, Robust adaptive controllers.

.

Course Plan ELECTRONICS & INSTRUMENTATION-EC1

No	Topic	No. of Lectures
1	**Introduction:**	
1.1	Parametric models of dynamical systems	1
1.2	Adaptive control problem	2
1.3	Real time parameter estimation: Least squares and regression models	2
1.4	Estimating parameters in Dynamical Systems	1
1.5	Prior information, MLE, RLS	2
1.6	Instrument variable method	2
2	**Deterministic Self tuning regulators (STR):**	
2.1	Pole placement design	2
2.2	Indirect self -tuning regulators	2
2.3	Continuous time self-tuners	2
2.4	Direct self-tuning regulators, disturbances with known characteristics	2
3	**Stochastic and Predictive Self tuning regulators:**	
3.1	Design of Minimum variance and Moving average controllers	2
3.2	Stochastic self - tuning regulators	1
3.3	Unification of direct self - tuning regulators	2
3.4	Linear quadratic STR, adaptive predictive control	2
4	**Model reference adaptive control (MRAS):**	
4.1	The MIT Rule.	1
4.2	Determination of adaptation gain.	2
4.3	Lyapunov theory, Design of MRAS using Lyapunov theory, BIBO stability	2
4.4	Output feedback, Relations between MRAS and STR.	2
5	**Properties of Adaptive systems:**	
5.1	Nonlinear dynamics, Analysis of Indirect discrete time self -tuners	2
5.2	Stabilty of direct discrete time algorithms	2
5.3	Switched delay line phase shifters.	2
5.4	Robust adaptive controllers.	2

References

1. D.-W.Gu, P.Hr.Petkov and M.M.Konstantinov, Robust Control Design with MATLAB, Springer, 2005.
2. Alok Sinha, Linear Systems- Optimal and Robust Controls, CRC Press, 2007.
3. S. Skogestad and Ian Postlethwaite, Multivariable feedback control,John Wiley & Sons, Ltd, 2005.
4. G.E. Dullerud, F. Paganini, A course in Robust control theory- A convex approach, Springer, 2000.
5. Kemin Zhou with J.C. Doyle and K. Glover, Robust and Optimal control, Prentice Hall, 1996.

6. G Balsa, R.Y. Chiang, A.K.Packard and M.G.Safonov, Robust Control Toolbox (Ver. 3.0)
7. User's Guide. Natick, MA: The Mathworks, 2005. http: // www. mathworks. Com /access / helpdesk /hellp/toolbox/robust60 11
8. Kemin Zhou, John Comstock Doyle, Keith Glover, Robust and optimal control, Prentice Hall, 1996.
9. Kemin Zhou, John Comstock Doyle, Essentials of robust control, Prentice Hall, 1998.
10. Stephen Boyd, Laurent El Ghaoul, Eric Feron, Linear Matrix Inequalities in System and ControlTheory, SIAM, 1994.
11. Karl Johan Astrom, Bjorn Wittenmark, Adaptive Control, Wesley Publishing Company, Inc

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER
221EAE006ADAPTIVE CONTROL SYSTEM

Time: 2:30hours **Max. Marks:60**

PART A

Answer ***all*** questions. Each question carries ***5 marks***.

1. State the principal difference between adaptive control system and conventional closed loop control system.
2. State the salient features of Model Reference Adaptive Systems (MRAS)
3. Mention the features of self-tuning regulators.
4. What is the effect of cancellation of process zero in indirect self-tuner?
5. State the Lypunov's stability theorem for time varying systems.

PART B

Answer ***any five*** questions. Each question carries ***7 marks***

6. Draw the block diagram of an IP measurement scheme and explain its importance inan Adaptive Control System.
7. Explain in detail the process of Parametric Identification by Recursive Least square estimation. Differentiate between ARMAX and ARIMAX.
8. Elaborate on Minimum-degree pole placement method for design of Adaptive controllers. Give the Algorithm using the above method to obtain the Self-tuning regulator
9. Briefly discuss about stability problem of sinusoidal perturbation adaptive controller. Discuss the applications of gain scheduling with suitable example.
10. Give an account of various stochastic self-tuning regulators.
11. Explain the procedure to obtain a model reference adaptive controller using MIT rule.
12. Design a MRAS controller for a first order system by Lyapunov method. State the conditions to be met to ensure parameter convergence.

COURSE CODE	COURSE NAME	ELECTRONICS & INSTRUMENTATION-EC1 CATEGORY	L	T	P	CREDIT
221EAE007	LOW POWER VLSI SYSTEMS	PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This course aims to acquire knowledge on various low power VLSI systems and low power design methodologies.

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

CO 1	Appreciate the need for low power designs
CO 2	Familiarize nanometer transistor models
CO 3	Compare different low power arithmetic components
CO 4	Design low power memory devices
CO 5	Compare various low power design methodologies

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			1	1			
CO 2			1	1			
CO 3	2		2	1			
CO 4	2		3	1			
CO 5	2		3	1			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	40
Analyse	20
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss the need for low power VLSI chips.
2. Explain how delay-energy product is related to transistor sizing.

Course Outcome 2 (CO2):

1. Describe the effect of temperature and variability on MOSFET performance.
2. Discuss Alpha Power Law model.

Course Outcome 3 (CO3):

1. Construct a carry select adder and explain its working.
2. Describe the operation of an array multiplier.

Course Outcome 4 (CO4):

1. Explain the sources of power dissipation on DRAM and SRAM .
2. Discuss how multi data-bit configuration chip helps in power reduction.

Course Outcome 5 (CO5):

1. Discuss the circuit level tools for power estimation.
2. Describe the techniques for power reduction at the algorithmic level.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

First Semester M.Tech. Degree Examination_____, _____

Course Code: 221EAE007

Course Name: Low Power VLSI Systems

Time: 2.5 Hours Max. Marks: 60

PART A

Answer all questions. Each question carries 5 marks.

1. Discuss the constraints on the reduction of V_t. (K2)
2. Draw the structure of a FinFET and identify the significance of 'fin'. (K3)
3. Draw the structure of an 8-bit Wallace tree multiplier and explain the operation. (K2)
4. Discuss how multi data-bit configuration chip helps in power reduction.(K2)
5. Categorize the techniques to reduce power at the physical design level. (K4)

PART B

Answer any five questions. Each question carries 7 marks.

6. Describe the effects of V_{dd} and V_t on gate speed, for a given device technology. (K2)
7. Discuss the impact of DIBL and GIDL on the sub-threshold leakage of nanometer CMOS transistor. (K2)
8. Construct an 8-bit Ripple Carry Adder and discuss the working. (K3)
9. Describe the methods for active power reduction in SRAM circuits. (K2)
10. Discuss how data retention power reduction is made possible in DRAM circuits. (K2)
11. Examine the low power design methodologies adopted at the gate level. (K4)
12. Identify the architecture level low power design methodologies. (K3)

Syllabus

Module I - Introduction to Low Power Design

Need for low power VLSI chips, Sources of power dissipation in Digital Integrated circuits, Degrees of Freedom, Emerging Low power approaches, Dynamic dissipation in CMOS, Effects of Vdd and Vt on speed, Constraints on Vt reduction, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device Innovation.

Module II - Nanometer Transistors and Their Models

Sub-100nm Transistor, Alpha Power Law Model, Sub-threshold current and leakages, Temperature Sensitivity, Variability, Strained Silicon and Silicon-on-Insulator (SOI), FinFETs.

Module III - Low Power Arithmetic Components

Adders : Ripple Carry Adder, Carry Look Ahead Adder, Carry Skip Adder, Carry Select Adder, Multipliers : Array Multiplier, Wallace Tree Multiplier, Dadda Multiplier.

Module IV - Low Power Memory Design

Introduction :Multi-data-bit Configuration Chip, Low-voltage Data-bus Interface, Sources of Power Dissipation in DRAM and SRAM, Low Power DRAM Circuits, Low Power SRAM Circuits.

Module V – Low Power VLSI Design Methodology

Low Power Physical Design, Low Power Gate Level Design, Low Power Architecture Level Design, Algorithmic Level Power Reduction, Power Estimation Techniques

Course Plan

No	Topic	No. of Lectures
1	**Introduction to Low Power Design**	
1.1	Need for low power VLSI chips, Sources of power dissipation in Digital Integrated circuits, Degrees of Freedom	2
1.2	Emerging Low power approaches, Dynamic dissipation in CMOS, Effects of Vdd and Vt on speed	2
1.3	Constraints on Vt reduction, Transistor sizing & gate oxide thickness	2
1.4	Impact of technology Scaling, Technology & Device Innovation	2
2	**Nanometer Transistors and Their Models**	
2.1	Sub-100nm Transistor, Alpha Power Law Model	2
2.2	Sub-threshold current and leakages, Temperature Sensitivity, Variability	3
2.3	Strained Silicon and Silicon-on-Insulator (SOI)	2

2.4	FinFETs	1
3	**Low Power Arithmetic Components**	
3.1	Adders : Ripple Carry Adder, Carry Look Ahead Adder,	2
3.2	Carry Skip Adder	2
3.3	Carry Select Adder, Multipliers : Array Multiplier,	2
3.4	Wallace Tree Multiplier, Dadda Multiplier	2
4	**Low Power Memory Design**	
4.1	Introduction :Multi-data-bit Configuration Chip, Low-voltage Data-bus Interface	1
4.2	Sources of Power Dissipation in DRAM and SRAM	2
4.3	Low Power DRAM Circuits	3
4.4	Low Power SRAM Circuits	2
5	**Low Power VLSI Design Methodology**	
5.1	Low Power Physical Design, Low Power Gate Level Design	2
5.2	Low Power Architecture Level Design	2
5.3	Algorithmic Level Power Reduction	1
5.4	Power Estimation Techniques	3

References

1. Jan M. Rabaey, MassoudPedram, “Low Power Design Methodologies” Kluwer Academic, 1997(Module 1,3,4)
2. Jan Rabaey Low “Power Design Essentials”, Springer, 2009 (Module 2)
3. AbdellatifBellaouar, Mohamed I. Elmasry, “Low-Power Digital VLSI Design Circuits and Systems”, Kluwer Academic, 1995 (Module 5)
4. Gary Yeap "Practical Low Power Digital VLSI Design”, Kluwer AcademicPublishers, 1998

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EAE008	DIGITAL IMAGE PROCESSING	PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This course provides an introduction to techniques for acquiring, processing and extracting useful information from digital images to equip students with knowledge required to solve real-world problems in several areas including medical, computer vision, remote sensing, surveillance etc.

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

CO 1	Familiarize different types of representation of digital images and to identify different types of transforms necessary for various image processing applications
CO 2	Differentiate and interpret the various image enhancement techniques.
CO 3	Outline the various image restoration and compression techniques and apply them for image processing tasks.
CO 4	Familiarize various morphological operations in image processing and identify the suitable segmentation methods for image processing tasks.
CO 5	Analyse various techniques for extracting useful information from images and apply them in image processing applications.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2		2	2	2	3	
CO 2	3		2	3	3	3	
CO 3	3	1	3	3	3	3	
CO 4	3	1	3	3	3	3	
CO 5	3	1	3	3	3	3	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Bring out the mathematical model of image formation.
2. Explain the terms, 4-connectivity, 8-connectivity and m-connectivity with respect to a digital image.
3. Apply sampling on the given 2D signal and identify the reconstruction filter.
4. Find the 2D correlation and 2D convolution of given pixel sets.
5. Prove the given property of 2D DFT.
6. Computation of DFT, DCT, Haar Transform, KLT of given 2D signal

Course Outcome 2 (CO2):

1. Perform the use of log transformation, gamma transformation, contrast stretching on images
2. Perform histogram equalisation on the given image.
3. Write the algorithm for computing median of an n x n neighbourhood.
4. Apply mean and median filters over a given image.
5. Explain the selection of masks used for smoothening and sharpening of images.
6. With block diagram explain homomorphic filtering
7. Python/Matlab implementation of image enhancement techniques.

Course Outcome 3 (CO3):

1. Explain inverse filtering for image restoration.
2. Derive the transfer function of Wiener filter for image restoration. Give advantages and disadvantages.
3. Explain lossy and lossless image compression schemes.
4. Obtain the Huffman code for the word 'IMAGEPROCESSING' and determine its efficiency.
5. With block diagram explain JPEG compression.
6. Python/Matlab implementation of image compression and restoration techniques.

Course Outcome 4 (CO4):

1. Explain the following morphological operations: (i) Erosion (ii) Dilation (iii) opening (iv) closing and state their uses
2. Explain the different edge detection techniques using first and second derivatives used in image processing. Discuss the masks used.
3. Analyze the usage of Canny edge detector.
4. Explain the different segmentation methodsand apply it on images.
5. Python/Matlab implementation of image segmentation and morphological operations.

Course Outcome 5 (CO5):

1. Explain different measures of textures.
2. Analyze Statistical approaches, Structural and spectral approaches.
3. Explain the significance of co occurrence matrix in texture analysis.
4. Explain different Clustering algorithms
5. Explain different Feature extraction methods and how to apply it on applications like object detection, classification etc. in image processing.
6. Explain Active contour method for object recognition.
7. Python/Matlab implementation of image texture analysis, object recognition etc.
8. Implementation of state of the art machine learning algorithms for image processing tasks.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

First Semester M.Tech. Degree Examination_____, _____

Course Code: 221EAE008

Course Name: DIGITAL IMAGE PROCESSING

PART A

(Answer all questions. Each carries 5 marks)

1	For the given image segment, compute the transform coefficients using i) DFT ii) Haar transform $\begin{bmatrix} 2 & 1 \\ 2 & 3 \end{bmatrix}$	5
2	With a block schematic explain homomorphic filtering.	5
3	What do you mean by compression ratio? Do you consider that lower compression ratioensures better images upon reproduction?2. How can achievable compression ratio to be determined from image histogram?	5
4	Prove the following duality principles in morphologic operations a). $(A \oplus B)^C = A^C \ominus \hat{B}$ b). $(A \cdot B)^C = A^C \circ \hat{B}$	5
5	Give the steps for PCA on images.	5

PART B

(Answer any 5. Each carries 7 marks)

6	State and explain 2D sampling theorem for band limited images. If a continuous image □□(□□, □□) = 2 □□□□□□ 2□□(4□□ + 6□□)is sampled with sampling frequency in x direction as 10 and y direction as 5. a) Find the Fourier transform of the sampling function b) Fourier transform of the image after it has been low pass filtered. c) In order to reconstruct the original image from the sampled data what are the maximum intervals Δ□□,Δ□□that can be used and the limits of bandwidth of low pass reconstruction filter that can be used.	7
7	Compute the K-L Transform of the Image segment x(m, n) = $\begin{bmatrix} 4 & 35 & 7 \\ 4 & 27 & 7 \\ 2 & 34 & 3 \\ 7 & 24 & 4 \end{bmatrix}$ Also recover the original signal from the transform coefficients.	7
8	Perform Histogram equalization on the 3 bit image shown below and obtain the histogram equalized image.	7

$$X(m, n) = \begin{bmatrix} 4 & 4 & 4 & 4 & 4 \\ 3 & 4 & 5 & 4 & 3 \\ 3 & 5 & 5 & 5 & 3 \\ 3 & 4 & 5 & 4 & 3 \\ 4 & 4 & 4 & 4 & 4 \end{bmatrix}$$

9	Derive the transfer function of Wiener filter. Give the condition in which Wiener filter reduces to an inverse filter.	7
10	Consider the simple 4x8 8 bit image. Compress using Huffman coding and comoutr the compresssion achieved and effectiveness of coding. 21 21 95 95 169 169 243 243 21 21 95 95 169 169 243 243 21 21 95 95 169 169 243 243 21 21 95 95 169 169 243 243	7
11	Explain split and merge procedure in image segmentation.	7
12	Write short note on GLCM. Also explain the descriptors to characterise the co occurrence matrix.	7

Syllabus

Module 1: Digital Image Fundamentals and transforms on images

Digital Image Fundamentals: Image formation model, representing digital images, grey scale and colour images, basic relationship between pixels, fundamental steps in Digital Image Processing.

2 D sampling and quantization on images: 2 D sampling and quantization, 2D Fourier transform, 2 D sampling theorem, reconstruction from sampled data.

2D correlation and convolution for digital images.

Other 2D image transforms: DFT and properties (symmetry, linearity, translation in time and frequency domain, convolution, correlation), DCT, Haar transform, KLT.

Module 2: Image enhancement and filtering

Basic intensity transformations: Log transformation, Gamma transformation, contrast stretching, histogram processing-histogram equalization and matching.

Spatial filters for image processing: Mechanics for spatial filtering on images and concept of spatial masks, smoothing filters, median filter, sharpening filters, Laplacian filter, unsharp masking and high boost filtering.

Frequency domain filtering: Filtering in frequency domain,low pass and high pass filtering using Butterworth and Gaussian, homomorphic filtering.

Module 3: Image restoration and image compression

Image Restoration: Imagedegradation and restoration models, Inverse filtering and Wiener filtering, Geometric mean filters, Image denoising.

Image Compression: Need for compression, Image compression model, Lossless and lossy compression, Basic compression methods- Huffman coding, bit plane coding, run length coding, transform coding and predictive coding, JPEG image compression standard.

Module 4: Morphological operations and Image segmentation

Morphological operations: Structuring elements, dilation and erosion, Opening and closing, Hit-Miss transforms. Uses of morphological operations. Boundary extraction and hole filling.

Image Segmentation: Edge based segmentation-Basic edge detection, Canny edge detector. Region based segmentation-Region growing method, Region splitting and merging, Segmentation based on thresholding.

Module 5: Image description, clustering and object recognition

Image descriptors: Image texture analysis -Measures of textures. Statistical approaches, Structural and spectral approaches. GLCM, statistical models fortextures. Principal component analysis for description.
Image Clustering: Different Clustering algorithms
Object recognition: Feature extraction from Images -SIFT, HoG, Active contour method.

Course Plan

No	Topic	No. of Lectures
1	**Module 1: Digital Image Fundamentals and transforms on images**	
1.1	Digital Image Fundamentals: Image formation model, representing digital images, grey scale and colour images, basic relationship between pixels. Fundamental steps in Digital Image Processing.	2
1.2	2 D sampling and quantization on images: 2D sampling and quantization, 2 D Fourier transform, 2 D sampling theorem, reconstruction from sampled data.	3
1.3	2D Correlation and convolution for digital images.	1
1.4	Other 2D image transforms: DFT and properties-(symmetry, linearity, translation in time and frequency domain, convolution, correlation), DCT,Haar transform, KLT.	3
2	**Module 2: Image enhancement and filtering**	
2.1	Basic intensity transformations: Log transformation, Gamma transformation, contrast stretching, histogram processing-histogram equalization and matching.	3
2.2	Spatial filters for image processing: Mechanics for spatial filtering on images and concept of spatial masks, smoothing filters, median filter, sharpening filters, Laplacian filter, unsharp masking and high boost filtering.	3
2.3	Frequency domain filtering: Filtering in frequency domain, low pass and high pass filtering using Butterworth and Gaussian,	3

	homomorphic filtering.	
3	**Module 3: Image restoration and image compression**	
3.1	Image Restoration: Image degradation and restoration models	1
3.2	Inverse filtering and Wiener filtering, Geometric mean filters, Image denoising.	2
3.3	Image Compression: Need for compression, Image compression model, Lossless and lossy compression	1
3.4	Basic compression methods- Huffman coding, bit plane coding, run length coding, transform coding and predictive coding	2
3.5	JPEG image compression standard.	1
4	**Module 4: Image segmentation and morphological operations**	
4.1	Edge based segmentation-Basic edge detection, Canny edge detector.	2
4.2	Region based segmentation-Region growing method, Region splitting and merging.	1
4.3	Segmentation based on thresholding.	1
4.4	Morphological operations: Structuring elements, dilation and erosion, Opening and closing, Hit-Miss transforms. Uses of morphological operations. Boundary extraction and hole filling.	3
5	**Module 5: Image description, clustering and object recognition**	
5.1	Image texture analysis - Measures of textures. Statistical approaches, Structural and spectral approaches. GLCM, statistical models for textures.	2
5.2	Principal component analysis for description.	2
5.3	Image Clustering: Different Clustering algorithms	2
5.4	Object recognition: Feature extraction from Images -SIFT, HoG, Active contour method.	2

References

1. Tinku Acharya and Ajoy K. Ray-Image Processing Principles and Applications, A JohnWiley & Sons, Mc., Publication 2005.
2. Gonzalez and Woods, Digital image processing, Prentice Hall, 2002.
3. K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.
4. S Jayaraman, S Esakkirajan, T Veerakumar, Digital image processing, Tata Mc Graw Hill, 2015

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221EAE009	MECHATRONICS	PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This course aims to develop skills to understand and design different Mechatronics systems.

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

CO 1	Explain the key elements of Mechatronics system
CO 2	Describe principles of sensors and its characteristics
CO 3	Familiarize hydraulic and pneumatic systems
CO 4	Implement ladder programming in PLC systems
CO 5	Design and Analyse various Mechatronics systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3				
CO 2			3		1		
CO 3			3				
CO 4	1		3	1	1		
CO 5	1		3	2	1		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20
Analyse	40
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications
(Minimum 10 publications shall be referred) : 15 marks
Course based task/ Seminar/ Data Collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks

End Semester Examination Pattern:

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question . Students should answer all questions. Part B will contain 7 questions with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Course Level Assessment Questions

Course Outcome 1(CO1)

1. Explain the integrated design issues in mechatronics
2. Explain the applications and scope of mechatronics

Course Outcome 2 (CO2)

1. Explain proximity sensors
2. With neat diagram explain the working principle of LVDT also plot output characteristics

Course Outcome 3 (CO3)

1. Explain
   i) pilot operated valves
   ii) pressure control valves
2. Compare hydraulic and pneumatic systems

Course Outcome 4 (CO4)

1. Write ladder program for XOR gate
2. Explain the basics of PLC programming

Course Outcome 5 (CO5)

1. Explain the mechatronics system for Antilock brake system (ABS) control
2. Explain the mechatronics system forAutomatic car park system

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION

Course Code: **221EAE009**

Course Name: Mechatronics

Max Marks: 60 **Duration: 2.5 Hours**

PART A

Answer ALL Questions. Each question carries 5 marks.

1. With neat block diagram and flowchart explain mechatronics system design process.
2. Explain optical encoder.
3. Compare hydraulic and pneumatic systems.
4. Write a ladder program for jump instruction.
5. Explain the mechatronics system for coin counter.

PART B

Answer any FIVE questions. Each question carries 7 mark.

6. a)	Explain the measurement system of a mechatronics system with an example	4
6. b)	Explain different control systems with an example	3
7.	Define i) Response time ii) Time constant iii) rise time iv) settling time with example	7
8.	Explain i) pilot operated valves ii) pressure control valves	7
9. a)	Explain the basic PLC structure.	5
9. b)	Write ladder program for AND Gate.	2
10.	Explain the mechatronics system for pick and place robot.	7
11	With neat diagram explain the physical components of a hydraulic system and pneumatic system.	7
12.	With neat diagram explain the working principle of LVDT also plot output characteristics.	7

SYLLABUS

Module 1:

Introduction to mechatronics: Elements of mechatronics system, Mechatronics design process, System, Measurement system, Control systems, Microprocessor based controller, Integrated design issues in mechatronics, Applications in mechatronics, Advantages and disadvantages, Scope of mechatronics

Module 2:

Sensors and transducers: Types of transducers- passive and active, Static and dynamic characteristics of transducers, Displacement sensors- potentiometer, resistive strain gauge, capacitive element, LVDT, Proximity sensors- eddy current, inductive, capacitive, photo electric, Position sensors- photo electric, hall effect, optical encoder, Proximity switches, Velocity sensors- electromagnetic transducers Tachogenerator- toothed rotor, variable reluctance, AC, DC, Pyro electric sensors, Force sensors- hydraulic load cell, pneumatic load cell, strain gauge load cell

Module 3:

Hydraulic and pneumatic actuating systems: Hydraulic systems- physical components of a hydraulic system, Pneumatic systems, Comparison of hydraulic and pneumatic systems, Control valves- directional control valves, pilot operated valves, pressure control valves, Electro pneumatics- components

Module 4:

Programmable logic controllers: Basic PLC structure, PLC architecture, Basics of PLC programming, Features of programmable controller, Ladder programming, Ladder diagrams- series connection, parallel connection, AND, OR, NAND, NOR, XOR, boolean expression, relay circuit, timer, latch circuit, counters, shift registers, master and jump control, data comparisons

Module 5:

Case studies: Pick and place robot, Car park barriers, Antilock brake system (ABS) control, Boat autopilot, Automatic car park system, Coin counter

Course Plan

No	Topic	No. of Lectures
1	Introduction to mechatronics	
1.1	Elements of mechatronics system	1
1.2	Mechatronics design process	1
1.3	System	1
1.4	Measurement system	1
1.5	Control systems	1

1.6	Microprocessor based controller	1
1.7	Applications, Advantages, disadvantages and scope of mechatronics	1
2	Sensors and transducers	
2.1	Types of transducers- passive and active, Static and dynamic characteristics of transducers	1
2.3	Displacement sensors- potentiometer, resistive strain gauge, capacitive element, LVDT	2
2.4	Proximity sensors- eddy current, inductive, capacitive, photo electric	2
2.5	Position sensors- photo electric, hall effect, optical encoder	2
2.7	Velocity sensors- electromagnetic transducers Tachogenerator- toothed rotor, variable reluctance, AC, DC	2
2.8	Pyro electric sensors	1
2.9	Force sensors- hydraulic load cell, pneumatic load cell, strain gauge load cell	2
3	Hydraulic and pneumatic actuating systems	
3.1	Hydraulic systems- physical components of a hydraulic system	2
3.2	Pneumatic systems	1
3.3	Comparison of hydraulic and pneumatic systems	1
3.4	Control valves- directional control valves, pilot operated valves, pressure control valves	2
3.5	Electro pneumatics- components	1
4	Programmable logic controllers	
4.1	Basic PLC structure	1
4.2	PLC architecture	1
4.3	Basics of PLC programming	1
4.4	Features of programmable controller	1
4.5	Ladder programming	1
4.6	Ladder diagrams- series connection, parallel connection, AND, OR, NAND, NOR, XOR, boolean expression, relay circuit, timer, latch circuit, counters, shift registers, master and jump control, data comparisons	3
5	Case studies	
5.1	Pick and place robot	1
5.2	Car park barriers	1
5.3	Antilock brake system (ABS) control	1
5.4	Boat autopilot	1
5.5	Automatic car park system	1
5.6	Coin counter	1

References

1. K.P. Ramachandran, G.K. Vijayaraghavan, M.S. Balasundaram, Mechatronics- Integrated Mechanical Electronic Systems, Wiley India Pvt Ltd.
2. William Bolton, Mechatronics – A multidisciplinary Approach Fourth Edition Pearson Education
3. Devadas Shetty and Richard A. Kolk, Mechatronics System Design Second Edition Cengage Learning India Private Limited
4. Michael B. Histand and David G. Alciatore, Introduction to Mechatronics and Measurement Systems, McGRAW- HILL International Editions
5. Mechatronics- HMT Limited, Tata McGraw Hill Education Private Limited

COURSE CODE	COURSE NAME	ELECTRONICS & INSTRUMENTATION-EC1 CATEGORY	L	T	P	CREDIT
221EAE010	TRANSDUCERS AND SMART INSTRUMENTS	PROGRAM ELECTIVE 2	3	0	0	3

Preamble: This course provides an introduction to key concept in Transducers and smart instruments and to make students aware about the measuring instruments and the methods of measurement and the use of different transducers.

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

CO 1	Categorize and characterize a conventional transducer
CO 2	Analyze and quantify the uncertainties in measurement data
CO 3	Design smart sensors with special features.
CO 4	Acquire a comprehensive knowledge of manufacturing techniques and design aspectsof micro sensors and actuators
CO 5	Keep abreast with the latest sensor technology and advanced measurement methodologies

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	2	1				
CO 2	2	2	2	2		1	
CO 3	3	3	1	2		1	
CO 4	2	2	1	2		1	
CO 5	2	3	2	2			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	40
Analyse	20
Evaluate	
Create	

Mark Distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the college There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questionsshall be useful in the testing of knowledge, skills, comprehension, application,analysis, synthesis, evaluation and understanding of the students), with 1question from each module, having 5 marks for each question. Students shallanswer all questions. Part B contains 7 questions (such questions shall be usefulin the testing of overall achievement and maturity of the students in a course,through long answer questions relating to theoretical/practical knowledge,derivations, problem solving and quantitative evaluation), with minimum onequestion from each module of which student shall answer any five. Each questioncan carry 7 marks. Total duration of the examination will be 150 minutes.

Course Level Assessment Questions

Course outcome 1 (CO1):

1. What are the two most important requirement for using a sensor? Explain the main difference and advantages of inductive and capacitive sensor.
2. How static and dynamic characteristics affect the performance of a sensor.

Course outcome 2 (CO2):

1. Suppose vehicle arrive at a signalised road intersection at an average rate of 360 per hour and the cycle of the traffic lights is set at 40 seconds. In what percentage of cycles will the number of vehicles arriving be a) exactly 5, b) less than 5 ? If after the lights change to green, there is time to clear only 5 vehicles before the signal changes to red again, what is the probability that waiting vehicles are not cleared in one cycle, Usingpoission distribution
2. Define the importance of error analysis and explain the different types of errors in transducers .

Course outcome 3 (CO3):

1. What is the concept of smart sensors? Where can they be used?
2. What are the selection criteria for different microcontrollers?

Course outcome 4 (CO4):

1. Explain how micro pressure sensor works and explain the various sensing elements used in it.
2. Define bio sensor and acoustic wave sensor. Explain the types of bio sensor.

Course outcome 5 (CO5)

1. What is the difference between thin film and thick film sensors?
2. What is the importance of sensor node? How do sensor node communicate in WSN.

SYLLABUS

MODULE 1: Overview of conventional transducers and its Characteristics:

Overview of conventional sensors - Resistive, Capacitive, Inductive, Piezoelectric, Magnetostrictive and Hall effect sensors – Static and Dynamic Characteristics and their specifications.

MODULE 2:Measurement error and uncertainty analysis:

Importance of error analysis – Uncertainties, precision and accuracy in measurement - Limiting error and probable error - Random errors - Distributions, mean, width of the distribution and standard error - Uncertainty as probability - Gaussian and Poisson probability distribution functions, confidence limits, error bars, and central limit theorem - Error propagation - single and multi-variable functions, propagating error in functions - Data visualization and reduction- Least square fitting of complex functions.

MODULE 3: Smart sensors:

Definition – Integrated smart sensors - Interface electronics - Design, sensing elements and parasitic effects, sensor linearization - Accuracy and Dynamic range - Universal Sensor Interface –converters - front end circuits. DAQ – Design - Digital conversion techniques - Microcontrollers and digital signal processors for smart sensors – selection criteria - Timer, Analog comparator, ADC and DAC modules – Remote calibration – Smart Transducer Interface standard (IEEE 1451)

MODULE 4: Micro sensors and actuators

Micro system design and fabrication – Micro pressure sensors (Piezo resistive and Capacitive) – Resonant sensors – Acoustic wave sensors – Bio micro sensors – Micro actuators – Micro mechanical motors and pumps- Introduction to Nano sensors

MODULE 5: Recent trends in sensor technologies

Thick film and thin film sensors- IC sensors – Optical sensors - Electro chemical sensors – RFIDs - Sensor nodes – Wireless Sensor Network - Multisensor data fusion - Soft sensor.

Course Plan

No	Topics	No. of Lectures
1	**Overview of conventional transducers and its Characteristics:**	
1.1	Overview of conventional sensors - Resistive, Capacitive, Inductive, Piezoelectric	3
1.2	Magnetostrictive and Hall effect sensors	2
1.3	Static and Dynamic Characteristics and their specifications	2
2	**Measurement error and uncertainty analysis:**	
2.1	Importance of error analysis – Uncertainties, precision and accuracy in measurement -Limiting error and probable error - Random errors	3
2.2	Distributions, mean, width of the distribution and standard error - Uncertainty as probability - Gaussian and Poisson probability distribution functions, confidence limits, error bars, and central limit theorem	4
2.3	Error propagation - single and multi-variable functions, propagating error in functions - Data visualization and reduction- Least square fitting of complex functions.	3
3	**Smart sensors:**	
3.1	Definition – Integrated smart sensors - Interface electronics - Design, sensing elements and parasitic effects, sensor linearization - Accuracy and Dynamic range	3
3.2	Universal Sensor Interface –converters - front end circuits. DAQ – Design - Digital conversion techniques	2
3.3	Microcontrollers and digital signal processors for smart sensors – selection criteria - Timer, Analog comparator, ADC and DAC modules – Remote calibration – Smart Transducer Interface standard (IEEE 1451)	3
4	**Micro sensors and actuators**	
4.1	Micro system design and fabrication – Micro pressure sensors (Piezo resistive and Capacitive)	2
4.2	Resonant sensors – Acoustic wave sensors – Bio micro sensors	2
4.3	Micro actuators – Micro mechanical motors and pumps- Introduction to Nano sensors.	3
5	**Recent trends in sensor technologies**	
5.1	Thick film and thin film sensors- IC sensors	2
5.2	Optical sensors - Electro chemical sensors – RFIDs	3
5.3	Sensor nodes – Wireless Sensor network - Multisensor data fusion - Soft sensor	3

References

1. Ernest O Doebelin and Dhanesh N Manik, "Measurement Systems Application and Design", 6thEdition, Tata Mc-Graw Hill, 2011.
2. D. Patranabis, "Sensors and Transducers", Second Edition, PHI, 2004.
3. Gerord C.M. Meijer, Smart Sensor Systems, John Wiley and Sons, 2008.
4. Tai-Ran Hsu, MEMS and Micro Systems: Design and Manufacture, Tata McGraw Hill, 2002.
5. Ifan G. Hughes and Thomas P.A. Hase, Measurements and theirUncertainties: A Practical Guide to Modern Error Analysis, Oxford University Press, 2010.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER
221EAE010 TRANSDUCERS AND SMART INSTRUMENTS

Time: 2:30hours **Max. Marks:60**

PART A

Answer ***all*** questions. Each question carries ***5 marks***

1. Describe the temperature instabilities of resistive, inductive and capacitive elements.
2. A resistance is determined by voltmeter ammeter method. The voltmeter reads 100V with a probable error of ±12 V and ammeter reads 10 A with a probable error of ±2A. Determine the probable error in the computed value of resistance.
3. Explain in detail about front end circuits for bridge modes
4. Discuss in detail about actuation using Piezoelectric crystals.
5. Compare and contrast thick and thin film sensors.

PART B

Answer ***any five*** questions. Each question carries ***7 marks***

6. Explain any one differential displacement element with a typical application.
7. An experiment was conducted to determine the concentration of a sodium hydroxide solution. The eight repeat measurements of the volume of hydrochloric acid titrated (all in ml) are: 25.8, 26.2, 26.0, 26.5, 26.1, 25.8 and 26.3. Calculatei) the mean and ii) the average deviation.
8. Explain in detail about the importance of erroranalysis.
9. Discuss about the analog comparator in DSP's and MCU's.
10. Explain about a micro device that function on the principle of micro actuation.
11. Discuss the types of electrochemical sensors and explain any one of them.
12. Anticipate how membranes are used as sensing elements in solid state sensors.Design a network to generate your photo in the style of LeonardoDaVinci'sMonalisa.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
221LAE100	ADVANCED PROCESS CONTROL LAB	LABORATORY	0	0	2	1

Preamble: Students will be able to do programming in PLC, LABVIEW, MATLAB or any other similar tools for the analysis, design and control of various industrial level applications.

Course Outcomes: The COs shown are only indicative.

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

CO 1	Design and implement PLC programming and Ladder Logics
CO 2	Implement data acquisition and GUI (Graphical user interface) using LabVIEW
CO 3	Implement various control systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			2	1	3		
CO 2			2	1	3		
CO 3			2	1	3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	20%
Evaluate	20%
Create	0%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	100	-	-

List of Experiments

Tools - Numerical computing Environment - MATLAB/ Lab VIEW/ Python or any other equivalent tools.

Note: Minimum 8 experiments have to be done.

1. Data Acquisition and control using Lab VIEW.
2. Controller tuning techniques
3. Determining the non-linearity of a system.
4. Distributed Control.
5. Digital Implementation of PID controller
6. Control of Robotic arm.
7. PLC
8. Cascade control.
9. Feed forward control.
10. Ratio Control
11. Inferential Control
12. Override Control

SEMESTER II

Discipline:ELECTRONICS & INSTRUMENTATION

Stream : EC1

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222TEC100	FOUNDATIONS OF DATA SCIENCE	DISCIPLINE CORE 2	3	0	0	3

Preamble: Nil

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

CO 1	Understand the basics of machine learning and different types.
CO 2	Differentiate regression and classification, Understand the basics of unsupervised learning and non-metric methods
CO 3	Apply statistical methods in non-linear classification and neural networks
CO 4	Understand the basics of deep learning networks, convolutional neural networks

Mapping of course outcomes with program outcomes (1-3)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	2	3	3	2	2
CO 2	2	2	2	2	2	2	2
CO 3	2	1	2	3	3	1	1
CO 4	2	1	2	3	3	1	1

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Continuous Internal Evaluation : 40 marks
Micro project/Course based project : 20 marks
Course based task/Seminar/Quiz : 10 marks
Test paper, 1 no. : 10 marks

End Semester Examination Pattern:

Total : 60 marks

Part A: Answer all – 5 questions x 5 marks : 25 marks

Part B: Answer 5 of 7: 5 questions x 7 marks : 35 marks

There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such question shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Model Question paper

Total: 60 marks

Part A (Answer all) 25 marks

1. Discuss different types of machine learning with examples. (5)
2. Differentiate regression and classification with examples (5)
3. How SVM is used for multiclass problem? (5)
4. Explain clustering with examples. (5)
5. Discuss different activation functions used in deep neural networks (5)

Part B (Answer any 5) 35 marks

6. Explain the terms features, training set, target vector, test set, and curse of dimensionality in machine learning. (7)
7. Show that the Bayesian classifier is optimal with respect to minimizing the classification error probability. (7)
8. Give a step by step description of the perceptron algorithm in classification. (7)
9. Obtain the cost function for optimization in SVM for separable classes. (7)
10. Describe convolutional neural networks with detailed description of each layers (7)

11. Obtain the decision surface for an equi-probable two class system, where the probability density functions of n-dimensional feature vectors in both classes are normally distributed. (7)

12. Explain the principle of back propagation neural networks with neat architecture diagram (7)

Syllabus and Course Plan (total hours: 37)

No	Topic	hours
1	**Module 1**	**8 hours**
1.1	Basics of machine learning, supervised and unsupervised learning,examples,	2
1.2	features, feature vector, training set, target vector, test set	1
1.3	over-fitting, curse of dimensionality.	1
1.4	Evaluation and model selection: ROC curves, evaluation measures,	2
1.5	validation set, bias-variance trade-off.	1
1.6	confusion matrix, recall, precision, accuracy.	1
2	**Module 2**	**7 hours**
2.1	Regression: linear regression, error functions in regression	1
2.2	multivariate regression, regression applications, bias and variance.	1
2.3	Classification : Bayes' decision theory,	2
2.4	discriminant functions and decision surfaces,	1
2.5	Bayesian classification for normal distributions, classification applications.	2
3	**Module 3**	**7 hours**
3.1	Linear discriminant based algorithm: perceptron, perceptron algorithm,	1
3.2	support vector machines.	2
3.3	Nonlinear classifiers, the XOR problem,	2
3.4	multilayer perceptrons,	1
3.5	backpropagation algorithm.	1
4	**Module 4**	**8 hours**
4.1	Unsupervised learning:	1
4.2	Clustering, examples, criterion functions for clustering,	2
4.3	proximity measures, algorithms for clustering.	1
4.4	Ensemble methods: boosting, bagging.	2
4.5	Basics of decision trees, random forest, examples.	2
5	**Module 5**	**7 hours**
5.1	Introduction to deep learning networks,	1

5.2	deep feedforward networks,	2
5.3	basics of convolutional neural networks (CNN)	2
5.4	CNN basic structure, Hyper-parameter tuning, Regularization - Dropouts,	1
5.5	Initialization, CNN examples	1

Reference Books

1. Bishop, C. M. “Pattern Recognition and Machine Learning” Springer, New York, 2006.
2. Theodoridis, S. and Koutroumbas, K. “Pattern Recognition”. Academic Press, San Diego, 2003.
3. Hastie, T., Tibshirani, R. and Friedman, J. “The Elements of Statistical Learning”. Springer.
4. Duda, R.O., Hart, P.E., and Stork, D.G. “Pattern Classification”. Wiley, New York,
5. Ian Goodfellow, Yoshua Bengio, Aaron Courville. “Deep Learning” MIT Press, 2016

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222TAE001	DESIGN OF EMBEDDED SYSTEMS	PROGRAM CORE 2	3	0	0	3

Preamble: This course aims to get complete idea of embedded product design skills to understand, analyze and design different embedded products in software as well as hardware aspects

Course Outcomes: The COs shown are only indicative. For each course, there can be 4 to 6 COs.

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

CO 1	Familiarize the fundamentals of Embedded System design
CO 2	Analyze Embedded design life cycle and can be applied to selection process
CO 3	Design and Analyzeembedded products
CO 4	Analyze Processes and Operating systems and to evaluate the performance
CO 5	Apply anddevelopproduct design using debugging tools for the product design

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3				
CO 2				3			
CO 3					3		
CO 4	2			2			
CO 5						2	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply (k3)	20
Analyze (k4)	20
Evaluate (k5)	20
Create(k6)	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Micro project/Course based project: 20 marks
Course based task/Seminar/Quiz: 10 marks
Test paper, 1 no. : 10 marks
The project shall be done individually. Group projects not permitted. Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Explain the requirement and specification for the embedded system design using suitable example.

Course Outcome 2 (CO2)

1. Explain the embedded Product specification design and selection of tools with suitable example.

Course Outcome 3 (CO3)

1. Explain the embedded system program design using design patterns with suitable example.
2. Explain the program validation and testing for embedded system programming

Course Outcome 4 (CO4)

1. Explain the analysis and optimization of
    a) Execution time of program
    b) Program energy and power

Course Outcome 5 (CO5)

1. Explain the various hand and software debugging tools and techniques for embedded product design.

Model Question Paper

Reg No.....
Name.....

APJ Abdul kalam Technological University
Second Semester M.Tech_____,_____
Course Code:222TAE001
Course Name: Design of Embedded Systems

Time: 3 Hours Max. Marks: 60

Part A
Answer all questions from each module. Each question carries 5 marks.

1.
    a. Briefly explain the characteristics of Embedded computingapplications. (3 marks)
    b. Discuss the challenges faced in embedded computing system design (2 marks)
2. What is Dhrystone bench mark? Compare the performance of any twoProcessor with the help of Dhrystone bench mark.
3. Briefly explain the different component of embedded programs.
4. Explain the difference between priority based scheduling and rate monotonic scheduling.
5. Write short notes on cross assembler.

Part B
Answer any five questions. Each question carries seven marks.

6. Explain the embedded system design process with major level of abstraction in the design process.
7. Design a complete model train controller with all detailed levels of abstraction.

8. How can you check the availability of RTOS for your product design? Elaborate your answer with the help of detailed check list.
9. Explain the complete design of a software modem including design integration and testing.
10. With suitable example explain the major type of testing strategies used in embedded program design.
11. Design a telephone answering machine including specification, architecture and final testing.
12.
    a. With the help of block diagram explain the working oh logic analizer (4 marks)
    b. Write short notes on JTAG. (3 marks)

Syllabus

Module 1: Fundamentals of Embedded Systems:
Introduction-Embedding Computers, characteristics of embedded computing applications, challenges in embedded computing design –design process: requirements-specification architecture design-designing hardware and software components-system integration and testing structural description behavioral description
Design Example: Model train controller

Module 2: The Embedded design life cycle and selection process
Introduction, Product specification, Hardware/Software partitioning, Iteration and implementation, Detailed hardware and software design, Hardware/software integration, Product testing and release, Maintaining and upgrading existing products

The selection process: Packaging the Silicon, Adequate Performance, RTOS availability, Tool chain Availability, Other issues in the selection process.

Module 3:Program Design and Analysis
Introduction, Components for embedded programs, Model of Programs, Compilation techniques, Program-level performance analysis, Software performance optimization, Program-level energy and power analysis and optimization, Program Validation and Testing,
Design Examples: Software Modem, Digital Still Camera

Module 4:Processes and Operating systems
Introduction, Multiple task and multiple processes, Preemtive real time operating systems, Priority based scheduling ,Interprocess communication mechanism, Evaluating operating system performance, Power optimization strategies for processes
Design example: Telephone answering machine, Engine control unit.

Module 5Development and Debugging Tools: Software and Hardware tools like Cross Assembler, Compiler,Debugger, Simulator, InCircuit Emulator (ICE), Logic Analyzer.
Debugging Techniques: Introduction to BDM, JTAG and NEXUS

Course Plan

No	Topic	No. of Lectures
1	**Module 1: Fundamentals of Embedded Systems**	
1.1	Introduction-Embedding Computers, characteristics of embedded computing applications challenges in embedded computing design	1
1.2	Design process: requirements-specification architecture design-designing hardware and software components	3
1.3	System integration and testing structural description behavioral description	3
1.4	Design Example: Model train controller	1
2	**Module 2: The Embedded design life cycle and selection process**	
2.1	Introduction, Product specification, Hardware/Software partitioning	1
2.2	Iteration and implementation, Detailed hardware and software design	2
2.3	Hardware/software integration, Product testing and release	2
2.4	Maintaining and upgrading existing products	1
2.5	The selection process: Packaging the Silicon, Adequate Performance, RTOS availability	2
2.6	Tool chain Availability, Other issues in the selection process.	2
3	**Module 3:Program Design and Analysis**	
3.1	Introduction, Components for embedded programs, Model of Programs	1
3.2	Compilation techniques, Program-level performance analysis	2
3.3	Software performance optimization	1
3.4	Program-level energy and power analysis and optimization	2
3.5	Program Validation and Testing	2
3.6	Design Examples: Software Modem Digital Still Camera	1
4	**Module 4:Processes and Operating systems**	
4.1	Priority based scheduling ,Interprocess communication mechanism	2
4.2	Evaluating operating system performance,	2

4.3	Power optimization strategies for processes	2
4.4	Design example: Telephone answering machine, Engine control unit	1
5	**Module 5: Development & Debugging Tools**	
5.1	Software and Hardware tools like Cross Assembler, Compiler	2
5.2	Debugger, Simulator, InCircuit Emulator (ICE), Logic Analyzer	2
5.3	Debugging Techniques: Introduction to BDM, JTAG and NEXUS	2

Reference Books

1. Computer as Components: Principles of embedded computing design, 3rd edition- Elsevier; Marilyn wolf
2. Computer as Components: Principles of embedded computing design, Elsevier; Wayne wolf
3. Embedded System Design, An introduction to processes, tools & Techniques, CMP ,books; Arnold S. Berger.
4. An Embedded software Primer, Pearson; David E Simon
5. Embedded System Design: A unified Hardware/Software Introduction, Wiley India
6. Edition; Frank Vahid/Tony Givargis

SEMESTER II

PROGRAM ELECTIVE III

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE100	ADVANCED PROCESS CONTROL	PROGRAM ELECTIVE 3	3	0	0	3

Preamble: This course introduces students to the avenues of Advanced Control Systems.

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

CO 1	Analyse and tune feedback control systems
CO 2	Analyse and design multivariable control systems
CO 3	Design and implement adaptive control systems
CO 4	Design and implement digital control

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
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	End Semester Examination
Apply	80%
Analyse	20%
Evaluate	0%
Create	0%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Evaluation shall only be based on application, analysis or design based questions (for both internal and end semester examinations)

Continuous Internal Evaluation (40 Marks)

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred)	:	15 marks
Course based task/Seminar/Data collection and interpretation	:	15 marks
Test paper, 1 no.	:	10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination (60 Marks)

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Derive the expressions for the closed loop responses of a liquid level system for servo and regulator operations. Mathematically show the effect of P, I and D actions on the response of a control system.

2. Compare continuous and discontinuous control modes.

3.Compare different tuning techniques for feedback control systems.

Course Outcome 2 (CO2)

1. Mathematically model the given Multivariable system.

2.Design the controller for the given MIMO system.

3. Check the stability of the given multivariable control system.

Course Outcome 3(CO3):

1. Design Model Reference Adaptive Controller for a first order process

2. Design the parameter estimator for a given control system

3. Explain the implementation schemes for controller and estimator

Course Outcome 4 (CO4):

1. Design a Digital Compensator for the system given using Minimal prototype design

2.Realise a digital PID controller using Position/Velocity algorithm. Explain the algorithm with the help of a flow chart.

3. Compare different FIELDBUS protocols. Explain the functional requirements of a DCS system.

Syllabus

MODULE-I

Review of control modes for SISO systems- Discontinuous control modes, continuous control modes,Basic control actions, Composite control modes, Controller tuning, open loop and closed loop tuning

MODULE-II

Multivariable systems - Modelling of multivariable systems, Analysis of multivariable systems - stability, resiliency, interaction, robustness.Controller design for multivariable systems, Tuning of multivariable controllers

MODULE-III

Adaptive control - Self Tuning Regulator - Introduction, Need for adaptive control, Adaptive control schemes-overview, Real time parameter estimation – least squares and regression models, Estimating parameters in dynamical systems, Deterministic self tuning regulator -Pole placement design, Direct and indirect self tuning regulators

MODULE-IV

Model Reference Adaptive systems - Model reference adaptive systems - Design of MRAS, Stability, Applications, Implementation of adaptive controllers, controller design, Estimator implementation,Interaction of Estimation and control, Prototype algorithms

MODULE-V

Digital Control- Design of Digital Compensators -Minimal prototype design, Hierarchical Control, Distributed Control (DCS) architecture, Functional requirements of DCS, Fieldbus,Digital implementation of PID controller – Positionalgorithm, Velocity algorithm

Course Plan

No	Topic	No. of Lectures
1	**Review of control modes for SISO systems**	
1.1	Discontinuous control modes, continuous control modes	3
1.2	Basic control actions , Composite control modes	3
1.3	Controller tuning, open loop and closed loop tuning	2
2	**Multivariable systems**	
2.1	Modelling of multivariable systems	2
2.2	Analysis of multivariable systems - stability, resiliency, interaction, robustness.	3
2.3	Controller design for multivariable systems, Tuning of multivariable controllers	3
3	**Adaptive control - Self Tuning Regulator**	
3.1	Introduction, Need for adaptive control, Adaptive control schemes-overview	1
3.2	Real time parameter estimation – least squares and regression models, Estimating parameters in dynamical systems	4
3.3	Deterministic self tuning regulator -Pole placement design, Direct and indirect self tuning regulators	3
4	**Model Reference Adaptive systems**	
4.1	Model reference adaptive systems - Design of MRAS, Stability, Applications	3
4.2	Implementation of adaptive controllers, controller design, Estimator implementation	4
4.3	Interaction of Estimation and control, Prototype algorithms	1
5	**Digital Control**	
5.1	Design of Digital Compensators -Minimal prototype design	3
5.2	Hierarchical Control, Distributed Control (DCS) architecture, Functional requirements of DCS, Fieldbus	4
5.3	Digital implementation of PID controller – Position algorithm, Velocity algorithm	1

Reference Books

1. 'Process Systems analysis and Control', D.R. Coughanour, Mc.Graw Hill, II Edition, 1991.

2.George Stephanopoulos, Chemical Process Control, an introduction to theory and practice, Prentice-Hall

3.Eckman. D.P., Automatic Process Control, Wiley Eastern Ltd., New Delhi, 1993

4.Astrom, K. J., and B. Wittenmark, Adaptive Control, Second edition, Pearson EducationIndia (2006).

5. William L Luyben, Process Modeling, Simulation and Control for Chemical Engineers, Second Edition, McGraw-Hill International Editions, 1990

6. Krishna Kant, Computer based Industrial Control, Second Edition, PHI learning Pvt. Ltd., 2013

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER
222EAE100 - ADVANCED PROCESS CONTROL

Time: 2:30 hours **Max. Marks:60**

PART A

Answer ***all*** questions. Each question carries ***5 marks***

1. Compare multi position and floating control modes.
2. Check the stability of the given multivariable system.
3. Explain how parameter estimation is done using FIR model for a dynamic system.
4. Design Model Reference Adaptive System (MRAS) for a first order plant?
5. With the help of mathematical expression explain velocity algorithm for PID controller. List its advantages over position algorithm.

PART B

Answer ***any five*** questions. Each question carries ***7 marks***

6. Explain how the gain cross over frequency and amplitude ratio of a feedback control system are determined experimentally and optimum controller settings are determined.
7.
   a. Calculate the Niederlinski index of the given multivariable system……. and hence comment on the stability of the system.
   b. Calculate the Morari resiliency index (MRI) of the given multivariable system…… and comment on the resiliency
8. The given system……. is controlled using P-controller. It is desirable to choose the feedback gain so that the closed loop transfer function is……..Construct a continuous time indirect self tuning algorithm for the system.
9. Consider the given plant….. Determine a controller that can give the closed loop system shown…… Determine model reference adaptive controllers based on gradient and stability theory respectively.
10. Design a minimal prototype controller for the system given…… for step changes in setpoint.

11. With the help of a schematic diagram, explain the functional requirements of a DCS system.
12. Derive the expression for the closed loop response of a first order system controlled by a PI controller for servo operation.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE001	MIXED SIGNAL CIRCUIT DESIGN	PROGRAM ELECTIVE 3	3	0	0	3

Preamble: Introduction to Op amp and Op amp Topologies, Introduction to Switched Capacitor circuits,BASIC sampling circuits for analog signal sampling, Introduction to D/A converter and itsvarious types, Introduction to A/D converter and its various types, Noise shaping modulators,Filtering topologies.

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

CO 1	Familiarize the concepts of analog design.
CO 2	Analyze Data converters, CMOS Amplifiers and Switched Capacitor Circuits.
CO 3	Design systems including Data converters, CMOS Amplifiers and Switched Capacitor Circuits.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	1		2	2		1	
CO 2	1		2	2			
CO 3	1		2	3	1		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply(K3)	40
Analyse(K4)	20
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications
(minimum 10 publications shall be referred) : 15 marks
Course based task/ Seminar/ Data Collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks

End Semester Examination Pattern:
The end semester examination will be conducted by the respective College. There will be two parts;Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from eachmodule, having 5 marks for each question. Students should answer all questions. Part B will contain7 questions with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1)

1. Draw and explain folded cascode configuration and list out its advantages.
2. Explain open loop and closed loop sample and hold architectures.

Course Outcome 2 (CO2)

1. Draw and explain the working of a Switched Capacitor integrator
2. Explain BiCMOS sample and hold circuit.
3. Explain the working of delta sigma DAC.

Course Outcome 3 (CO3)

1. Folding and interpolating ADC
2. Implementation of bilinear filter using switched capacitor.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SECOND SEMESTER M. TECH DEGREE EXAMINATION
Program: Applied Electronics and Instrumentation
Course Code: 222EAE001
Course Name: MIXED SIGNAL CIRCUIT DESIGN

Max Marks: 60 **Duration: 2.5 Hours**

PART A
Answer ALL Questions. Each carries 5 mark.

1 How miller compensation is implemented in a 2-stage op-amp?

2 Discuss the non ideal effects in switched capacitor circuits.

3 Compare open loop and closed loop sample and hold architecture.

4 Why only 2^N -1 comparators are required for an N bit flash ADC?

5 List the advantages and disadvantages of noise shaping modulators.

PART B
Answer any FIVE questions. Each question carries 7 mark.

6 Draw and explain folded cascode configuration and list out its advantages.

7 Draw the circuit diagram and explain the working of a Switched Capacitor integrator.

8 Assume that the specifications of a biquad are f_0= 1KHz,Q=2,$K_0=K_2=0$,$K_1=2\pi f_0/Q$(Band pass filter) The clock frequency is 100KHz.Design the capacitor ratios of a low Q switched capacitor circuit and determine the maximum capacitor ratio and the total capacitance, assuming that C_1 and C_2 have unit values.

9 Explain BiCMOS sample and hold circuit with necessary diagram.

10 What number of comparators are needed for a folding and interpolating ADC that has a number of coarse bits=3 and number of fine bits=4 and uses an interpolation of 4 on the fine bits?

11 How a bilinear filter can be implemented using switched capacitors?

12 With detailed block diagram, explain the working of delta sigma DAC.

Syllabus

Module 1

Op amp Topologies:Introduction to op amp,Op amp Topologies: Telescopic, Folded-Cascode, OTA,Two-Stage Operational Amplifier: Miller Compensation, common mode feedback.

Module 2

Switched Capacitor circuits:Introduction to Switched Capacitor circuits-Basicbuilding blocks,Operation and Analysis, some practicalcircuits such as switched capacitor integrator, biquadcircuit, and switched capacitor filter, switched capacitoramplifierNon-ideal effectsin switched capacitor circuits

Module 3

Sampling circuits:Basic sampling circuits for analog signal sampling.Different types of sampling switches Sample-and-HoldArchitectures: Open-loop & closed-loop architectures, Switched capacitor Sample and Hold, BiCMOS Sample and Hold
.

Module 4

DAC and ADC:Input/output characteristics of an ideal DAC and ADC,performance metrics of DAC and ADC,Nyquist rate D/A converters, Resistor-Ladder D/A converter architecture, Successive approximation converters, Flash converter, Interpolating A/D converters,Folding A/D converters, Pipelined A/D converters

Module 5

Filtering Topologies: Noise shaping modulators, Decimating filters and interpolating filters,Filtering topologies - bilinear transfer function and biquadratic transfer function,Higher order modulators, Delta sigma D/A

Course Plan

No	Topic	No. of Lectures
1		
1.1	Introduction to op amp	1
1.2	Op amp Topologies: Telescopic, Folded- Cascode, OTA	4
1.3	Two-Stage Operational Amplifier: Miller Compensation, common mode feedback.	3
2		

2.1	Introduction to Switched Capacitor circuits- Basic building blocks	1
2.2	Operation and Analysis, some practical circuits such as switched capacitor integrator, biquad circuit, and switched capacitor filter, switched capacitor amplifier	5
2.3	Non-ideal effects in switched capacitor circuits.	2
3		
3.1	Basic sampling circuits for analog signal sampling.	2
3.2	Different types of sampling switches Sample-and-Hold Architectures: Open-loop & closed-loop architectures, Switched capacitor Sample and Hold, BiCMOS Sample and Hold.	5
4		
4.1	Input/output characteristics of an ideal DAC and ADC, performance metrics of DAC and ADC	2
4.2	Nyquist rate D/A converters, Resistor-Ladder D/A converter architecture	2
4.3	Successive approximation converters, Flash converter, Interpolating A/D converters,Folding A/D converters, Pipelined A/D converters.	6
5		
5.1	Noise shaping modulators, Decimating filters and interpolating filters	2
5.2	Filtering topologies - bilinear transfer function and biquadratic transfer function,	3
5.3	Higher order modulators, Delta sigma D/A.	2

Reference Books

1. CMOS Analog Circuit Design - Philip E. Allen and Douglas R. Holberg, Oxford University Press, International Second Edition/Indian Edition, 2010
2. Design of Analog CMOS Integrated Circuits- BehzadRazavi, TMH Edition, 2002
3. Analog Integrated Circuit Design- David A. Johns,Ken Martin, Wiley Student Edition, 2013
4. Gregorian, Temes, "Analog MOS Integrated Circuit for Signal Processing", John Wiley & Sons,1986

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE002	DEEP LEARNING	PROGRAM ELECTIVE 3	3	0	0	3

Preamble: This course provides an introduction to key concept in deep learning and equip students with knowledge required to develop best deep learning solutions for real world problems in domains such as computer vision, natural language processing etc.

Course Outcomes: The COs shown are only indicative. For each course, there can be 4 to 6 COs.

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

CO 1	Demonstrate the uses and limitations of fully connected neural networks
CO 2	Compare different CNN networks for classification and detection in terms of architecture, performance and computational requirements
CO 3	Develop a convolutional neural network for a real-world application
CO 4	Apply regularization and optimization techniques in CNN training
CO 5	Demonstrate the use of RNNS and LSTM for analysing sequential data
CO 6	Apply the concepts of attention models, transformers and generative models

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3						
CO 2	3						
CO 3	3		3	3	3		
CO 4	3						
CO 5	3						
CO 6	3		3	3			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	40%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Course project/Preparing a review article based on peer reviewed original publications(minimum 10 publications shall be referred): 15 marks
Course based task/Seminar/Quiz: 15 marks
Test paper, 1 no.: 10 marks

End Semester Examination Pattern:

60 Marks
Part A: 5×5 Marks
Part B: 5×7 Marks

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Suppose you have a 3-dimensional input $x = (x_1, x_2, x_3) = (2, 2, 1)$ fully connected with weights $(0.5, 0.3, 0.2)$ to one neuron which is in the hidden layer with sigmoid activation function. Calculate the output of the hidden layer neuron.
2. Consider the case of the XOR function in which points $\{(0, 0), (1, 1)\}$ belong to one class, and $\{(1, 0), (0, 1)\}$ belong to the other class. Design a multilayer perceptron for this binary classification problem.

Course Outcome 2 (CO2)

1. Implement AlexNet, VGG Net, ResNet and Inception Net for a classification problem. Compare and contrast the performance in terms of accuracy and computational requirements.
2. Implement RCNN, Fast RCNN, Faster RCNN, YOLO and Mask RCNN for detection problem. Compare and contrast the performance in terms of accuracy and computational requirements.

Course Outcome 3(CO3):

3. Draw and explain the architecture of convolutional neural networks.
4. You are given a classification problem to classify the handwritten digits. Suggest a learning algorithm with its architecture, an objective function, and an optimization routine, along with how input and output will be prepared for the classifier

Course Outcome 4 (CO4):

1. Explain how L2 regularization improves the performance of deep feed forward neural networks.
2. Explain the use of data augmentation and dropouts

Course Outcome 5 (CO5):

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

2. Draw and explain the architecture of LSTM.
3. List the differences between LSTM and GRU

Course Outcome 6 (CO6):

1. Explain the use of transformers for image recognition
2. Explain the basic principle and architecture of generative adversarial network

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SECOND SEMESTER M. TECH DEGREE EXAMINATION
Program: Applied Electronics and Instrumentation
Course Code: 222EAE002
Course Name: DEEP LEARNING

Max Marks: 60 **Duration: 2.5 Hours**

PART A
Answer ALL Questions. Each carries 5 mark.

1 There is huge gap between training accuracy and testing accuracy, while training a particular machine learning model. What might be the reason. Suggest possible methods of overcoming it — 5

2 Draw the block diagram of a naïve inception block. What is the disadvantage of this block? Explain how adding 1x1 convolution helps to overcome the difficulty. — 5

3 Consider a Convolutional Neural Network having three different convolutional layers in its architecture as — 5

Layer-1	Filter Size – 3×3, Number of Filters – 10, Stride – 1, Padding – 0
Layer-2	Filter Size – 5×5, Number of Filters – 20, Stride – 2, Padding – 0
Layer-3	Filter Size – 5×5 , Number of Filters – 40, Stride – 2, Padding – 0

If we give a 51×51 RGB image as input to the network, then determine the dimension of the vector after passing through layer 3 in the architecture.

4 You have a dataset D1 with 1 million labelled training examples for classification, and dataset D2 with 100 labelled training examples. Your friend trains a model from scratch on dataset D2. You decide to train on D1, and then apply transfer learning to train on D2. State one problem your friend is likely to find with his approach. How does your approach address this problem? — 5

5 Differentiate between soft attention and hard attention. 5

PART B

Answer any FIVE questions. Each question carries 7 mark.

6 Astronomers are using a linear classifier to classify long exposed CCDimages into star, nebula and galaxy. The predicted scores of this linear classifier, during one particular iteration of training is given below 7

Class	Test Image		
	Star	Nebula	galaxy
Star	3.2	1.3	2.2
Nebula	5.1	4.9	2.5
Galaxy	-1.7	2	-3.1

Calculate the softmax loss for Nebula. Find minimum and maximum softmax loss, if there are C classes.

7 Draw the computational graph and calculate the analytical gradients at each node for the following function 7

$$f(w,x) = \frac{1}{1+e^{-(w_0x_0+w_1x_1+w_2)}}$$

where $w_0 = 2,\ w_1 = -3, w_2 = -3,\ x_0 = -1,\ x_1 = -2$

8 Consider a CNN implemented with following arrangement. 7

Input 128x128x3
Conv 4- 10, stride 2, pad 0
Conv 9-10,stride 2, pad 2
Pool 2 stride 2, pad 0
Conv 3-5 stride 2, pad 0
FC 5

FC-N denotes fully connected layer with N neuron outputs. Conv M-N indicates convolution layer of size MxMxD, with M filters and D activation volume of previous layer. Pool 2 indicates 2x2 maxpooling layer. Find activation volume and number of parameters at each layer.

9 Write disadvantages of SGD. Explain how ADAM overcome it. 7

10 Imagine you were asked to write a poem in the writing style of John Keats. What kind of network will you use? Draw and explain the structure of identified network with equations. 7

11 You were asked to design an object detection frame work to be used in Google‘s autonomous car Waymo. The designed framework should be able to detect and identify multiple objects (pedestrians, other vehicles etc.) from images obtained from the camera feed of Waymo. Draw and explain the general structure of the network. Justify your answer. 7

12 Design a network to generate your photo in the style of Leonardo DaVinci’s Monalisa. 7

Syllabus

MODUE 1: Introduction to Machine Learning

Introduction: Supervised Vs. Unsupervised Learning, Classification Vs. Regression, Machine Learning Vs. Deep LearningMachine Learning System Design: Data-driven Approach, Datasets: Training, Testing and Validation Sets, Over fitting and Under fitting, Hyper parameters, K-nearestneighbour classification

Linear classification: Loss function, Multiclass SVM,Softmax classifier. Optimization, Numeric andAnalytic gradients.

MODULE 2: Neural Networks

Deep feedforward networks/ Multilayer perception: Perceptron, activation functions, Example: Learning XOR, Architecture of deep neural network

Back propagation, Gradient-Based Learning.

Convolutional Neural Networks: Convolution, Pooling Layers, spatialarrangement, layer patterns, layer sizing patterns.

MODULE 3: Training Neural Networks

Initialization, batch normalization, Hyper parameter optimization.

Optimization algorithms: SGD, Momentum, Adagrad, RMS Prop, Adam

Regularization methods: L1 and L2 regularization, Early stopping, drop outs, ensembles, data augmentation, Update rules, transfer learning

MODULE 4: CNN architectures

AlexNet, VGG Net, ResNet, Inception Net

Object Detection: RCNN, Fast RCNN, Faster RCNN, YOLO, Mask RCNN

Recurrent Neural Networks: RNN, Bidirectional RNN, LSTM, GRU

MODULE 5: Attention Models, Transformers and Generative Models

Attention: Multimodal attention, Self-Attention

Transformers: BERT and vision transformer

Autoencoders, Variational auto encoders, Generative Adversarial Network

Course Plan

No	Topic	No. of Lectures
1	**Introduction to Machine Learning**	
1.1	Introduction: Supervised Vs. Unsupervised Learning, Classification Vs. Regression, Machine Learning Vs. Deep Learning	1
1.2	Machine Learning System Design: Data-driven Approach, Datasets: Training, Testing and Validation Sets, Over fitting and Under fitting, Hyper parameters, K-nearestneighbour	3

	classification	
1.3	Linear classification: Loss function, Multiclass SVM, Softmax classifier. Optimization, Numeric andAnalytic gradients.	4
2	**Neural Networks**	
2.1	Deep feedforward networks/ Multilayer perception: Perceptron, activation functions, Example: Learning XOR, Architecture of deep neural network	2
2.2	Back propagation, Gradient-Based Learning.	2
2.3	Convolutional Neural Networks: Convolution, Pooling Layers, spatialarrangement, layer patterns, layer sizing patterns.	3
3	**Training Neural Networks**	
3.1	Initialization, batch normalization, Hyper parameter optimization.	2
3.2	Optimization algorithms: SGD, Momentum, Adagrad, RMS Prop, Adam	2
3.3	Regularization methods: L1 and L2 regularization, Early stopping, drop outs, ensembles, data augmentation, Update rules, transfer learning	2
4	**CNN architectures**	
4.1	AlexNet, VGG Net, ResNet, Inception Net	3
4.2	Object Detection: RCNN, Fast RCNN, Faster RCNN, YOLO, Mask RCNN	3
4.3	Recurrent Neural Networks: RNN, Bidirectional RNN, LSTM, GRU	3
5	**Attention Models, Transformers and Generative Models**	
5.1	Attention: Multimodal attention, Self-Attention	3
5.2	Transformers: BERT and vision transformer	3
5.3	Autoencoders, Variational auto encoders, Generative Adversarial Network	4

Reference Books

1. Ian Goodfellow, YoshuaBengio, and Aaron Courville. Deep learning. MIT press,2016.
2. Francois Chollet. Deep learning with Python. Simon and Schuster, 2021.
3. Ivan Vasilev. Advanced Deep Learning with Python: Design and implement advanced next-generation AI solutions using TensorFlow and PyTorch. Packt Publishing Ltd, 2019.
4. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006
5. Michael A Nielsen. Neural networks and deep learning. Determination press, 2015.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE003	ROBOTICS AND INTELLIGENT SYSTEMS	PROGRAM ELECTIVE 3	3	0	0	3

Preamble: This course will serve as an introductory robotics course for the design of control of complex robotic systems and also provide an introduction to artificial intelligence, neural network etc.

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

CO1	Describe the basic concepts related to robotics design
CO2	Familiarize kinematics and dynamics of robot structure.
CO3	Develop the basic principles in Robotics programming
CO4	Familiarize the principles of Artificial Intelligence and Neural Network for robotic design and control.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2		2	1		1	
CO 2	2		3	2	2	2	
CO 3	2		3	2		1	
CO 4	2	1	2	2	2	2	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20
Analyse	60
Evaluate	20
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Evaluation shall only be based on application, analysis or design based questions (for both internal and end semester examinations).

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

60 Marks

Part A: 5×5 Marks
Part B: 5×7 Marks

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Differentiate between cartesian coordinate and cylindrical robot.
2. Describe in detail the anatomy of an industrial robot
3. Discuss about the salient features of different drive systems used in robots.

Course Outcome 2 (CO2):

1. Describe composite rotation matrix of a robot manipulator in detail.
2. Determine the inverse kinematic solution of a RRR robot configuration with three DOF with 2D manipulator.
3. Discuss Denavit - Hartenberg convention in detail.

Course Outcome 3(CO3):

1. Explain the various programming methods used in robotics with examples and featuresof each.
2. Write a VAL robot program to perform pick and place operation on the conveyer system. it consist of two conveyors running parallel with centre distance of 600 mm at same level. An industrial robot is fixed centrally between the conveyors. The robot is used to transfer work pieces from conveyor 1 to 2 at a constant speed. Draw a schematic view of the system assume all necessary dimension
3. Explain WAIT, SIGNAL, DELAY commands used for robot programming with example.

Course Outcome 4 (CO4):

1. List out with examples of some real-world applications in Artificial Intelligence.
2. Explain the control of a robotic arm using neural network.

3. Explain the different types of search used in AI

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
SECOND SEMESTER M. TECH DEGREE EXAMINATION
Program: Applied Electronics and Instrumentation

Course Code: 222EAE003
Course Name: ROBOTICS AND INTELLIGENTSYSTEMS

Max Marks: 60 **Duration: 2.5 Hours**

PART A
Answer all questions. Each question carries 5 marks

1. How are robots classified, explain?
2. Define path planning in the context of robotics. What is trajectory of a robot?
3. Discuss about different methods of robot programming
4. Why LISP is used for Artificial Intelligence?
5. Write the difference between supervised and unsupervised learning.

PART B
Answer any five questions. Each question carries 7 marks

6. Draw and explain the architecture of robotic system.
7. What are the various inputs of an inverse kinematics algorithm? Explain functioning of an inverse kinematics algorithm.
8. Write short notes on Jacobian Work Envelope xx.
9. Explain Basic Commands and Operations with examples for robotic programmimg.
10. What is the "minimal" set of primitives needed for a Lisp interpreter?
11. Explain about various types of learning in problem solving.
12. Explain different models of Artificial Neural Network.

Syllabus

Module 1:

Robot anatomy: Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple problems- Specifications of Robot-Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems-Robot Drive systems- Hydraulic, Pneumatic and Electric system.

Module 2:

Kinematics, dynamics and control - Object location, three dimensional transformation matrices, inverse transformation, kinematics and path planning, Jacobian work envelope, manipulator dynamics, dynamic stabilization, position control and force control, present industrial robot control schemes.

Module 3:

Robot Programming: Methods of robot programming, lead through programming methods, robot program as a path in space - defining position in space, speed control, motion interpolation, WAIT, SIGNAL, DELAY commands, Branching.
Basic Commands and Operations: Motion commands- move and related statements, points in workspace, paths and frames.

Module 4:

AI for Robotics: Introduction to Artificial Intelligence, goals of AI research, AI techniques- knowledge representation, problem representation, search techniques. LISP programming. AI and Robotics. LISP in the factory. Robotic Paradigms.

Module 5:

Neural Network Approach in Robotics: Introduction, Connectionist Models, Learning Principles and Learning Rules: Supervised, unsupervised, reinforcement learning. Sensor based robot learning, Neural Network in Robotics: Control of robot hands by neural network, neural set approach to robot motion coordination, robotic motor control using reinforcement learning optimization.

Course Plan

No	Topic	No. of Lectures
1	**Robot anatomy**	
1.1	Definition, law of robotics, History and Terminology of Robotics	1
1.2	Accuracy and repeatability of Robotics-Simple problems	2
1.3	Speed of Robot-Robot joints and links-Robot classifications	2
1.4	Architecture of robotic systems-Robot Drive systems-	2

	Hydraulic, Pneumatic and Electric system	
2	**Kinematics, dynamics and control**	
2.1	Object location, three dimensional transformation matrices	1
2.2	inverse transformation, kinematics and path planning	1
2.3	Jacobian work envelope, manipulator dynamics, dynamic stabilization	2
2.4	Position control and force control, present industrial robot control schemes.	2
3	**Robot Programming**	
3.1	Methods of robot programming,	1
3.2	Lead through programming methods	1
3.3	robot program as a path in space - defining position in space	2
3.4	speed control, motion interpolation	2
3.5	WAIT, SIGNAL, DELAY commands, Branching	1
3.6	Basic Commands and Operations: Motion commands-move and related statements	1
3.7	Points in workspace, paths and frames	1
4	**AI for Robotics**	
4.1	Introduction to Artificial Intelligence, goals of AI research.	1
4.2	AI techniques- knowledge representation, problem representation, search techniques	2
4.3	LISP programming.	1
4.4	AI and Robotics. LISP in the factory. Robotic Paradigms.	1
5	**Neural Network Approach in Robotics**	
5.1	Introduction, Connectionist Models	1
5.2	Learning Principles and Learning Rules: Supervised, unsupervised, reinforcement learning	2
5.3	Sensor based robot learning	1
5.4	Neural Network in Robotics: Control of robot hands by neural network	1
5.5	Neural set approach to robot motion coordination	1
5.6	Robotic motor control using reinforcement learning optimization	1

Reference Books

1. Bratko I., Prolog Programming for Artificial Intelligence, 3/e, Pearson Education.2001

2. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)

3. Russell, Stuart and Norvig, Peter, Artificial Intelligence: A Modern Approach" Prentice Hall, 2003.

4. Klafter, Chmielewski and Negin, Robotic Engineering An Integrated Approach, PHI, 2007.

5. D.W. Patterson, “Introduction to AI and Expert Systems”, PHI, 1992

6. R.J. Schalkoff, “Artificial Intelligence - an Engineering Approach”, McGraw Hill Int. Ed., Singapore, 1992

7. Russell S., Norvig, P, Artificial Intelligence: A Modern Approach, Pearson Education, 2009.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE004	OPTICAL INSTRUMENTATION	PROGRAM ELECTIVE 3	3	0	0	3

Preamble: This course provides an introduction to key concept in optical instrumentation, and trained the students in fundamental and advance *optical* component and basic *instrumentation.*

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

CO 1	Apply fundamental knowledge of mathematics and Optics to design application specific optical fiber.
CO 2	Apply Lasers in Instrumentation for the measurement of Pressure, temperature, Level and find the solutions for the errors if any.
CO 3	Describe the advantages of using Lasers
CO 4	Apply opto-electronic components and lasers in Medical instrumentation

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			1	1	1		
CO 2			3	1	1		
CO 3			3	1			
CO 4			2	1	1		
CO 5			2	2			

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	40
Analyse	20
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Course level Assessment Questions:

Course outcome 1 (CO1):

1. What is an optical fiber, explain its types along with their properties.
2. Explain the working principle of photodetector with neat sketch.

Course outcome 2 (CO2):

1. Illustrate the working of the type of LASER with their application, and define why is laser safety important.
2. Explain the fundamental characteristics and properties of laser and laser mode.

Course outcome 3 (CO3):

1. Explain different types of fiber optic sensors, and how does it work as a sensor.
2. What are the best type of fiber optic sensors for in- plane and through thickness permeability measurements.

Course outcome 4 (CO4):

1. Explain how the laser instruments are used for plastic surgery, and explain the medical application of laser in dermatology.
2. Explain holographic interferometry and its application in detail.
3. Explain LED , OLED , AMOLED with neat sketches.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Second Semester M. Tech. Degree Examination _____ , _____

Course Code: 222EAE004

Course Name: OPTICAL INSTRUMENTATION

Time: 2.5 Hours **Max. Marks: 60**

PART A

Answer all questions. Each question carries 5 marks.

1. Define basic principles of light propagation through a fiber.
2. What is the basic principle of Q-Switching ? Mention its advantages.
3. What are Moire fringes?
4. Explain applications of holography in non-destructive testing
5. Explain the following.
   a) CCD
   b) AMOLED

PART B

Answer any five questions. Each question carries 7 marks.

1. What are the different types of optical fibers and explain their transmission characteristics.
2. Explain about the operation of
   a) Mode locking (3 Marks)
   b) Cavity dumping (4 Marks)
3. What is the use of fiber optic gyroscope? Explain its working with neat diagram.
4. Explain the application of lasers in the removal of tumours of vocal chords.
5. Discuss the application of laser in dermatology.
6. Explain about the operation of
   a.) Photodiodes
   b.) Phototransistors
7. What is magneto optic modulators ?

Syllabus

MODULE 1

Optical Fibers and Their Properties:

Introduction to Optical Fibers - principles of light propagation through a fiber – Different types of fibers and their properties –Transmission characteristics of optical fiber –Absorption losses – Scattering losses –Dispersion - advantages and disadvantages of optical fibers Light sources for fiber optics, photo detectors, source coupling, splicing and connectors. Waveguides and Micro-Optical Fiber Bundles.

MODULE 2

Laser Instruments

Fundamental characteristics of Lasers – Three level and four level lasers – Properties of Laser and Laser modes – Resonator configuration – Q-switching and Mode locking – Cavity dumping – Types of lasers: Gas lasers, Solid lasers, Liquid lasers – Semi conductor lasers. Laser Safety: Radiation hazards, maximum permissible exposure, classification, safety measures and Personal Protective Equipment (PPE).

MODULE 3

Industrial Applications of Optical Instruments

Fiber optic sensors – Fiber optic Instrumentation system - Interferometric method of measurement of length - Moiré fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain. Fiber optic gyroscope – polarization maintaining fibers – applications.

MODULE 4

Applications of Lasers

Industrial applications of lasers – Laser Doppler Velocity meter – Laser heating Medical Applications Lasers - Laser and Tissue interaction, Laser instruments for surgery - CO2 laser as bloodless scalpel, Removal of tumors of vocal cords, Brain surgery, Plastic surgery, Gynecology, Oncology, Dermatology and Ophthalmology. Holography – Basic principle; methods (reflection, transmission, and hybrid), Holographic Components, Holographic Interferometry and Applications, Holography for Non-destructive Testing.

MODULE 5

Opto-Electronic Components:

Photodiodes, phototransistors, photomultipliers, optoisolators/optocouplers, IOC elements, photoresistors, CCD, laser diodes, LED, OLED, AMOLED; Magneto Optic and Acoustic – optic and other types of Optical Modulators – Detectors – Applications in Instrumentation.

Course Plan:

No	Topics	No. of Lectures
1	**Optical Fibers and their Properties:**	
1.1	Introduction to Optical Fibers - principles of light propagation through a fiber- Different types of fibers and their properties.	3
1.2	Transmission characteristics of optical fiber –Absorption losses – Scattering losses –Dispersion	2
1.3	Advantages and disadvantages of optical fibers Light sources for fiber optics, photo detectors, source coupling, splicing and connectors. Waveguides and Micro-Optical Fiber Bundles.	3
2	**Laser Instruments:**	
2.1	Fundamental characteristics of Lasers – Three level and four level lasers – Properties of Laser and Laser modes	2
2.2	Resonator configuration – Q-switching and Mode locking – Cavity dumping	2
2.3	Types of lasers: Gas lasers, Solid lasers, Liquid lasers – Semi conductor lasers. Laser Safety: Radiation hazards, maximum permissible exposure, classification, safety measures and Personal Protective Equipment (PPE)	4
3	**Industrial Applications of Optical Instruments**	
3.1	Fiber optic sensors – Fiber optic Instrumentation system - Interferometric method of measurement of length - Moiré fringes	2
3.2	Measurement of pressure, temperature, current, voltage, liquid level and strain.	3
3.3	Fiber optic gyroscope – polarization maintaining fibers – applications	2
4.	**Applications of Lasers:**	
4.1	Industrial applications of lasers – Laser Doppler Velocity meter – Laser heating Medical Applications Lasers - Laser and Tissue interaction	2
4.2	Laser instruments for surgery - CO2 laser as bloodless scalpel,Removal of tumors of vocal cords, Brain surgery, Plastic surgery, Gynecology, Oncology, Dermatology and Ophthalmology.	3
4.3	Holography – Basic principle; methods (reflection, transmission, and hybrid), Holographic Components, Holographic Interferometry and Applications, Holography for Non-destructive Testing.	4
5	**Opto-Electronic Components:**	
5.1	Photodiodes, phototransistors, photomultipliers, optoisolators/optocouplers.	2

5.2	IOC elements, photoresistors, CCD, laser diodes, LED, OLED, AMOLED; Magneto Optic and Acoustic	3
5.3	Optic and other types of Optical Modulators – Detectors – Application in Instrumentation.	3

Reference Books

1. Understanding Fiber Optics, 4th or 5th edition; Jeff Hecht; Prentice Hall publishers
2. Optical Fibre Communication', G. Keiser, 'McGraw Hill, 1995.
3. Monte Ross, 'Laser Applications', McGraw Hill, 1968.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE005	PWM AND POWER CONVERTERS	PROGRAM ELECTIVE 3	3	0	0	3

Preamble: This course provides the concepts of multilevel and multiphase inverters,different modulation schemes, common mode voltage elimination schemes and the implementation of PWM controller.

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

CO 1	Describe the basic concepts of different types of PWM schemes and their performance
CO 2	Analyse harmonic distortion in multilevel inverters
CO 3	Compare different topologies of multilevel inverters
CO 4	Describe different modulation schemes and optimum switching in multilevel inverters
CO 5	Compare common mode voltage elimination schemes in multilevel and multiphase inverters
CO 6	Implement a PWM controller using a simulation platform

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3				
CO 2			3				
CO 3			3				
CO 4			3				
CO 5			3				
CO 6				1	3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	50%
Analyse	50%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewedoriginal publications (minimum 10 publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks.

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:
60 Marks
Part A: 5×5 Marks
Part B: 5×7 Marks

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Illustrate the square wave operation of three-phase inverter

2.Explain the concepts of sine triangle PWM and space vector PWM

3. Describe current hysteresis control of VSI

Course Outcome 2 (CO2)

1.Analyse harmonic distortion factor for three-phase inverters

2.Explain triplen Carrier Ratios and Subharmonics

Course Outcome 3(CO3):

1. Explain different multilevel inverter topologies

2. Explain Five-phase and Six-phase inverters

Course Outcome 4 (CO4):

1. Explain sine triangle PWM and Space vector PWM for 3-level inverters

2.Illustrate space vector approach to Over modulation

Course Outcome 5 (CO5):

1. Explain common mode voltage elimination schemes in multilevel and multiphase inverters

Course Outcome 6 (CO6):

1. Apply modern simulation tools to implement PWM controller

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
Second Semester M. Tech. Degree Examination _____ , _____
Course Code: 222EAE005

Course Name: PWM AND POWER CONVERTERS

Time: 2.5 Hours **Max. Marks: 60**

PART-A

Answer *all* questions. Each question carries 5 marks

1. Explain why PWM signals are more suitable for Speed control applications of motors.
2. Derive expression for WTHD of a 3-level inverter
3. Realize a 3-level inverter using two 2-level inverters. Draw the resulting space vector diagram
4. Explain the importance of zero vectors in space vector pulse width modulation.
5. What is the effect of common mode voltage in motor drives?

PART – B

Answer *any 5* questions. Each question carries 7 marks

6. Which PWM scheme is suitable for eliminating predominant low order harmonics? Justify your answer.
7. Prove that the total harmonic distortion of a square wave inverter is 0.48
8. With schematic explain a 2-level six phase inverter.
9. With schematic explain a 3-level NPC inverter topology and issues of neutral point fluctuation.

10. The overmodulation region of PWM provides a useful extension of the operating range of an inverter without requiring an increased DC link voltage. Justify your answer.

11. Describe the steps involved in the implementation of space vector PWM for a 2-level voltage source inverter.

12. With schematic explain any one technique of common mode voltage elimination scheme in an induction motor drive.

Syllabus

Module1: Voltage Source Inverters

Three phase Voltage Source Inverters (VSI) - Fundamental Concepts of PWM schemes, Sine-triangle PWM - Space Vector PWM -Comparison of Sine-triangle PWM and Space vector PWM

Module 2: Harmonic Distortion

HarmonicDistortion- Harmonic distortion factors for 3 phase inverters

Module 3: Multilevel and Multiphase Inverters

Multilevel Inverters – Different multilevel inverter topologies – Multiphase inverters

Module 4: Modulation Schemes for Multilevel Inverters

Modulation schemes for multilevel inverters –Sine-triangle PWM andSpace vector PWM for multilevel inverters - Optimum switching in space vectorPWM – Overmodulation

Module 5: Common Mode Voltage Elimination Schemes

Common mode voltage elimination schemes in multilevel and multiphase inverters – Implementation of PWM controller

Course Plan

No	Topic	No. of Lectures
1	**Voltage Source Inverters (VSI)** (8 hours)	
1.1	Three phase voltage source inverters (VSI)	2
1.2	Fundamental Concepts of PWM schemes, Sine-triangle PWM, Spacevector PWM, Selective Harmonic Elimination PWM, Random PWM.	4
1.3	Comparison of Sine-triangle PWM and Space vector PWM	1
1.4	Current hysteresis control of a voltage source inverter	1
2	**Harmonic Distortion**(8 hours)	

2.1	Harmonic voltage distortion factor and Harmonic current distortion factor	3
2.2	Harmonic distortion factors for three phase inverters	2
2.3	WTHD of three level inverter	1
2.4	Triplencarrier ratios and subharmonics	2
3	**Multilevel and Multiphase Inverters**(8 hours)	
3.1	NPC, Cascaded H-Bridge and Flying capacitor inverters	4
3.2	Multilevel inverters with open-end winding induction motor	2
3.3	Multiphase inverters –five and six phases only	2
4	**Modulation Schemes for Multilevel Inverters**(8 hours)	
4.1	Sine triangle PWM and Space vector PWM for multilevel inverters	3
4.2	Optimum switching in space vector PWM	2
4.3	Zero vectors and importance of their placement in PWM	1
4.4	Over modulation of a voltage source inverter- Space vector approach to over modulation	2
5	**Common Mode Voltage EliminationSchemes** (8 hours)	
5.1	Common mode voltage and its adverse effects	2
5.2	Common mode voltage elimination schemes in multilevel and multiphase inverters	4
5.3	Implementation of PWM controllers - Overview	2

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

3. Current literature

SEMESTER II

PROGRAM ELECTIVE IV

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE006	ROBUST CONTROL	PROGRAM ELECTIVE 4	3	0	0	3

Preamble: This course introduces students to the rapidly emerging, multi-disciplinary, and exciting field of Robust Control systems.

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

CO 1	Familiar with Robust control and its classification. Understand norms for signals and systems, uncertainty and robustness
CO 2	Analyse stability
CO 3	Discuss design constraints and performance of H2 optimal control and estimation techniques.
CO 4	Do control design, H-infinity optimal control techniques

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	1	2	2	1	1		
CO 2	1	1	2	2	2	1	
CO 3	2	2	2	1	1		1
CO 4	3	1	2	1	2		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20%
Analyse	60%
Evaluate	20%
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Course Level Assessment Questions

Course Outcome 1 (CO1): Robust control and its classification, norms for signals and systems, uncertainty and robustness.

1. Explain the different types of Robust control?
2. Define and calculate Additive and multiplicative perturbations in robust control

Course Outcome 2 (CO2): Stability analysis of Robust Control

1. Discuss the various Norms for signals and SISO & MIMO systems.
2. Explain the Robust stability condition for plants with additive uncertainty.

Course Outcome 3 (CO3):Design constraints and performance of H2 optimal control and estimation techniques

1. Given P and W, find a proper stabilizing controller to minimize the 2-norm of a weighted closed-loop transfer function.
2. Discuss the H_2-optimal control against general deterministic inputs.

Course Outcome 4 (CO4): Control design, H-infinity optimal control techniques

1. Obtain the Characteristics of an H-infinity sub-optimal controllers.

2. Consider a double integrator $\begin{bmatrix}\dot{x}1\\ \dot{x}2\end{bmatrix} = \begin{bmatrix}0 & 1\\ 0 & 0\end{bmatrix}\begin{bmatrix}x1\\ x2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u$, $|u| \leq 1$ Design the sliding manifold: $\sigma = c_1x_1 + x_2 = 0$, $c1 > 0$

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER
222EAE006 - ROBUST CONTROL

Time: 2:30 hours **Max. Marks: 60**

PART A

Answer ***all*** questions. Each question carries ***5 marks***.

1. Explain about Multiplicative perturbation.
2. What do you understand by Plant Uncertainity.
3. What is Co prime Factorisation.
4. Discuss the Analytic Constraints for Robust Control
5. Compare Gain Margin & Phase margin Optimisation

PART B

Answer ***any five*** questions. Each question carries ***7 marks***

6. Explain in detail about Design Objectives and Specifications of Robust Control.
7. Evaluate the asymptotic tracking performance of Robust Control.
8. Explain in detail about Parameterisation of all Stabilizing controller.
9. Discuss about various Design Constraints & Design for performance of an Unstable system.
10. Explain the Sliding Mode Control of a Linear System with Full State Feedback.
11. Obtain Trade-Off between Performance and Robustness via H∞ Control
12. Suppose that $\{P_i : i=1,2,\ldots,n\}$ is a set of MIMO plants and that there is a single controller K that internally stabilizes each Pi in the set. Show that there exists a single transfer function P such that the set

$P = \{ F_u(P,\Delta) \mid \Delta \in H_\infty, \|\Delta\|_\infty \leq 1\}$ is also robustly stabilized by K and that $\{Pi\} \subset P$

Syllabus

Module 1

Introduction- Definition of robust control-Classification of robust control-Elements of robust control theory-Modelling-Design objectives and specifications-Additive and multiplicative perturbations

Module 2

Norms for signals and systems, input output relationships, internal stability, asymptotic tracking, performance. Uncertainty and robustness: plant uncertainty, robust stability, robust performance.

Module 3

Stabilization: controller parameterization for stable plant, co- prime factorization, controller parameterization for general plant, asymptotic properties, strong and simultaneous stabilization.

Module 4

Design constraints: algebraic constraints, analytic constraints. Design for performance: unstable, 2-norm minimization. Linear Quadratic Controllers – Characterization of H2 optimal controllers – H2 optimal estimation- Kalman Bucy Filter – LQG Controller.

Module 5

Stability Margin Optimization: optimal robust stability, gain margin optimization, phase margin optimization. Characterization of H-infinity sub-optimal controllers by means of Riccati equations – H-infinity control with full information – H-infinity estimation. Loop Shaping, Sliding mode control and H∞ control. Applications in control design.

Course Plan

No	Topic	No. of Lectures
1	**Introduction**	
1.1	Definition of robust control	1
1.2	Classification of robust control-Elements of robust control theory	2
1.3	Design objectives and specifications	2
1.4	Additive and multiplicative perturbations	2
2	**Norms , Uncertainty and robustness**	

2.1	Norms for signals and systems, input output relationships,	2
2.2	Internal stability, asymptotic tracking performance.	2
2.3	Plant uncertainty, robust stability, robust performance.	3
3	**Stabilization:**	
3.1	Controller parameterization for stable plant, co- prime factorization, controller	3
3.2	Parameterization for general plant, asymptotic properties.	2
3.3	Strong and simultaneous stabilization.	2
4	**Design constraints: H2 OPTIMAL CONTROL**	
4.1	Algebraic constraints, analytic constraints.	2
4.2	Design for performance: unstable, design example.	3
4.3	2-norm minimization..	2
4.4	Characterization of H2 optimal controllers	1
4.5	– H2 optimal estimation- KalmanBucy Filter – LQG Controller	2
5	**Stability Margin Optimization:**	
5.1	Optimal robust stability, gain margin optimization, phase margin optimization.	3
5.2	Loop Shaping, Sliding mode control and H∞ control.	2
5.3	Applications in control design.	2
5.4	H-infinity sub-optimal controllers by means of Riccati equations	2
5.5	H-infinity control with full information – Hinfinity estimation	2

Reference Books

1. 1.S.P. Bhattacharyya, H. Chapellat, L.H. Keel, “Robust Control: The ParametricApproach”, Prentice Hall, 2007.
2. Chandrasekharan, P.C., “Robust Control of Linear Dynamical Systems”,AcademicPress, 1996.
3. U. Mackenroth “Robust Control Systems: Theory and Case Studies”,Springer International Edition, 2010.
4. J. B. Burl, “ Linear optimal control H2 and H-infinity methods”, Addison W Wesley, 1998
5. Kemin Zhou, John Comstock Doyle, “Essentials of Robust Control”, PrenticeHallInternational, 1998.
6. Sinha, “Linear Systems: Optimal and Robust Control”, Taylor & Francis Group,2007.

U. Mackenroth, “Robust Control Systems Theory and Case studies”, Springer, 2013.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE007	CAD FOR VLSI	PROGRAM ELECTIVE 4	3	0	0	3

Preamble: This course deals with the fundamentals of Computer Aided Design (CAD) tools for the design, analysis, synthesis, test, verification, routing and placement of Digital Very Large Scale Integration (VLSI) systems.

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

CO 1	Apply different algorithms in VLSI design flow
CO 2	Apply Optimization of VLSI Design in circuit partitioning, floor planning and placement
CO 3	Familiarize pin assignment and global routing
CO 4	Implement hardware models for high level synthesis
CO 5	Familiarize basics of Verilog tool

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3	3			1
CO 2			3	3	3		
CO 3			3	3	3		
CO 4			3	3	3		
CO 5	3					3	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	40
Analyse	20
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewedoriginal publications (minimum 10 publications shall be referred) : 15 marks

Course based task/Seminar/Data collection and interpretation : 15 marks

Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:60 Marks
Part A: 5×5 Marks
Part B: 5×7 Marks

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the prim's algorithm for spanningtree with necessary pseudo code.
2. Explain Dijkstra's Algorithm.
3. Explain a suitable Data structures to represent a Graph.

Course Outcome 2(CO2):

1. Discuss types of placement problems.
2. Explain different steps in the application of Kernighan-Lin algorithm applied for edge – weighted undirected graph.
3. Describe the shape function, floor plan sizing in floor planning.

Course Outcome 3 (CO3):

1. Explain Maze routing algorithm
2. Discuss the relevance of Lee's algorithm inGlobal routing.

Course Outcome 4 (CO4):

1. Explain the force directed scheduling algorithm and explain the role of it in high level synthesis.
2. Explain ASAP Scheduling.
3. What is high level synthesis? How is it difficult from logic level synthesis.

Course Outcome 5 (CO5):

1. Explain the basic constructs used in Verilog.
2. Explain FSM model in Verilog.
3. Explain the various behavioural modelling with Always blocks. Give Suitable examples.

Model Question Paper

APJ Abdul Kalam Technological University
Second Semester M.Tech-Applied Electronics
Course Name: CAD for VLSI
Course Code: 222EAE007

Time:2.5 Hours **Max. Marks: 60**

PART A

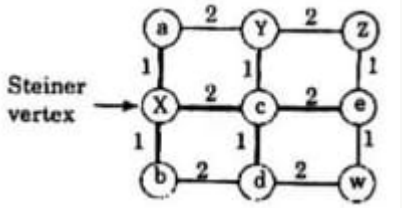
Answer all questions. Each question carries 5 marks.

1. Explain Dijkstra's Algorithm.
2. Discuss types of placement problems.
3. Explain Maze routing algorithm.
4. Explain ASAP Scheduling.
5. Explain the basic constructs used in Verilog.

PART B

Answer any five questions. Each question carries 7 marks.

6. Explain the prim's algorithm for spanning tree with necessary pseudo code.
7. Explain a suitable Data structures to represent a Graph.
8. Explain different steps in the application of Kernighan-Lin algorithm applied for edge – weighted undirected graphs.
9. Determine a minimum weight strainer tree as shown in figure corresponding to the net {a,b,c,d,e}. Assume that all horizontal edges have weights equal to 2 and all vertical edges have weights equal to 1.



10. Explain the force directed scheduling algorithm and explain the role of it in high level synthesis.
11. Explain FSM model in Verilog.
12. Explain the various behavioural modelling with Always blocks. Give Suitable examples.

Syllabus

MODULE 1: INTRODUCTION TO VLSI DESIGN FLOW

Introduction to VLSI Design Methodologies: New Trends in VLSI Design Cycle, New Trends in Physical Design Cycle.

Graph Algorithms:Data structures for Representation of Graphs, Breadth First Search, Depth First Search, Topological Sort, Spanning Tree Algorithm - Kruskal's and Prim's, Shortest path Algorithm - Dijkstra's Algorithm for single pair shortest path.

MODULE 2: LAYOUT, PLACEMENT, PARTITIONING AND PLANNING

Layout Compaction: Problem Formulation, Longest Path Algorithm for DAGs – without cycles and with cycles, Liao-Wong Algorithm, Bellman-Ford Algorithm.

Placement and Partitioning: Constructive Placement, Iterative Improvement, The Kernighan-Lin Partitioning Algorithm, Simulated Annealing

Planning: Classification of Floor planning algorithms, Constraint based floor planning, Rectangular Dualization.

MODULE 3: PIN ASSIGNMENT AND GLOBAL ROUTING

Pin Assignment: Classification of pin assignment algorithms, General and channel Pin assignments.

Global Routing: Classification of global routing algorithms, Maze routing algorithms – Lee's Algorithm, Line-Probe algorithm, Strainer Tree based Algorithm.

Detailed Routing: Classification of routing Algorithms, Single layer routing algorithms.

MODULE 4: HIGH LEVEL SYNTHESIS

High-level Synthesis- Hardware models for High-level Synthesis, lntemal Representation of the Input Algorithm - Allocation, Assignment and Scheduling, Some Scheduling Algorithms - ASAP Scheduling - Mobllity-based Scheduling, Force-directed Scheduling – List Scheduling.

MODULE 5: VERILOG BASICS

Introduction – BehavioralModeling with continuous assignments – Basic Constructs, Behavioral Modelling with Always Blocks – Registers, Latches, Counters, Combinational logic, Memories,Blocking and Non Blocking assignments – Finite State Machines –Parameterized Modules – Structural primitives – Test Benches.

Course Plan

No	Topic	No. of Lectures
1	**MODULE 1 INTRODUCTION TO VLSI DESIGN FLOW**	
1.1	Introduction to VLSI Design Methodologies:	1
1.2	New Trends in VLSI Design Cycle	1
1.3	New Trends in Physical Design Cycle	1
1.4	Graph Algorithms:Data structures for Representation of Graphs,	2
1.5	Breadth First Search, Depth First Search, Topological Sort,	2
1.6	Spanning Tree Algorithm - Kruskal's and Prim's,	1
1.7	Shortest path Algorithm - Dijkstra's Algorithm for single pair shortest path.	1
2	**MODULE 2 LAYOUT, PLACEMENT, PARTITIONING AND PLANNING**	
2.1	Layout Compaction: Problem Formulation, Longest Path Algorithm for DAGs – without cycles and with cycles, Liao-Wong Algorithm, Bellman-Ford Algorithm.	2
2.2	Placement and Partitioning: Constructive Placement, Iterative Improvement, The Kernighan-Lin Partitioning Algorithm, Simulated Annealing.	2
2.3	Planning: Classification of Floor planning algorithms, Constraint based floor planning, Rectangular Dualization.	2
3	**MODULE 3 PIN ASSIGNMENT AND GLOBAL ROUTING**	
3.1	Pin Assignment: Classification of pin assignment algorithms, General and channel Pin assignments.	2
3.2	Global Routing: Classification of global routing algorithms, Maze routing algorithms–Lee's Algorithm, Line-Probe algorithm, Strainer Tree based Algorithm.	2
3.3	Detailed Routing: Classification of routing Algorithms,	2
3.4	Single layer routing algorithms.	2
4	**MODULE 4 – HIGH LEVEL SYNTHESIS**	
4.1	High-level Synthesis- Hardware models for Highlevel Synthesis	2
4.2	lntemal Representation of the Input Algorithm - Allocation, Assignment and Scheduling	3
4.3	Some Scheduling Algorithms - ASAP Scheduling - Mobllity-based Scheduling	2
4.4	Force-directed Scheduling – List Scheduling	2
5	**MODULE 5 VERILOG BASICS**	
5.1	Introduction – BehavioralModeling with continuous assignments – Basic Constructs	2
5.2	Behavioral Modelling with Always Blocks – Registers,	2

	Latches, Counters, Combinational logic, Memories,	
5.3	Blocking and Non Blocking assignments – Finite State Machines –	2
5.4	Parameterized Modules – Structural primitives – Test Benches.	2

Reference Books

1. S.H. Gerez, *Algorithms for VLSI Design Automation*, John Wiley & Sons, 2e,2006
2. N.A. Sherwani, *Algorithms for VLSI Physical Design Automation*, Kluwar Academic Publishers,2002.
3. Neil H. E. Weste, David Harris, Ayan Banerjee, *CMOS VLSI Design, A Circuits and Systems Perspective*, 3e, 2006, Pearson Education
4. VivekSagdeo, *The Complete Verilog Book*,2002, Kluwer Academic Publishers
5. Samir Palnitkar, Verilog *HDL*, 2e, SunSoft Press
6. J. Bhaskar, *VERILOG HDL SYNTHESIS: A Practical Primer*, 2e, Star Galaxy Publishing

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE008	BIOINFORMATICS	PROGRAM ELECTIVE 4	3	0	0	3

Preamble: This course aims to develop the skillto perform big data analysis and analyze genomic sequences. After the completion of the course the student will be able to perform big data analysis with emphasis on molecular data processing technologies.

Prerequisite: Basic knowledge of python programming.

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

Course Outcomes	
CO 1	Familiarize the central dogma of molecular theory, nature and scope of Bioinformatics and various file formats for biomolecular sequences
CO 2	Access and retrieve data from biological data bases.
CO 3	Familiarize the concept of sequence alignment and database search tools.
CO 4	Build bio informatics programming capability
CO 5	Compare various sequencing technologies and associated data processing.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3		3		3		1
CO 2	3		3		3		1
CO 3	3		3		3		1
CO 4	3		3		3		1
CO 5	3		3		3		1

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	70%
Analyse	30%
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed
original publications (minimum 10 publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks.

Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks

The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Familiarize the central dogma of molecular theory, nature and scope of Bioinformatics and various file formats for biomolecular sequences

1. Explain the Structure of DNA, RNA and Protein
2. What is meant by gene density? Explain the gene densities in eukaryotes and prokaryotes.
3. Explain various file formats for biomolecular sequences.

Course Outcome 2 (CO2): Access and retrieve data from biological data bases.

1. Explain the different types of biological data bases.
2. What are the features of Biological databases?

Course Outcome 3 (CO3): Familiarize the concept of sequence alignment and database search tools.

1. Explain the significance of sequence alignment.
2. Explain the importance of scoring matrices in sequence alignment.
3. Needleman–Wunsch & Smith–Waterman algorithms for global and local sequence alignment.
4. Familiarize Database search tools: BLAST &FastA

Course Outcome 4 (CO4): Build bio informatics programming capability

1. What is the basic structure of HTML page? Explain.
2. Explain split() and join() functions in Python.
3. What is Biopython ? Explain its applications

Course Outcome 5 (CO5): Compare various sequencing technologies and associated data processing.

1. Explain first Generation, second Generation and third Generation sequencing technologies.
2. Explain FPKM and RPKM.

Syllabus

Module 1: Computational Biology and Bioinformatics (10 Hours)

Computational Biology: Cell - Central Dogma of Molecular Biology - Structure of DNA, RNA and Protein - Coding and Non-coding RNAs - mRNA, tRNA, miRNA and siRNA. Eukaryotic &Prokaryotic genome, Gene structure, GC content, Gene Density in Eukaryotes &Prokaryotes, Bioinformatics: Nature & Scope of Bioinformatics, Genome projects and Importance of bioinformatics, extracting, collecting and storing sequences; file formats for biomolecular sequences: GenBank, Fasta.

Module 2: Biological Databases (6 Hours)

Biological Databases : NCBI, ENSEMBL, UNIPROT, PFAM, Primary Sequence Databases, Composite protein sequence databases, Secondary Databases, Composite protein pattern databases, Structure classification databases.

Module 3: Sequence Alignment & Search Tools (6Hours)

Pairwise and Multiple sequence alignments: basic concepts of sequence alignment, Use of pairwise alignments and Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results. Needleman–Wunsch & Smith–Waterman algorithms for global and local sequence alignment. Familiarize Database search tools: BLAST &FastA

Module 4: Advanced Programming for Bioinformatics (9 Hours)

WebTechnology: Client Server Technology, Web servers, Web browsers, basic HTML, Scripting Languages: Python- Regular expressions, control statements, functions, string manipulations, Creation and accessing Modules and Packages in Python, Parallel programming/ Computing; Access public databases and different types of files using BioPython.

Module 5: Sequencing Technologies and data processing (9 Hours)

Introduction to sequencing technologies : First Generation (Sanger sequencing), Second Generation (Next Generation Sequencing, NGS), Third Generation (long-read sequencing). Data file formats : FASTA, FASTQ, BAM, SAM, vcf, BED. Quality assessment & pre-processing of NGS data. Variant discovery : Mapping to reference genome & variant calling, Introduction to Gene expression and quantification : Microarray & RNA-Seq.

Gene expression estimation from RNA-Seqdata : TPM, FPKM, RPKM. Gene & Transcript annotation :blastn, blastx, DIAMOND, UNIPROT database, KEGG.

Reference Books

1. Arthur Lesk, Introduction to Genomics, Oxford University Press, 3e,2017
2. David W. Mount, Bioinformatics:Sequence and Genome Analysis, Coldspring harbor Laboratory,2e,2004
3. JinXiong, Essential Bioinformatics, Cambridge University Press, 1e,2007
4. Xinkun Wang, Next-Generation Sequencing Data Analysis, 2016, CRC Press
5. SupratimChoudhuri, Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools, Academic Press, 1e, 2014
6. Jonathan M. Keith, Bioinformatics: Volume I: Data, Sequence Analysis, and Evolution, Humana, 2017
7. EijaKorpelainen ,JarnoTuimala, PanuSomervuo, Mikael Huss, Garry Wong, RNA-seq Data Analysis: A Practical Approach, Chapman & Hall/CRC Mathematical and Computational Biology, 1e, 2014
   Laiq Hasan, Acceleration of Bioinformatics Sequence Alignment, LAP Lambert Academic Publishing, 2011.
8. AsheeshShanker, Bioinformatics: Sequences, Structures, Phylogeny, Springer, 1e, 2018
9. Dr Martin Jones, Python for Biologists: A complete programming course for beginnersCreate Space Independent Publishing Platform,1e, 2013
10. YASH AKBARI, PYTHON PROGRAMMING : BLACK BOOK, ebook,https://www.amazon.in/PYTHON-PROGRAMMING-BLACK-YASH-AKBARI-ebook/dp/B08F3RZS7N

Course Plan

No	Topic	No. of Lectures
1	**Computational Biology and Bioinformatics**	
1.1	Cell - Central Dogma of Molecular Biology, Structure of DNA	2
1.2	RNA and Protein: Coding and Non-coding RNAs -mRNA	2
1.3	tRNA, miRNA and siRNA	2
1.4	Importance of bioinformatics, Pattern recognition and prediction	1
1.5	Folding	1
1.6	Eukaryotic &Prokaryotic genome, Gene structure, GC content, Gene Density in Eukaryotes &Prokaryotes	1
1.7	Nature & Scope of Bioinformatics,Genome projects.extracting, collecting and storing sequences. Biomolecular sequences: Extracting, collecting and storing sequences. File formats for biomolecular sequences: GenBank, Fasta	1
2	**Biological Databases**	

2.1	Biological Databases : NCBI, ENSEMBL, UNIPROT, PFAM	1
2.2	Primary Sequence Databases, Composite protein sequence databases	2
2.3	Secondary Databases	1
2.4	Composite protein pattern databases,	1
2.5	Structure classification databases.	1
3	**Sequence Alignment & Search Tools**	
3.1	Basic concept of sequence alignment, Pairwise alignments and Multiple sequence alignment for analysis of Nucleic acid and interpretation of results.	1
3.2	Pairwise alignments and Multiple sequence alignment for analysis of protein sequences and interpretation of results.	1
3.3	Needleman–Wunsch algorithm for global and local sequence alignment.	1
3.4	Smith–Waterman algorithm for global and local sequence alignment.	1
3.5	Familiarize Database search tools: BLAST &FastA	2
4	**Advanced Programming for Bioinformatics**	
4.1	WebTechnology: Client Server Technology, Web servers, Web browsers, basic HTML,	3
4.2	Scripting Language: Python- Regular expressions, control statements, functions, string manipulations, Creation and accessing Modules and Packages in Python, Parallel programming/ Computing..	5
4.3	Access public databases and different types of files using BioPython.	1
5	**Sequencing Technologies and data processing**	
5.1	Introduction to sequencing technologies : First Generation (Sanger sequencing), Second Generation (Next Generation Sequencing, NGS), Third Generation (long-read sequencing).	1
5.2	Data file formats : FASTA, FASTQ, BAM, SAM, vcf, BED.	1
5.3	Quality assessment & pre-processing of NGS data. Variant discovery : Mapping to reference genome & variant calling,	2
5.4	Introduction to Gene expression and quantification :Microarray& RNA-Seq	3
5.5	Gene expression estimation from RNA-Seqdata : TPM, FPKM, RPKM.	1
5.6	Gene & Transcript annotation :blastn, blastx, DIAMOND, UNIPROT database, KEGG.	1

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

----------SEMESTER M.TECH DEGREE EXAMINATION

Course Code: 222EAE008

Program: Applied Electronics and Instrumentation Engineering

Course Name: Bioinformatics

Max.Marks: 60 Duration: 3Hours

PART A

Answer all questions. Each carries 5 marks

1. List the roles of mRNA ,tRNA and rRNA.
2. Write short note on primary biological databases.
3. Explain the pairwise alignments for analysis of protein sequences and interpretation of results.
4. What is web browser and what is the purpose of web browser?
5. Explain the advantages of RNA-sequencing over Microarray Technology.

PART B

Answer any five questions. Each carries 7 marks

6. Explain the bio-sequences associated with central dogma of molecular biology.
7. Using Needleman and Wunsch dynamic programming method, construct thepartial alignment score table for the following two sequences, using the following scoring parameters: match score: +5, mismatch score: -1, gap penalty: -2.

   GCATGCU
   GATTACA

   Write down the optimal global alignment between these sequences along withoptimal score.
8. Discuss the principal features and structures of NCBI and UniProt database projects.
9. Write a python script to generate all possible ORFs in the given sequence :
   ATGTACTTATAGATTCTGATGCCCGCAACACACCCCATATAGCATTCATAAGTA
   CAT

10. Write a python script to accept two input numbers (10,6) as command line arguments, and returns the values of arithmetic operations (addition, subtraction, multiplication and division) which are in separate subroutines.
11. Draw the analysis workflow for RNA-Seq data analysis and explain.
12. Draw the analysis workflow for variant discovery and explain.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE009	IOT BASED SYSTEM DESIGN	PROGRAM ELECTIVE 4	3	0	0	3

Preamble: The digital space has witnessed major transformations in the last couple of years and as per industry experts would continue to evolve itself. The latest entrant to the digital space is the Internet of Things (IoT). IoT can also be defined as interplay for software, telecom and electronic hardware industry and promises to offer tremendous opportunities for many industries. The number of Internet-connected devices (12.5 billion) surpassed the number of human beings (7 billion) on the planet in 2011, and by 2020, Internet-connected devices are expected to number between 26 billion and 50 billion globally. Therefore, to leverage India's strength as a leader in the global service industry, this course will help students to become part of the IoT ecosystem in the country.

Course Outcomes: The COs shown are only indicative.

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

CO 1	Explain the concept of IoT.
CO 2	Describe Networking basics for IoT application development
CO 3	Analyze various protocols for IoT.
CO 4	Design a PoC of an IoT system using various hardware platforms
CO 5	Apply data analytics and use cloud offerings related to IoT.
CO 6	Analyze applications of IoT in real time scenario.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	1	1	-	3	-	-	-
CO 2	-	-	-	-	1	2	-
CO 3	-	-	2	-	2	-	-
CO 4	-	-	3	-	2	-	-
CO 5	2	-	-	3	-	-	-
CO 6	2	-	-	3	-	-	-

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	30
Analyse	20
Evaluate	10
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The end semester examination will be conducted by the University. There will be two parts; Part A and Part B. Part A contain 5 numerical questions (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students), with 1 question from each module, having 5 marks for each question. Students shall answer all questions. Part B contains 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student shall answer any five. Each question can carry 7 marks. Total duration of the examination will be 150 minutes.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER
222EAE009 -IOT BASED SYSTEM DESIGN

Time: 2:30 hours **Max. Marks: 60**

PART A
Answer *all* questions. Each question carries *5 marks*.

1. Discuss the IoT system architecture and standards.
2. Discuss the available indegenious RISC V based SoC solutions for prototyping the IoT node.
3. Briefly discuss MQTT protocol and its application in IoT.
4. Write a short note on IoT Security.
5. What is TinyML? Discuss the significance of TinyML in IoT perspective.

PART B
Answer *any five* questions. Each question carries *7 marks*

6. Discuss 6LoWPAN and its applications in IoT.
7. How to interface a sensor or actuator to an embedded hardware development board? discuss with reference to the IoT context.
8. Compare the LoRa, LoRaWAN, sigfox and NB-IoT connectivity technologies.
9. Discuss about Open and commercial Cloud solutions for IoT applications.
10. Discuss about ARM Cortex Microcontroller Security and Root Security Services (RSS)
11. Discuss the detailed procedure for designing an IoT based system for Smart vehicle status monitoring system, also mention the hardware, software, cloud and security concepts used in designing the complete system with relevant flow diagrams and figures.
12. Discuss the detailed procedure for designing an IoT based system for Smart Irrigation systems. Mention the hardware, software, cloud and security concepts used in designing the complete system with relevant flow diagrams and figures.

Syllabus

MODULE 1

Overview of IoT - Introduction to the Internet of Things, IoT system architecture and standards, Networking Basics - TCP/IP, Networking Basics - IP addressing basics (IPV4 and IPV6), Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks.

MODULE 2

IoT hardware Platforms - IoT Design Methodology – Embedded computing logic – Microcontroller-System on Chips, Hardware platforms for prototyping IoT node-Arduino, Raspberry Pi, NodeMCU, ESP32, ARM Cortex Microcontrollers, IoT mote hardware platforms, Swadeshi RISC V based solutions, Interfacing sensors and actuators with hardware platforms, Developing IoT applications using Raspberry Pi with Python Programming.

MODULE 3

IoT connectivity & Protocols- IoT Access Technologies: WiFi, Zigbee, Zwave, Bluetooth,UWB, sub1GHz, LoRaWAN, Sigfox and NB-IoT; Topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN; IoT application level protocols: MQTT, CoAP, XMPP, HTTP/Rest Services, WebSockets.

MODULE 4

Data analytics, Cloud and IoT Security - No SQL Databases Vs SQL Databases, Apache web servers, JSON, Open and commercial Cloud solutions for IoT, Python Web Application Frameworks for IoT, IoT data visualisation tools, IoT Security - Need for encryption, standard encryption protocol, lightweight cryptography, Trust models for IoT, ARM Cortex Microcontroller Security, Root Security Services (RSS).

MODULE 5

IoT Case studies- Smart Lighting, Smart home, Smart Agriculture, Smart farming, IoT for health care & patient monitoring, Smart and Connected Cities, Building end-to-end smart applications with TinyML

Course Plan

No	Topic	No. of Lectures
1	**Overview of IoT**	
1.1	Introduction to the Internet of Things	1
1.2	IoT system architecture and standards	1
1.3	Networking Basics - TCP/IP	1
1.4	Networking Basics - IP addressing basics (IPV4 and IPV6)	2
1.5	Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks	2
2	**IoT hardware Platforms**	
2.1	IoT Design Methodology – Embedded computing logic – Microcontroller-System on Chips	1
2.2	Hardware platforms for prototyping IoT node- Arduino, Raspberry Pi, NodeMCU, ESP32, ARM Cortex Microcontrollers, IoT mote hardware platforms, Swadeshi RISC V based solutions	3
2.3	Interfacing sensors and actuators with hardware platforms	2
2.4	Developing IoT applications using Raspberry Pi with Python Programming.	2
3	**IoT connectivity & Protocols**	
3.1	IoT Access Technologies: WiFi, Zigbee, Zwave, Bluetooth,UWB, sub1GHz, LoRaWAN, Sigfox and NB-IoT	3
3.2	Topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN	2
3.3	IoT application level protocols: MQTT, CoAP, XMPP, HTTP/Rest Services, WebSockets	3
4	**Data analytics, Cloud and IoT Security**	
4.1	No SQL Databases Vs SQL Databases	1
4.2	Apache web servers	1
4.3	JSON	1

4.4	Open and commercial Cloud solutions for IoT	2
4.5	Python Web Application Frameworks for IoT	1
4.6	IoT data visualisation tools	1
4.7	IoT Security - Need for encryption, standard encryption protocol, lightweight cryptography, Trust models for IoT	1
4.8	ARM Cortex Microcontroller Security, Root Security Services (RSS)	1
5	**IoT Case studies**	
5.1	Smart Lighting, Smart home	1
5.2	Smart Agriculture, Smart farming	1
5.3	IoT for health care & patient monitoring	1
5.4	Smart and Connected Cities	1
5.5	Building end-to-end smart applications with TinyML	4

Reference Books

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, —IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017

2. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions with the IoT Architecture Reference Model", Springer Open, 2016

3. Vijay Madisetti ,ArshdeepBahga, Adrian McEwen (Author), Hakim Cassimally "Internet of Things: A Hands-on-Approach" ArshdeepBahga& Vijay Madisetti, 2014.

4. Gian Marco Iodice, TinyML Cookbook: Combine artificial intelligence and ultra-low-power embedded devices to make the world smarter

5. Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols, Wiley, 2012

6. Vijay Madisetti ,ArshdeepBahga, Adrian McEwen (Author), Hakim Cassimally "Internet of Things A Hands-on-Approach" ArshdeepBahga& Vijay Madisetti, 2014

7. S.Misra, A. Mukherjee, and A.Roy, 2020. Introduction to IoT. Cambridge University Press.

8. Rajkamal, “Internet of Things : Architecture and Design Principles”, McGraw Hill (India) Private Limited

9. ChuanKunWn,”Internet of Things Security: Architectures and Security Measures”, Springer 2021.

10. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, “Enabling things to talk – Designing IoT solutions with the IoT Architecture Reference Model”, Springer Open, 2016

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE010	SOFT COMPUTING	PROGRAM ELECTIVE 4	3	0	0	3

Preamble: This course provides an introduction to key concepts in soft computing as Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms to equip students with knowledge required to develop intelligent systemsto solve real world problems in domains such as control system,machine learning etc.

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

CO 1	Familiarize the basic areas of Soft Computing including Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms.
CO 2	Comprehend fuzzy logic and the concept of fuzziness involved in various systems.
CO 3	Analyze the various neural network architectures.
CO 4	Apply genetic algorithm concepts and their applications.
CO 5	Design hybrid system to apply the principles of soft computing in various applications

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			3		2		
CO 2			3		3		
CO 3			3		3		
CO 4			3		3		
CO 5	2		3	3	3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	30
Analyse	30
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Preparing a review article based on peer reviewedoriginal publications (minimum 10 publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

60 Marks
Part A: 5×5 Marks
Part B: 5×7 Marks

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare and contrast the three different soft computing techniques.
2. Give the advantages of using soft computing approach for real world problems.

Course Outcome 2 (CO2):

1. Given fuzzy sets A and B as A = 0.2/1 +0.9/2 + 0.7/3 + 0.6/4 + 0.1/5 and B = 0.3/1 + 1.0/2 + 0.5/3 + 0.4/4 + 0.1/5, compute:
   (a) The subset hood value S(A, B) and S(B, A),
   (b) Union of A and B.
2. With block diagram explain the different components of fuzzy rule based system.

Course Outcome 3 (CO3):

1. Give the architecture of McCulloh Pits neuron and explain how a logic is implemented in it. How can you model the logic **S=A+B+C** using MCP neuron model?
2. Draw and explain the architecture of convolutional neural networks.

Course Outcome 4 (CO4):

1. Explain the following selection methods in genetic algorithm.
   (a) Tournament selection (b) Roulette wheel selection
2. What makes genetic algorithm a good optimization tool?

Course Outcome 5 (CO5):

1. With the architecture explain fuzzy backpropagation algorithm. Also give the convergence condition.
2. Explain the neural realization of basic fuzzy logic operations in neuro-fuzzy systems

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER
222EAE010SOFT COMPUTING

Time: 2:30hours **Max. Marks:60**

PART A

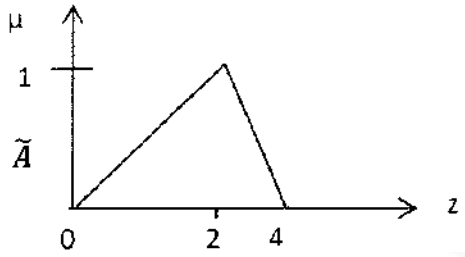
(Answer all questions. Each carries 5 marks)

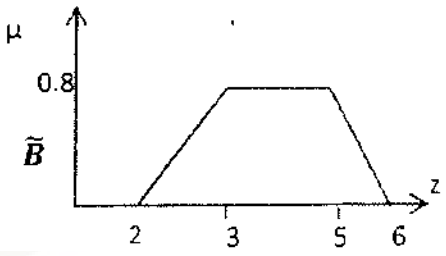
1	Let A = {(3, .5), (5, 1), (7, .6) } and B= {(3, 1), (5, .6) } are two fuzzy sets in X={ 1,2,3....10}. Applying the definitions of fuzzy set operations , prove the De Morgan laws related to fuzzy sets.	5
2	Explain perceptron convergence theorem.	5
3	Give the architecture of Convolutional Neural Network. Give any two benefits of using convolutional layers instead of fully connected ones for visual tasks.	5
4	Explain any two popularly used crossover operators in genetic algorithm.	5
5	With block diagram explain a fuzzy neural system.	5

PART B

(Answer any 5 questions. Each carries 7 marks)

6	What is defuzzification process? Explain any two defuzzification strategies used in decision making infuzzy logic systems. For the fuzzy sets given find the defuzzified value.	7





7	Consider fuzzy sets M, N and T given as M = { 0.9/low+0.3/average+0.5/high }, N= { 0.9/small+0.3/medium+0.5/big } and	7

T ={ 0.4/low+0.1/average+0.7/high }.

Find the fuzzy relation for Cartesian product R=MxN and max min composition between T and R.

8 Consider a multilayer feed forward network having 2 input nodes,1 hidden layer with 2 nodes and one output node. 7

Given the training set as :

Input pairs: [(0.4, -0.7) (0.3,-0.5)] Target output: [0.1 0.05]

Initial weight matrix as:

Weights to hidden node : [w_{11} w_{12} ;w_{21} w_{22}]= [0.1 -0.2; 0.4 0.2]

Weights to output node : [0.2 -0.5]

(w_{ij} denote weight from jth to ith node)

Given learning rate =0.6 and activation function of neurons as

$$f(x) = \frac{1}{(1 + e^{-2x})^{-1}}$$

Find the updated weights when the given training pairs are fed in order.

9 What are support vectors in SVM algorithm? Differentiate between hard margin and soft margin SVMs. 7

10 Give architecture Discrete Hopfield network and explain the algorithm used. How can you store the pattern (1,1,1,0) in a Hopfield net. Describe the form of weight matrix. Also test the net with mistakes in the first and second component of the stored vector. 7

11 What are the steps involved in optimization using genetic algorithm? What makes genetic algorithm a good optimization tool? 7

12 With the architecture explain fuzzy backpropagation algorithm. Also give the convergence condition. 7

Syllabus

Module 1

Introduction to soft computing - Fuzzy Systems, Artificial Neural Networks, Genetic Algorithm and Evolutionary Programming.
Introduction to Fuzzy Logic - Membership functions, Operations on fuzzy sets, Fuzzy Relations. Fuzzy rule base and Approximate Reasoning - Introduction to Fuzzy Decision Making.

Module 2

Overview of Artificial Neural Networks - Basic Models and Learning rules of ANN's. McCulloh-Pitts Neuron.
Supervised Learning Networks: Perceptron Networks, Linear Separability, Adaptive Linear Neuron, Multiple Adaptive Linear Neurons, MLP -Backpropagation Network.

Module 3

Unsupervised Learning Networks: Kohonen Neural Network, Hamming Neural Network - Hopfield Neural Network- Bi-directional Associative Memory -Adaptive Resonance Theory Neural Networks- Support Vector Machines - Spike Neuron Models, Convolutional Neural Networks, Deep Learning neural networks.

Module 4

Basic Concepts of Genetic Algorithm – Encoding - Fitness Function - Reproduction - Inheritance Operators - Cross Over - Inversion and Deletion - Mutation Operator - Convergence of Genetic Algorithm.

Module 5

Hybrid Systems -Neural Networks, Fuzzy Logic and Genetic - GA Based Weight Determination - LR-Type Fuzzy Numbers - Fuzzy Neuron - Fuzzy BP Architecture - Learning in Fuzzy BP- Inference by Fuzzy BP - Fuzzy ArtMap. A Brief Introduction - soft computing Tools - GA in Fuzzy Logic Controller Design, Fuzzy Logic Controller.

Course Plan

No	Topic	No. of Lectures
1	**Module 1: Soft Computing, Introduction to fuzzy sets**	
1.1	Introduction to soft computing - Fuzzy Systems, Artificial Neural Networks, Genetic Algorithm and Evolutionary Programming.	2
1.2	Introduction to Fuzzy Logic - Membership functions, Operations on fuzzy sets, Fuzzy Relations.	2

1.3	Fuzzy rule base and Approximate Reasoning	2
1.4	Introduction to Fuzzy Decision Making	2
2	**Module 2: Introduction to Artificial Neural Networks**	
2.1	Overview of Artificial Neural Networks – Basic Models and Learning rules of ANN's	2
2.2	McCulloh-Pitts Neuron	1
2.3	Supervised Learning Network: Perceptron Networks, Linear Separability	1
2.4	Adaptive Linear Neuron, Multiple Adaptive Linear Neurons	2
2.5	MLP – Backpropagation Network	2
3	**Module 3: Different Neural Network architectures**	
3.1	Unsupervised Learning Networks: Kohonen Neural Network	1
3.2	Hamming Neural Network - Hopfield Neural Network- Bi-directional Associative Memory	2
3.3	Adaptive Resonance Theory Neural Networks- Support Vector Machines	2
3.4	Spike Neuron Models, convolutional neural networks, deep learning neural networks.	3
4	**Module 4: Introduction to Genetic Algorithm**	
4.1	Basic Concepts of Genetic Algorithm – Encoding	1
4.2	Fitness Function	1
4.3	Reproduction - Inheritance Operators	2
4.4	Cross Over - Inversion and Deletion - Mutation Operator	2
4.5	Convergence of Genetic Algorithm	2
5	**Module 5: Hybrid systems**	
5.1	Hybrid Systems -Neural Networks, Fuzzy Logic and Genetic algorithm.	1
5.2	GA Based Weight Determination	2
5.3	LR-Type Fuzzy Numbers - Fuzzy Neuron - Fuzzy BP Architecture - Learning in Fuzzy BP- Inference by Fuzzy BP	2
5.4	Fuzzy ArtMap	1
5.5	A Brief Introduction - soft computing Tools - GA in Fuzzy Logic Controller Design, Fuzzy Logic Controller.	2

Reference Books

1. 1.S.N.Sivanandam , S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt.Ltd., 2nd Edition, 2011.
2. S.Rajasekaran, G.A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications ", PHI Learning Pvt.Ltd., 2017.
3. James A. Freeman and David M. Skapura, ―Neural Networks Algorithms, Applications, and Programming Techniques‖, Addison Wesley, 2003.
4. Timothy J. Ross, Fuzzy Logic with engineering applications – Wiley India.
5. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc
6. Goldberg D.E., Genetic Algorithms in Search, Optimization, and Machine Learning- Addison Wesley.

SEMESTER II

INTERDISCIPLINARY ELECTIVE

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE012	VIRTUAL INSTRUMENTATION	INTER DISCIPLINARY ELECTIVE	3	0	0	3

Preamble: Nil

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

CO 1	Develop software program in VI
CO 2	Experiment with plug-in DAQ interfaces for prototype measurement systems
CO 3	Implement basis concepts incorporating various VI Toolsets based on the application in Virtual Instruments.
CO 4	Familiarize Smart Sensors
CO 5	Develop VI for real time systems, embedded controller, HMI/SCADA software and Active X programming.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	1		2	2	1	1	
CO 2	1		2	2	1	1	
CO 3	1		3	2	2	1	
CO 4			2	2	2		
CO 5	1		2	2	1		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	40
Analyse	20
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Course level Assessment Questions:

Course outcome 1 (CO1):

1. Draw the general architecture of a virtual instrument and explain the functions of each block.
2. What is graphical programing in VI and why is it differ from conventional programing

Course outcome 2 (CO2):

1. Create a VI to find the sum of N natural numbers using a while loop with a feedback node.
2. Explain the difference between global and local variables with suitable example.
3. Develop a VI program that displays a string in the array of LEDs each letter has to displayed in a separate array and the letters have to move from one array to another in the direction of left to right.

Course outcome 3 (CO3):

1. What are the major components of a PC based data acquisition system. How do the software and hardware work together to process data.
2. Explain data acquisition in LabVIEW with suitable example**.**

Course outcome 4 (CO4):

1. Define GPIB and how the communication can be established, Explain advantages over bus interface.
2. Explain the operation and functions of PXI controller and classify them**.**

Course outcome 5 (CO5):

1. Give an example for real time application in VI, and also explain development of virtual instrument using GUI.

2. What is HMI and SCADA,and also explain the components layers of SCADA.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Second Semester M.Tech. Degree Examination _____ , _____

Course Code: 222EAE012

Course Name: VIRTUAL INSTRUMENTATION

Time: 2.5 Hours Max. Marks: 60

PART A

Answer all questions. Each question carries 5 marks.

1. Explain the essential need for Virtual Instrumentation and compare it with the traditional instruments.
2. Draw and Explain the graphical and VI models with design flow.
3. Define resolution in DAC
4. Explain how VISA is Helpful in instrument control.
5. Explain development of virtual instrument using GUI

PART B

Answer any five questions. Each question carries 7 marks.

1. Draw the general architecture of a virtual instrument and explain the function of each block.
2. Pictorially represent data flow programming in VI
3. List out the important characteristics of DAC? Explain them
4. Explain IVI with basic architecture , also list out the advantage of interchangeable VI.
5. What is VISA ? Mention the various types of instruments can be controlled by VISA.
6. List the types of interfacing bus
7. Explain
    a) Virtual oscilloscope
    b) Virtual function generator

Syllabus

MODULE 1: Virtual Instrumentation

An Introduction: Historical perspective, Advantages, Block Diagram and Architecture of Virtual Instrument, Data-Flow Techniques, Graphical Programming in data flow, Comparison with convectional programming, Development of Virtual Instrumentation using GUI, Real Time systems.

MODULE 2: VI Programming Techniques

VIs and sub-VIs, Loops and Charts, Arrays, Clusters and Graphs, Case and Sequence Structures, Formula nodes, local and global variables, State Machine String and file I/O.

MODULE 3: Data Acquisition Basics

Introduction to PC based data acquisition , Sampling fundamentals, Input/Output techniques and buses. DC, DAC, Digital I/O, Counters and timers, DMA, Software and Hardware Installation, Calibration, Resolution, Data acquisition interface requirements.

MODULE 4: VI Interface

Common Instrument Interfaces: Current loop, RS 232C/RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office and Industrial applications, VISA and IVI.

MODULE 5: VI Toolsets and Applications

Distributed I/O modules-Virtual Laboratory, Virtual Oscilloscope, Virtual function generator, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

Course Plan

No	Topic	No. of Lectures
1	**Virtual Instrumentation**	
1.1	An Introduction: Historical perspective, Advantages, Block Diagram and Architecture of Virtual Instrument.	2
1.2	Data-Flow Techniques, Graphical Programming in data flow, Comparison with convectional programming,	3
1.3	Development of Virtual Instrumentation using GUI, Real Time systems.	2
2	**VI Programming Techniques**	
2.1	VIs and sub-VIs, Loops and Charts, Arrays, Clusters and Graphs.	2
2.2	Case and Sequence Structures, Formula nodes, local and global variables.	3
2.3	State Machine String and file I/O.	2
3	**Data Acquisition Basics**	
3.1	Introduction to PC based data acquisition , Sampling fundamentals,	1
3.2	Input/Output techniques and buses. DC, DAC, Digital I/O, Counters and timers, DMA,	3
3.3	Software and Hardware Installation, Calibration, Resolution, Data acquisition interface requirements.	4
4	**VI Interface**	
4.1	Common Instrument Interfaces: Current loop, RS 232C/RS485, GPIB. Bus Interfaces:	2
4.2	USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI.	4
4.3	Networking basics for office and Industrial applications, VISA and IVI.	3
5	**VI Toolsets and Applications**	
5.1	Distributed I/O modules-Virtual Laboratory, Virtual Oscilloscope, Virtual function generator, Simulation of systems using VI,	3
5.2	Development of Control system, Industrial Communication, Image acquisition and processing, Motion control	3
5.3	Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming,	3

Reference Books

1. Kevin James, “PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control”, Newnes, 2000.
2. LabVIEW Graphical Programming , Gary Johnson, Second edition, McGraw Hill, Newyork, 1997
3. S. Gupta, J.P. Gupta, ‘PC interfacing for Data Acquisition & Process Control’, 2nd Ed., Instrument Society of America, 1994.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE013	ROBOTIC DESIGN AND CONTROL	INTER DISCIPLINARY ELECTIVE	3	0	0	3

Preamble: This course will serve as an introductory robotics course for the design and control of complex robotic systems**.**

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

CO 1	Introduce the concepts of Robotic systems
CO 2	Analyse drives and sensory systems in robotics
CO 3	Model the kinematics and dynamics of robotics
CO 4	Familiarize the control of Robotics
CO 5	Implement Robot programming

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2	1	2	1		1	
CO 2	2		2	2	2		
CO 3	3	1	3	2	2		
CO 4	2	1	1	2	1	1	
CO 5	2		1	1	1		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	20%
Analyse	60%
Evaluate	20%
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred): 15 marks

Course based task/Seminar/Data collection and interpretation: 15 marks

Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60marks
The end semester examination will be conducted by the respective College. There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question (such questions shall be useful in the testing of knowledge, skills, comprehension, application, analysis, synthesis, evaluation and understanding of the students). Students should answer all questions. Part B will contain 7 questions (such questions shall be useful in the testing of overall achievement and maturity of the students in a course, through long answer questions relating to theoretical/practical knowledge, derivations, problem solving and quantitative evaluation), with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Note: The marks obtained for the ESE for an elective course shall not exceed 20% over the average ESE mark % for the core courses. ESE marks awarded to a student for each elective course shall be normalized accordingly. For example if the average end semester mark % for a core course is 40, then the maximum eligible mark % for an elective course is 40+20 = 60 %

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the commonly used robot configuration system?
2. Explain the different types of joints in robot design?

Course Outcome 2 (CO2):

1. Explain the performance and selection criteria of electric motors in robotics
2. Discuss mechanical grippers used in robots and list out its advantages.?

Course Outcome 3 (CO3):

1. Discuss Denavit - Hartenberg convention in detail
2. Explain the Lagrange Euler's formulation for robot arm.

Course Outcome 4 (CO4):

1. Differentiate between Cartesian control and Force control
2. Explain PID control of a single link flexible robot.

Course Outcome 5 (CO5):

1. Using VAL language, discuss the basic commands and explain the structure of the program for a typical pick and place operation.
2. Explain the manual lead through programming in robot application

Syllabus

Module 1:

Introduction to robotics: Brief History, Definition, Robot Anatomy, Three laws, Classification of robots, Robot terminologies: work volume, Degree of Freedom, resolution, accuracy, repeatability, dexterity, compliance, payload capacity, speed of response etc., Robotic arm – Components and structure, Types of joints andworkspace, Common kinematic arrangements, Wrists, End effectors- Areas of application.

Module 2:

Robot drive systems: End effectors and Automation, Types of drives – Hydraulic, Pneumatic and Electric, Comparison of all such drives, DC servo motors, Stepper motors, AC servo motor – salient features and applications, pulse count calculations End effectors - Types of Grippers – Mechanical, Magnetic, vacuum, pneumatic and hydraulic, selection and design considerations.

Module 3:

Robot Sensors: Internal and external sensors, Position- potentiometric, Optical sensors, Encoders - absolute, incremental, Touch and slip sensors, Velocity and acceleration sensors, Proximity sensors, Force and torque sensors, tactile sensors, Flow sensors, Temperature sensors, vision sensors.

Module 4:

Robot Kinematics and Dynamics- Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Forward and inverse kinematics, Jacobian, Dynamic Modelling: Forward and inverse dynamics, Equations of motion using Euler-Lagrange formulation, Newton Euler formulation.

Module 5:

Motion planning and control- Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Nonlinear model based control schemes. Serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control
Robot Programming – Programming methods, Robot languageclassification, Robot language structure, elements and itsfunctions. Motion, End-effecter and Sensor commands in VALprogramming language.

Course Plan

No	Topic	No. of Lectures
1	**Introduction to robotics**	
1.1	Definition, law of robotics, History and Classification of Robotics	1
1.2	Robot Terminologies	2
1.3	Robotic arm	2
1.4	Common kinematic arrangements, Wrists, End effectors-Areas of application	2
2	**Robot drive system**	
2.1	End effectors and Automation	1
2.2	Types of drives – Hydraulic, Pneumatic and Electric	2
2.3	DC servo motors, Stepper motors, AC servo motor	2
2.4	Types of Grippers	3
3	**Robot Actuators and Sensors**	
3.1	Internal and external sensors	2
3.2	Position Sensors	1
3.3	Velocity and acceleration sensors	1
3.4	Proximity sensors, Force and torque sensors.	2
3.5	Actuators- Hydraulic, Pneumatic and Electrical	2
4	**Robot Kinematics and Dynamics**	
4.1	Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation	2
4.2	DH representation parameters	1
4.3	Forward and inverse kinematics	2
4.4	Jacobian, Dynamic Modelling	1
4.5	Equations of motion using Euler-Lagrange formulation, Newton Euler formulation.	3
5	**Motion planning and control**	
5.1	control of a single link, Independent joint PID control	2
5.2	Control of a multi-link manipulator	1
5.3	Nonlinear model based control schemes	1
5.4	Robot Programming methods	1
5.5	Robot languageclassification, Robot language structure.	1
5.6	Motion, End-effecter and Sensor commands in VALprogramming language	2

Reference Books

1. John J. Craig, Introduction to Robotics, Pearson Education Inc., Asia, 3rd Edition, 2005
2. R. K. Mittal, I. J. Nagrath, “Robotics and Control”, McGraw Hill Education, 2017.
3. S. K. Saha, “Introduction to Robotics”,McGraw Hill Education, 2014
4. Robotics, control vision and intelligence-Fu, Lee and Gonzalez. McGraw Hill International, 2nd edition, 2007
5. Programming Robots with ROS, Morgan Quigley, Brian Gerkey, & William D Smart, SPD Shroff Publishers and Distributors Pvt Ltd., 2016

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
MODEL QUESTION PAPER
222EAE013 - Robotic Design and Control

Time: 2:30hours **Max. Marks:60**

PART A

Answer ***all*** questions. Each question carries ***5 marks***.

1. Define a robot and with a neat diagram explain the anatomy of a robot?
2. Compare the various drive systems used in robotics?
3. Differentiate between forward and inverse kinematics?
4. Distinguish textual and lead through programming.
5. Explain Position Sensors.

PART B

Answer ***any five*** questions. Each question carries ***7 marks***

6. Define the term degrees of freedom and explain six degrees of freedom associated with robot.
7. With a neat sketch explain the following hydraulic actuators
   (i) Rotary actuator (ii) Linear actuator
8. What do you mean by link parameter table? How it can be obtained by using Denavit - Hartenberg method?
9. List the typical features of robotic sensors? Explain any five sensors used in robotics and mention areas of application of each?
10. How can PID controller be useful in robot actuation and control?
11. Explain the structure of robot programming language?
12. Explain the Control of a multi-link manipulator.

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222EAE014	EMBEDDED RTOS	INTER DISCIPLINARY ELECTIVE	3	0	0	3

Preamble: This course aims to acquire knowledge on various embedded RTOS, how it offers a real time response to a problem, etc..

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

CO 1	Familiarize the need for an Embedded system and its peripherals
CO 2	Acquire knowledge on RTOS in Embedded systems
CO 3	Describe interrupts and software architecture
CO 4	Design RTOS
CO 5	Acquire knowledge on the various development tools

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			2		3		
CO 2	1		2	3			
CO 3			3	2			
CO 4	1		3		3	3	1
CO 5	-		2	1	3	3	1

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	40
Analyse	20
Evaluate	
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Preparing a review article based on peer reviewed original publications (minimum 10 publications shall be referred) : 15 marks
Course based task/Seminar/Data collection and interpretation : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

There will be two parts; Part A and Part B. Part A will contain 5 numerical/short answer questions with 1 question from each module, having 5 marks for each question. Students should answer all questions. Part B will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 7 marks.

Course level Assessment Questions:

Course outcome 1 (CO1):

1. Explain in detail about interrupt latency and their solutions.
2. State the special features on I2C?
3. List the functions performed by the physical layer of 802.3 standard?

Course outcome 2 (CO2):

1. What is the purpose of embedded OS?
2. Which type of OS is used to run an embedded computer?
3. What are the three main parts of Linux?

Course outcome 3 (CO3):

1. How do you solve round robin scheduling?
2. What is function queue scheduling?
3. What are the important considerations in RTOS?

Course outcome 4 (CO4):

1. Why RTOS may be required in the design of embedded systems?
2. What is the rule of the real time operating system RTOS in embedded software design?
3. What makes RTOS deterministic?

Course outcome 5 (CO5):

1. What are the testing activities in debugging?
2. What is the purpose of assert() macro?
3. How software development tools are used in embedded applications? Explain in detail.

Model Question Paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Second Semester M.Tech. Degree Examination _____ , _____

Course Code: 22EAE014

Course Name: Embedded RTOS

Time: 2.5 Hours Max. Marks: 60

PART A

Answer **all** questions. Each question carries 5 marks.

1. Write notes on I2C and CAN.
2. What is the difference between general purpose OS and RTOS?
3. Define Round Robin with Interrupts.
4. What are Semaphores and Queues?
5. What is the purpose of assert() macro?

PART B

Answer any **five** questions. Each question carries 7 marks.

1. Explain different components in an embedded hardware with neat sketch of embedded architecture.
2. a. Explain in detail the Scheduler Algorithms using in an operating system. (3 Marks)
   b. What are the various memory management functions? (4 Marks)
3. What are the main challenges of choosing a RTOS for an embedded system design?
4. Draw and Explain RTOS architecture.
5. What are the requirements needed while designing using RTOS?
6. What is an interrupt? Explain its significance in RTOS.
7. How software development tools are used in embedded applications? Explain in detail.

Syllabus

MODULE 1

Introduction to embedded systems: Categories of embedded systems, overview of embedded system architecture; specialties of embedded systems, recent trends in embedded systems,

Memory Systems- memory technology, memory organization, error detecting and correcting memory, access times, DRAM interfaces, DRAM refresh techniques, Cache coherency , Bus Snooping, MESI , MEI protocols, big and little Endian memory,dual port and shared memory.

Basic Peripherals- parallel port, timers/counters, real time clocks, serial ports, SPI, I2C, RS232, UART RS 422/RS485, USB, IEEE1394, Bluetooth, Zigbee, Wifi, CAN.

MODULE 2

Real Time Operating Systems:-Overview of Operating Systems, Operating System Internals, multitasking Operating Systems, Scheduler Algorithms, Commercial OS, Resource Protection, LINUX, Disk Partitioning.

Introduction to RTOS- Characteristics of an RTOS, Task and task states, Task and data, Semaphore and Timer functions, events, Memory Management, Interrupt routine in an RTOS environment.

An overview of Embedded Operating System-A survey on embedded OS and RTOs, A review of POSIX standards, the scheduler, objects, services, Hard real time and soft real time, Difference between general purpose OS and RTOS, Operating system for microcontroller.

MODULE 3

Interrupts - its significance in real time processing- saving and restoring context, disabling interrupts, characteristics of shared data, atomic and critical sections interrupt latency.

Survey of software Architectures: Round Robin, Round Robin with interrupts, Function Queue scheduling Architecture, RTOS Architecture, Architecture selection.

MODULE 4

Design using RTOS- Principle, Encapsulating Semaphores and Queues, Hard Real-Time scheduling considerations, saving memory space, saving power.

MODULE 5

Embedded Software Development Tools: Host and Target Machines, Linker/ Locator for embedded Software, Getting Embedded Software into the target system, Debugging

, Testing on your host machine, Instruction, Set Simulators, The Assert Macro, Using Laboratory tools.

Course Plan

No	Topic	No. of Lectures
1	**Introduction to embedded systems:**	
1.1	**Introduction to embedded systems:** Categories of embedded systems, overview of embedded system architecture; specialties of embedded systems recent trends in embedded systems	3
1.2	**Memory Systems**- memory technology, memory organization, error detecting and correcting memory, access times, DRAM interfaces, DRAM refresh techniques, Cache coherency , Bus Snooping, MESI , MEI protocols, big and little Endian memory ,dual port and shared memory	4
1.3	**Basic Peripherals**- parallel port, timers/counters, real time clocks, serial ports, SPI , I2C, RS232, UART RS 422/RS485, USB, IEEE1394, Bluetooth, Zigbee, Wifi, CAN.	3
2	**Real Time Operating Systems**	
2.1	**Real Time Operating Systems**:-Overview of Operating Systems , Operating System Internals, multitasking Operating Systems, Scheduler Algorithms, Commercial OS, Resource Protection, LINUX, Disk Partitioning	2
2.2	**Introduction to RTOS**- Characteristics of an RTOS, Task and task states, Task and data, Semaphore and Timer functions , events, Memory Management, Interrupt routine in an RTOS environment.	3
2.3	**An overview of Embedded Operating System-**A survey on embedded OS and RTOs, A review of POSIX standards, the scheduler, objects, services, Hard real time and soft real time, Difference between general purpose OS and RTOS, Operating system for microcontroller	3
3	**Interrupts**	
3.1	**Interrupts** - its significance in real time processing- saving and restoring context, disabling interrupts, characteristics of shared data, atomic and critical sections interrupt latency	4
3.2	**Survey of software Architectures**: Round Robin, Round Robin with interrupts, Function Queue scheduling Architecture, RTOS Architecture, Architecture selection	4
4	**Design using RTOS**	

4.1	**Design using RTOS-** Principle, Encapsulating Semaphores and Queues	3
4.2	Hard Real-Time scheduling considerations, saving memory space, saving power	3
5	**Embedded Software Development Tools**	
5.1	**Embedded Software Development Tools**: Host and Target Machines, Linker/ Locator for embedded Software, Getting Embedded Software into the target system.	4
5.2	Debugging Techniques, Testing on your host machine, Instruction, Set Simulators, The Assert Macro, Using Laboratory tools.	4

Reference Books

1. Steve Heath, Embedded System Design, 2nd edition, Newnes.
2. David Simon, "Embedded Software Primer", Addison- Wesley, 1999.
3. DM Dhamdhere, "Operating Systems: A concept based approach, 2E.
4. Qing Li, " Real time Concepts of Operating Systems".
5. Raj Kamal, "Introduction to Embedded Systems", Tata McGraw Hill Publications, 2002
6. Frank Vaid,Tony D. Givargis, "Embedded System Design- A Unified Hardware/ Software Introduction", John Wiley and Sons, Inc 2002.

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222PAE100	MINI PROJECT	PROJECT	0	0	4	2

Mini project can help to strengthen the understanding of student's fundamentals through application of theoretical concepts and to boost their skills and widen the horizon of their thinking. The ultimate aim of an engineering student is to resolve a problem by applying theoretical knowledge. Doing more projects increases problem solving skills.

The introduction of mini projects ensures preparedness of students to undertake dissertation. Students should identify a topic of interest in consultation with PG Programme Coordinator that should lead to their dissertation/research project. Demonstrate the novelty of the project through the results and outputs.The progress of the mini project is evaluated based on three reviews, two interim reviews and a final review. A report is required at the end of the semester.

Evaluation Committee - Programme Coordinator, One Senior Professor and Guide.

Sl. No	Type of evaluations	Mark	Evaluation criteria
1	Interim evaluation 1	20	
2	Interim evaluation 2	20	
3	Final evaluation by a Committee	35	Will be evaluating the level of completion and demonstration of functionality/ specifications, clarity of presentation, oral examination, work knowledge and involvement
4	Report	15	the committee will be evaluating for the technical content, adequacy of references, templates followed and permitted plagiarism level(not more than 25%)
5	Supervisor/Guide	10	
	Total Marks	100	

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
222LAE100	VLSI AND EMBEDDED SYSTEMS LAB	LABORATORY	0	0	2	1

Preamble: On completion of the LAB student will be capable of doing programming in ARM kit and a sound understanding of CMOS circuit design using modern tools.

Course Outcomes: The COs shown are only indicative.

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

CO 1	Design and analyse CMOS circuits
CO 2	Design and program in ARM development kits/ 32 bit processors
CO 3	Design and implement circuits using Verilog/VHDL

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1			2	1	3		
CO 2			2	1	3		
CO 3			2	1	3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	60%
Analyse	20%
Evaluate	20%
Create	0%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	100	-	-

List of Experiments

Part A is compulsory. From Part B, either Sections II or III can be selected based on the specialization of the stream.

Part A (VLSI Lab Experiments)

Section I

Tools - CADENCE/SYNOPSYS/MENTOR GRAPHICS or any other equivalent tools

Design (Schematic), Simulation & Characterization of the following CMOS Logic Circuits

(Use Technology Library 180nm or less)

1. Universal Gates
2. Inverter
3. Half Adder
4. Full Adder
5. J K Flip-Flops

Part B (Embedded system Lab experiments)

Section II

Implement the following programs in an ARM development board /any 32 bitProcessor development board.

1. Toggle all the LEDs connected to a port with some time delay.
2. Design a counter and display the output in a seven segment display.
3. Interface a 4*4 matrix keypad
4. Interface a Stepper motor
5. Using PWM output, control a motor

Section III

Tools - Synopsys / cadence / Mentor Graphics' Model Sim or any other equivalent tools.

Design and implement the following circuits in an FPGA Development Board using Verilog/VHDL.

1. Decoder
2. Multiplexer
3. Adder
4. ALU
5. 8 bit microprocessor

SEMESTER III

SEMESTER III

Slot	Course code	Courses	Marks		L-T-P	Hours	Credit
			CIE	ESE			
TRACK 1							
A*	223MxxXXX	MOOC	To be completed successfully		--	--	2
B	223AGEXXX	Audit Course	40	60	3-0-0	3	-
C	223Ixx100	Internship	50	50	--	--	3
D	223Pxx100	Dissertation Phase 1	100	--	0-0-17	17	11
TRACK 2							
A*	223MxxXXX	MOOC	To be completed successfully		--	--	2
B	223AGEXXX	Audit Course	40	60	3-0-0	3	-
C	223Ixx100	Internship	50	50	---	--	3
D	223Pxx001	Research Project Phase1	100	--	0-0-17	17	11
TOTAL			**190**	**110**		**20**	**16**

Teaching Assistance: 6 hours

*MOOC Course to be successfully completed before the commencement of fourth semester (starting from semester 1).

AUDIT COURSE

AUDIT COURSE						
SLOT	**SL NO**	**COURSE CODE**	**COURSE NAME**	**L-T-P**	**HOURS**	**CREDIT**
B	1	223AGE100	ACADEMIC WRITING	3-0-0	3	-
	2	223AGE001	ADVANCED ENGINEERING MATERIALS	3-0-0	3	-
	3	223AGE002	FORENSIC ENGINEERING	3-0-0	3	-
	4	223AGE003	DATA SCIENCE FOR ENGINEERS	3-0-0	3	-
	5	223AGE004	DESIGN THINKING	3-0-0	3	-
	6	223AGE005	FUNCTIONAL PROGRAMMING IN HASKELL	3-0-0	3	-
	7	223AGE006	FRENCH LANGUAGE (A1 LEVEL)	3-0-0	3	-
	8	223AGE007	GERMAN LANGUAGE (A1 LEVEL)	3-0-0	3	-
	9	223AGE008	JAPANESE LANGUAGE (N5 LEVEL)	3-0-0	3	-
	10	223AGE009	PRINCIPLES OF AUTOMATION	3-0-0	3	-
	11	223AGE010	REUSE AND RECYCLE TECHNOLOGY	3-0-0	3	-
	12	223AGE011	SYSTEM MODELING	3-0-0	3	-
	13	223AGE012	EXPERT SYSTEMS	3-0-0	3	-

MOOC COURSES

The MOOC course shall be considered only if it is conducted by the agencies namely AICTE/NPTEL/SWAYAM or NITTTR. The MOOC course should have a minimum duration of 8 weeks and the content of the syllabus shall be enough for at least 40 hours of teaching. The course should have a proctored/offline end semester examination. The students can do the MOOC according to their convenience, but shall complete it by third semester. The list of MOOC courses will be provided by the concerned BoS if at least 70% of the course content match with the area/stream of study. The course shall not be considered if its content has more than 50% of overlap with a core/elective course in the concerned discipline or with an open elective.

MOOC Course to be successfully completed before the commencement of fourth semester (starting from semester 1). A credit of 2 will be awarded to all students whoever successfully completes the MOOC course as per the evaluation pattern of the respective agency conducting the MOOC.

TEMPLATE FOR SYLLABUS

CODE		CATEGORY	L	T	P	CREDIT
223AGE100	**ACADEMIC WRITING**	AUDIT COURSE	3	0	0	NIL

Preamble: Learning academic writing sharpens minds, teaches students how to communicate, and develops their thinking capacities and ability to understand others. Writing is thinking, and every student deserves to be a strong thinker. It can also make them think more carefully about what they write. Showing work to others can help to foster a better culture of learning and sharing among students. It also gives students a sense of how they are contributing to the body of work that makes up an academic subject.

Course Outcomes: The COs shown are only indicative. For each course, there can be 4 to 6 COs.

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

CO 1	Understand the principles of scientific/ academic writing
CO 2	Analyse the technique of scientific writing from the reader's perspective
CO 3	Apply the concepts of setting expectations and laying the progression tracks
CO 4	Evaluate the merits of a title, abstract , introduction, conclusion and structuring of a research paper
CO 5	Justify the need using a project proposal or a technical report
CO 6	Prepare a review paper, an extended abstract and a project proposal

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1		3	1				
CO 2		3	1				
CO 3		3	1			2	
CO 4		3	1				
CO 5		3	2	2		2	
CO 6	1	3	3	2		2	

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	40%
Analyse	30%
Evaluate	30%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Course based task : 15 marks
Seminar/Quiz : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The examination will be conducted by the respective College. The examination willbe for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any Vive. Each question can carry 12 marks.

Model Question paper

		SET1	**Total Pages:**
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER M.TECH DEGREE EXAMINATION, MARCH 2024			
Course Code: 223AGE100			
Course Name: Academic Writing			
Max. Marks: 60			Duration: 2.5 Hours
Answer any five full questions, each carries 12 marks.			

1 a)	Make clear-cut distinctions between 6 factors that take their toll on readers' memory.	6
1 b)	How can you sustain the attention of the reader to ensure continuous reading?	6
2 a)	What are the different methods by which you can create expectations in the reader?	6
2 b)	Give an account of the topic and non-topic based progression schemes.	6
3 a)	Bring out the differences between an abstract and the introduction of a research paper.	8
3 b)	How are the title of the research paper and its structure related?	4
4	What are 7 principles for including visuals in your research paper. What are the recommended constituents of a conclusion segment of a research paper?	12

5	Give a detailed description of the process and contents of a project proposal for funding.	12
6 a)	What are the contexts recommended for choosing between active and passive voices in technical writing?	8
6 b)	What are the different visual forms that are relevant in a research paper and how do you choose them?	4
7	Give the design of a research paper with the purposes each part serves.	12
	****	

Syllabus and Course Plan (For 3 credit courses, the content can be for 40 hrs and for 2 credit courses, the content can be for 26 hrs. The audit course in third semester can have content for 30 hours).

Syllabus:

CODE 223AGE100	**ACADEMIC WRITING**	**Audit**
Module No.	Topics in a module	Hours
1	Fundamentals of Academic writing from a reader's perspective: acronyms, synonyms, pronouns, disconnected phrases, background ghettos, abusive detailing, cryptic captions, long sentences : all that take their toll on readers' memory.	6
2	Fluid reading & reading energy consumption: setting expectations and laying Progression tracks; Reading energy consumption	6
3	How to write the Title, abstract, introduction ; Structure the writing with headings & subheadings	6
4	Visuals: Resources, Skills, and Methods; Conclusion; References; Bibliography; Grammar in technical writing	6
5	Techniques of writing: An extended abstract, a project proposal, a research paper, a technical report.	6

Course Plan:

No	Topic	No. of Lectures
1	Fundamentals of Academic writing from a reader's perspective: acronyms, synonyms, pronouns, disconnected phrases, background ghettos, abusive detailing, cryptic captions, long sentences all take their toll on readers' memory.	
1.1	The Reading tool-kit to reduce memory required; reduce reading time	1
1.2	Acronyms, Pronouns, Synonyms; Background, broken couple, words overflow	1
1.3	Sustain attention: Keep the story moving forward; Twists, shouts, Pause to clarify, recreate suspense	2

1.4	Keep the reader motivated: Fuel and meet Expectations; Bridge knowledge gap: ground level; Title words; Just In Time to local background	2
2	Fluid reading & reading energy consumption: setting expectations and laying Progression tracks; Reading energy consumption	
2.1	Setting expectations of the reader from Grammar, from theme	1
2.2	Progression tracks for fluid reading: Topic & stress; topic and non topic based progression tracks; pause in progression	2
2.3	Detection of sentence fluidity problems: No expectations/ Betrayed expectations	2
2.4	Controlling reading energy consumption: the energy bill; Energy fuelling stations: Pause	1
3	How to write the Title, abstract, introduction ; Structure the writing with headings & subheadings	
3.1	Title: Face of the paper: Techniques, Qualities & Purpose of title; Metrics	1
3.2	Abstract: Heart of the paper: 4 parts; coherence; tense of verbs, precision; purpose & qualities of the abstract; Metrics	2
3.3	Structure: Headings & sub-headings: Skeleton of the paper: principles for a good structure; Syntactic rules; Quality & Purpose of structures; Metrics	1
3.4	Introduction: Hands of the paper: Start, finish; scope, definitions; answers key reader questions; As a personal active story; Traps, qualities; Metrics	2
4	Visuals: Resources, Skills, and Methods; Conclusion; References; Bibliography; Grammar in technical writing	
4.1	Visuals as the voice of your paper: principles; purpose & qualities of visuals; metrics	2
4.2	Conclusion: contents; purpose, quality; metrics; Abstracts Vs. Conclusion; examples, counter-examples	1
4.3	References, Bibliography: Styles, punctuation marks, quotes, citations	1
4.4	Grammar in Technical writing: Articles, Syntax, Main and subordinate clauses; Active & passive voices; some commonly made mistakes in technical writing.	2
5	Techniques of writing: An extended abstract, a project proposal, a research paper, a technical report.	
5.1	Extended abstract: abstract and keywords, introduction and objective, method, findings and argument, conclusion and suggestions and references.	1
5.2	Project Proposal:Types, executive summary, background including status, objectives, solution, milestones, deliverables, timelines, resources, budgeting, conclusion	2
5.3	Research paper: writing an overview article: provide a comprehensive foundation on a topic; explain the current state of knowledge; identify gaps in existing studies for potential future research; highlight the main methodologies and research techniques	2

5.4	Writing Technical Reports: Title page; Summary; Table of contents; Introduction; Body; Figures, tables, equations and formulae; Conclusion; Recommendations.	1
		30

Reference Books

1. SCIENTIFIC WRITING 2.0 A Reader and Writer's Guide: Jean-Luc Lebrun, World ScientiVic Publishing Co. Pte. Ltd., 2011

2. How to Write and Publish a ScientiVic Paper: Barbara Gastel and Robert A. Day, Greenwood publishers, 2016

3. Grammar, Punctuation, and Capitalisation; a handbook for technical writers and editors. www.sti.nasa.gov/publish/sp7084.pdf www.sti.nasa.gov/sp7084/contents.html

4. Everything You Wanted to Know About Making Tables and Figures. http://abacus.bates.edu/%7Eganderso/biology/resources/writing/ HTWtableVigs.html

223AGE001	ADVANCED ENGINEERING MATERIALS	CATEGORY	L	T	P	CREDIT
		AUDIT COURSE	3	0	0	-

Preamble: This course is designed in a way to provide a general view on typically used advanced classes of engineering materials including metals, polymers, ceramics, and composites.

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

CO 1	Analyse the requirement and find appropriate solution for use of materials.
CO 2	Differentiate the properties of polymers, ceramics and composite materials.
CO 3	Recognize basic concepts and properties of functional materials.
CO 4	Comprehend smart and shape memory materials for various applications.
CO 5	Appraise materials used for high temperature, energy production and storage applications.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	□				□	□	
CO 2	□				□	□	
CO 3	□				□	□	
CO 4	□				□	□	
CO 5	□				□	□	

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	60%
Apply	20%
Analyse	20%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Course based task : 15 marks
Seminar/Quiz : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The examination will be conducted by the respective College. The examination willbe for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any Vive. Each question can carry 12 marks.

Model Question paper

AUDIT COURSE

223AGE001 - ADVANCED ENGINEERING MATERIALS

(Answer any five questions. Each question carries 12 Marks)

1.	a) State the relationship between material selection and processing.	**5**
	b) Write about the criteria for selection of materials with respect to the cost and service requirements for engineering applications.	**7**
2.	a) Differentiate thermosetting and thermoplastics with suitable examples.	**5**
	b) Briefly discuss about the properties and applications of polymer nano composite materials.	**7**
3.	a) Write about the potential application areas of functionally graded materials.	**5**
	b) With a neat sketch describe any one processing technique of functionally graded materials.	**7**
4.	a) "Smart materials are functional"? Justify the statement.	**5**
	b) Explain the terms electrostriction and magnetostriction with its application.	**7**

5.	a) What are the factors influencing functional life of components at elevated temperature?	**5**
	b) What are super alloys and what are their advantages?	**7**
6	a) What is a shape memory alloy? What metals exhibit shape memory characteristics?	**4**
	b) Explain about the detection capabilities and uses of pyroelectric sensors.	**8**
7	a) Differentiate between conventional batteries and fuel cells.	**4**
	b) Explain the construction and working of a Li-ion battery.	**8**

Syllabus

Module	Content	Hours	Semester Exam Marks (%)
I	Requirements / needs of advanced materials. Classification of materials, Importance of materials selection, Criteria for selection of materials; motivation for selection, cost basis and service requirements. Relationship between materials selection and processing.	**5**	**20**
II	Classification of non-metallic materials. Polymer, Ceramics: Properties, processing and applications. Nano Composites - Polymer nanocomposites (PNCs), Processing and characterisation techniques – properties and potential applications.	**7**	**20**
III	Functionally graded materials (FGMs), Potential Applications of FGMs, classification of FGMs, processing techniques. limitations of FGMs.	**6**	**20**
IV	Smart Materials: Introduction, smart material types - pyroelectric sensors, piezoelectric materials, electrostrictors and magnetostrictors, shape memory alloys – associated energy stimulus and response forms, applications.	**5**	**20**
V	High Temperature Materials: super alloys – main classes, high temperature properties of superalloys, applications. Energy Materials: materials for batteries.	**7**	**20**

Course Plan

No	Topic	No. of Lectures
1	**Selection of materials for engineering applications**	
1.1	Benefits of advanced materials, classification of materials, importance of materials selection	2
1.2	Selection of materials for different properties, strength, toughness, fatigue and creep	1
1.3	Selection for surface durability, corrosion and wear resistance	1
1.4	Relationship between materials selection and processing	1
2	**Classification of non-metallic materials & nano composites**	
2.1	Rubber: properties, processing and applications.	1
2.2	Plastics: thermosetting and thermoplastics, applications and properties.	2
2.3	Ceramics: properties and applications.	1
2.4	Introduction to nano composites, classification	1
2.5	Processing and characterisation techniques applicable to polymer nanocomposites.	2
3	**Functionally graded materials**	
3.1	General concept, Potential Applications of FGMs	2
3.2	Classification of FGMs	1
3.3	FGMs processing techniques: powder metallurgy route, melt-processing route	2
3.4	Limitations of FGMs	1
4	**Smart materials**	
4.1	Introduction to smart materials, types	1
4.2	Pyroelectric sensors-material class, stimulus, detection capabilities and uses	1
4.3	Piezoelectric materials- material class, stimulus, sensing and actuating applications	1
4.4	Electrostrictors and magnetostrictors - material class, stimulus, micro positioning capabilities and applications	1
4.5	Shape memory alloys (SMAs) - material class, stimulus, temperature sensing and high strain responses, applications.	1
5	**High Temperature Materials and Energy Materials**	
5.1	Characteristics of high-temperature materials, superalloys as high-temperature materials	1
	superalloys - properties and applications	2
5.2	Introduction to lithium-ion battery (LIBs), operating mechanisms and applications	2
5.3	Introduction to Zn-based battery system, types and existing challenges	2

Reference Books

1. DeGarmo et al, “Materials and Processes in Manufacturing”, 10th Edition, Wiley, 2008.
2. R.E. Smallman and A.H.W. Ngan, Physical Metallurgy and Advanced Materials, Seventh Edition, Butterworth-Heinemann, 2007
3. Vijayamohanan K. Pillai and Meera Parthasarathy, “Functional Materials: A chemist’s perspective”, Universities Press Hyderabad (2012).
4. M.V. Gandhi, B.S. Thompson: Smart Materials and Structures, Chapman & Hall, 1992.
5. G. W. Meetham and M. H. Van de Voorde, Materials for High Temperature Engineering Applications (Engineering Materials) Springer; 1 edition (May 19, 2000)
6. Inderjit Chopra, Jayant Sirohi, “Smart Structures Theory”, Cambridge University Press, 2013

223AGE003	DATA SCIENCE FOR ENGINEERS	CATEGORY	L	T	P	CREDIT
		AUDIT COURSE	3	0	0	0

Preamble: This course covers essentials of statistics and Linear Algebra and how to prepare the data before processing in real time applications. The students will be able to handle missing data and detection of any outliers available in the dataset. This course explores data science, Python libraries and it also covers the introduction to machine learning for engineers.

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

CO 1	Study Data Science Concepts and statistics
CO 2	Demonstrate Understanding of Mathematical Foundations needed for Data Science
CO 3	Understand Exploratory analysis and Data Visualization and Preprocessing on given dataset
CO 4	Implement Models such as Naive Bayes, K-Nearest Neighbors, Linear and Logistic Regression
CO 5	Build real time data science applications and test use cases

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO 1	2		2			2	
CO 2	2		2	1		2	
CO 3	2		2	2	2	2	
CO 4	2		2	2	3	2	
CO 5	2		2	3	3	3	2

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	50%
Apply	30%
Analyse	20%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Course based task (Project/Assignments/Simulations/Case studies): 15 marks

Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:**60 marks**

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 mark.

Syllabus

Module	Content	Hours	Semester Exam Marks (%)
I	**Statistics for Data science** Probability: Basic concepts of probability, conditional probability, total probability, independent events, Bayes' theorem, random variable, Population, Sample, Population Mean, Sample Mean, Population Distribution, Sample Distribution and sampling Distribution, Mean, Mode, Median, Range, Measure of Dispersion, Variance, Standard Deviation, Gaussian/Normal Distribution, covariance, correlation.	**6**	**20**
II	**Linear Algebra** Vectors and their properties, Sum and difference of Vectors, distance between Vectors, Matrices,Inverse of Matrix, Determinant of Matrix, Trace of a Matrix, Dot Product, Eigen Values, Eigen Vectors, Single Value Decomposition	**6**	**20**
III	**Hypothesis Testing** Understanding Hypothesis Testing, Null and Alternate Hypothesis, Non-directional Hypothesis, Directional Hypothesis Critical Value Method, P-Value Method, Types of Errors-Type1 Error,Type2 Error, Types of Hypothesis Test Z Test, Chi-Square	**6**	**20**

IV	**Exploratory Data Analysis** Data Collection –Public and Private Data, Data Cleaning-Fixing Rows and Columns, Missing Values, Standardizing values, invalid values, filtering data, Data-Integration,Data-Reduction,Data Transformation	**6**	**20**
V	**Machine Learning and Python for Data Science** Python Data structures-List, Tuple, Set, Dictionary, Pandas, Numpy, Scipy, Matplotlib, Machine Learning-Supervised Machine Learning, Unsupervised Machine Learning,Regression, Classification, Naïve-Bayes	**6**	**20**

Course Plan

No	Topic	No. of Lectures
1	**Statistics for Data science**	
1.1	Probability: Basic concepts of probability, conditional probability, total probability	1
1.2	independent events, Bayes' theorem, random variable, Population	1
1.3	Sample, Population Mean, Sample Mean, Population Distribution	1
1.4	Sample Distribution and sampling Distribution, Mean, Mode, Median, Range, Propositional logic and predicate logic	1
1.5	Measure of Dispersion, Variance, Standard Deviation	1
1.6	Gaussian/Normal Distribution, covariance, correlation.	1
2	**Linear Algebra**	
2.1	Vectors and their properties,	1
2.2	Sum and difference of Vectors, distance between Vectors	1
2.3	Matrices,Inverse of Matrix,	2
2.4	Determinant of Matrix, Trace of a Matrix, Dot Product, Eigen Values, Eigen Vectors, Single Value Decomposition	2
3	**Hypothesis Testing**	
3.1	Understanding Hypothesis Testing, Null and Alternate Hypothesis	1
3.2	Non-directional Hypothesis, Directional Hypothesis Critical Value Method, P-Value Method,	2
3.3	Types of Errors-Type1 Error,Type2 Error,	1
3.4	Types of Hypothesis Test Z Test, Chi-Square,	2
4	**Exploratory Data Analysis**	
4.1	Data Collection –Public and Private Data	1
4.2	Data Cleaning-Fixing Rows and Columns	1
4.3	Missing Values	1
4.4	Standardizing values	1
4.5	Invalid values, filtering data	1
4.6	Data Integration, Data Reduction, Data Transformation	1

5	**Machine Learning and Python for Data Science**	
5.1	Python Data structures-List, Tuple, Set,	1
5.2	Dictionary, Pandas, Numpy, Matplotlib	2
5.3	Machine Learning-Supervised Machine Learning, Unsupervised Machine Learning	1
5.4	Regression, Classification	1
5.5	Naïve-Bayes	1

Reference Books

1. Python Data Science Handbook. Essential Tools for Working with Data, Author(s): Jake VanderPlas, Publisher: O'Reilly Media, Year: 2016
2. Practical Statistics for Data Scientists: 50 Essential Concepts, Author(s): Peter Bruce, Andrew Bruce, Publisher: O'Reilly Media, Year: 2017
3. Practical Linear Algebra for Data Science, by Mike X Cohen, Released September 2022, Publisher(s): O'Reilly Media, Inc.
4. Data Science from Scratch 'by Joel Grus, Released, April 2015, Publisher(s): O'Reilly Media, Inc.
5. Hands-On Exploratory Data Analysis with Python, by Suresh Kumar Mukhiya, Usman Ahmed, Released March 2020,Publisher(s): Packt Publishing

SET1 **Total Pages:**

Reg No.:_ Name:_____

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER M.TECH DEGREE EXAMINATION, MARCH 2024

Course Code: 223AGE003

Course Name: DATA SCIENCE FOR ENGINEERS

Max. Marks: 60 Duration: 2.5 Hours

Answer any five full questions, each carries 12 marks.

1	a) It is observed that 50% of mails are spam. There is software that filters spam mail before reaching the inbox. It accuracy for detecting a spam mail is 99% and chances of tagging a non-spam mail as spam mail is 5%. If a certain mail is tagged as spam finds the probability that it is not a spam mail.	5
	b) Depict the relevance of measures of central tendency in data wrangling with a suitable example	7
2.	a) Calculate the inverse of the Matrix $\begin{matrix} 2 & 4 & -6 \\ 7 & 3 & 5 \\ 1 & -2 & 4 \end{matrix}$	4
	b)Find all Eigenvalues and Corresponding Eigenvectors for the matrix if $\begin{matrix} 2 & -3 & 0 \\ 2 & -5 & 0 \\ 0 & 0 & 3 \end{matrix}$	8
3.	a) A statistician wants to test the hypothesis H0: $\mu = 120$ using the alternative hypothesis Hα: $\mu > 120$ and assuming that $\alpha = 0.05$. For that, he took the sample values as n =40, $\sigma = 32.17$ and $\bar{x} = 105.37$. Determine the conclusion for this hypothesis?	5
	b) Hypothesis testing is an integral part of statistical inference, list out the various types of hypothesis testing and also mentions their significances in data science.	7
4.	a) Brief in detail directional and non-directional hypothesis	6
	b) Differentiate null and alternate hypothesis and also elaborate on type 1 and type 2 errors	6
5.	a) Explain the concepts of Tuple, List and Directory in python with example	6
	b) Elucidate reinforcement learning and application in real world.	6

6. a) What is Feature Engineering , demonstrate with an example 6

b) Describe in detail different steps involved in data preprocessing. 6

7. a) Illustrate supervised learning model with linear regression model 5

b) Predict the probability for the given feature vector if an accident will happen or not? 7

Weather condition: rain, Road condition: good, Traffic condition: normal, Engine problem: no, the task is to predict using Naïve Bayes classification.

SNo.	Weather condition	Road condition	Traffic condition	Engine problem	Accident
1	Rain	bad	high	no	yes
2	snow	average	normal	yes	yes
3	clear	bad	light	no	no
4	clear	good	light	yes	yes
5	snow	good	normal	no	no
6	rain	average	light	no	no
7	rain	good	normal	no	no
8	snow	bad	high	no	yes
9	clear	good	high	yes	no
10	clear	bad	high	yes	yes

223AGE004	DESIGN THINKING	CATEGORY	L	T	P	CREDIT
		AUDIT COURSE	3	0	0	-

Preamble:

This course offers an introductory exploration of fundamental engineering concepts and techniques, the design process, analytical thinking and creativity, as well as the fundamentals and development of engineering drawings, along with their application in engineering problems.

Course Outcomes:

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

CO 1	Identify and frame design challenges effectively.
CO 2	Generate creative ideas through brainstorming and ideation
CO 3	Iterate on designs based on user insights
CO 4	Apply Design Thinking to real-world problems and projects.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1				2		2	2
CO 2	2		2	2			2
CO 3		2		2		2	2
CO 4	2		2	3	2		2

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	40
Analyse	30
Evaluate	30
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

AUDIT COURSES

Continuous Internal Evaluation Pattern: 40 marks

Course based task : 15 marks
Seminar/Quiz : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The examination will be conducted by the respective College. The examination willbe for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

Model Question paper

		SET1	**Total Pages:**
Reg No.:_____			Name:_____
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER M.TECH DEGREE EXAMINATION, MARCH 2024			
Course Code: 223AGE004			
Course Name: DESIGN THINKING			
Max. Marks: 60			Duration: 2.5 Hours
Answer any five full questions, each carries 12 marks.			

1 a)	How can a multidisciplinary team collaborate effectively to implement design principles?	7
1 b)	What are the key differences between human-centred design and other design methodologies?	5
2 a)	How do you measure the success of a design project in terms of user satisfaction and impact?	7
2 b)	How does the iterative nature of the design process contribute to better outcomes	5

3 a)	What are the fundamental principles of effective brainstorming, and how do they differ from traditional problem-solving approaches?	7
3 b)	What are some key principles of ergonomic design, and how do they contribute to the usability and comfort of products?	5
4 a)	Enumerate some examples of successful and unsuccessful market testing scenarios, and what lessons can be learned from these experiences to improve future product or service launches?	7
4b)	What is the primary purpose of creating prototypes in the design and development process?	5
5	What strategies and methodologies can designers use to embrace agility and respond quickly to changing user needs and market dynamics?	12
6	Illustrate any four examples of successful bio-mimicry applications in various industries.	12
7	What ethical considerations should designers keep in mind when designing for diverse user groups?	12
	****	

Syllabus:

Module 1

Design process: Traditional design, Design Thinking Approach, Introduction to Design Thinking, History and evolution of Design Thinking, Role of design thinking in the human-centred design process. Design space, Design Thinking in a Team Environment, Team formation.

Module 2

Design Thinking Stages: Empathize, Define, Ideate, Prototype and Test. The importance of empathy, Building a user-centred mindset. Problem statement formulation, User needs and pain points, establishing target specifications, Setting the final specifications.

Module 3

Generating Ideas, Brainstorming techniques, Application of Aesthetics and Ergonomics in Design. Bio-mimicry, Conceptualization, Visual thinking, Drawing/Sketching, Presenting ideas.

Module 4

Use of prototyping, Types of prototypes, Rapid prototyping techniques, User testing and feedback collection, Iterative prototyping, testing to gauge risk and market interest

Module 5

Entrepreneurship/business ideas, Patents and Intellectual Property, Agility in design, Ethical considerations in design. Overcoming common implementation challenges

Corse Plan SyllabusandCorsePlan (For 3credit courses, thec ontent can be for 40 hrs and for2credit courses, the content can be for 26 hrs. The audit course in third semester can have content for 30hours).

No	Topic	No. of lectures
1	**Design process:**	
1.1	Design process: Traditional design, Design Thinking Approach, Introduction to Design Thinking, History and evolution of Design Thinking.	3
1.2	Role of design thinking in the human-centred design process. Design space,	2
1.3	Design Thinking in a Team Environment, Team formation.	2

2	**Design Thinking Stages:**	
2.1	Design Thinking Stages: Empathize, Define, Ideate, Prototype and Test.	2
2.2	The importance of empathy, Building a user-centred mindset.	2
2.3	Problem statement formulation, User needs and pain points, establishing target specifications, Setting the final specifications.	3
3	**Ideation**	
3.1	Generating Ideas, Brainstorming techniques.	2
3.2	Application of Aesthetics and Ergonomics in Design. Bio-mimicry.	3
3.3	Conceptualization, Visual thinking, Drawing/Sketching, Presenting ideas.	2
4	**Prototyping and testing**	
4.1	Use of prototyping, Types of prototypes, Rapid prototyping techniques.	3
4.2	User testing and feedback collection, Iterative prototyping, testing to gauge risk and market interest	2
5	**IPR in design**	
5.1	Entrepreneurship/business ideas, Patents and Intellectual Property.	2
5.2	Agility in design, Ethical considerations in design. Overcoming common implementation challenges	2

Reference Books

1. Christoph Meinel, Larry Leifer and Hasso Plattner- "Design Thinking: Understand – Improve – Apply", Springer Berlin, Heidelberg, 2011.
2. Thomas Lockwood and Edgar Papke – "Design Thinking: Integrating Innovation, Customer Experience, and Brand Value", Allworth Press, 2009.
3. Pavan Soni – "Design Your Thinking", Penguin Random House India Private Limited, 2020.
4. Andrew Pressman- "Design Thinking : A Guide to Creative Problem Solving for Everyone", Taylor & Francis, 2018.
5. N Siva Prasad, "Design Thinking Techniques an Approaches" Ane Books Pvt. Ltd.,2023

SYLLABUS

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
223AGE005	FUNCTIONAL PROGRAMMING IN HASKELL	AUDIT COURSE	3	0	0	-

Preamble: This course introduces a functional programming approach in problem solving. Salient features of functional programming like recursion, pattern matching, higher order functions etc. and the implementation in Haskell are discussed.

Course Outcomes:

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

CO 1	Understand the functional programming paradigm which is based on the mathematics of lambda calculus.
CO 2	Develop Haskell programs using functions, guards and recursive functions
CO 3	Apply the concept of tuples, lists and strings in Haskell programming
CO 4	Apply the concept of algebraic data types, abstract data types, modules, recursive data types and user defined data types in Haskell programming
CO 5	Develop Haskell programs with files for reading input and storing output

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1					3		
CO 2	2			2	3		
CO 3	2			2	3		
CO 4	2			2	3		
CO 5	2			2	3		

Assessment Pattern

Bloom's Category	End Semester Examination
Apply	40%
Analyse	40%
Evaluate	20%
Create	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Course based task : 15 marks

Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus**.**

End Semester Examination: 60 marks

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

Model Question paper

			Total Pages:
Reg No.:_____		Name:_____	
APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2023			
Course Code: 223AGE005			
Course Name: Functional Programming in Haskell			
Max. Marks: 60		Duration: 2.5 Hours	
Answer any five full questions, each carries 12 marks.			

1 a.	Explain the basic differences between imperative style programming and functional style programming.	3
1 b.	Analyse each of the following lambda expressions to clarify its structure. If the expression is a function, identify the bound variable and the body expression, and then analyse the body expression. If the expression is an application, identify the function and argument expressions, and then analyse the function and argument expressions: i) λa.(a λb.(b a)) ii) λx.λy.λz.((z x) (z y)) iii) (λf.λg.(λh.(g h) f) λp.λq.p)	9
2 a.	Design a recursive function to find 2^n where n is a natural number.	4

2 b.	Explain various forms of function definitions in Haskell with the help of examples.	8
3 a.	Explain any three list operations along with function definitions and examples.	6
3 b.	Write a program to duplicate only even numbers among the elements of a list using a Haskell function by (i) Recursion (ii) List Comprehension and explain. Example : λ> dupli [1, 2, 3] ANS: [2,2]	6
4	Write Recursive definitions along with an explanation for the below arithmetic operations. Illustrate the recursive flow with the help of a diagram. i. add x y ii. mult x y iii. div x y	12
5	Write the Haskell code to split a list into two lists such that the elements with odd index are in one list while the elements with even index are in the other list.	12
6 a	Give the type definition of a binary tree along with explanation of two functions on binary trees.	6
6 b	Define a queue data type in Haskell along with any two operations on it with examples.	6
7 a.	Explain the basic steps of reading from files and writing to files in Haskell.	4
7 b.	Write a Haskell program to read from the file "input.txt", display the contents on the screen and write the contents to another file "output.txt".	8
****		

Syllabus and Corse Plan (For 3 credit courses, the content can be for 40 hrs and for 2 credit courses, the content can be for 26 hrs. The audit course in third semester can have content for 30 hours).

Module 1 (5 Hrs)

Introduction to Functional Programming: Programming language paradigms, imperative style programming, comparison of programming paradigms.
Functional programming, Functions - Mathematical concepts and terminology, Lambda calculus, Function definitions, programs as functions, Functional programming Languages. Haskell basics, GHCi interpreter.

Module 2 (6 Hrs)

Programming in Haskell: Expressions and evaluation, Lazy evaluation, let expressions, scopes.

Basic data types in Haskell, operators, infix operators, associativity and precedence, Arithmetic functions.

types, definitions, currying and uncurrying, type abstraction.

Function definitions, pattern matching, guards, anonymous functions, higher order functions.

Recursion, Programming exercises.

Module 3 (7 Hrs)

Data types: tuples and lists: Tuples , Lists: building lists, decomposing lists, functions on lists, built-in functions on lists, primitive and general recursion over lists, infinite lists.

Strings: functions on strings.

Polymorphism and overloading, conditional polymorphism

Module 4 (6 Hrs)

Type classes, Algebraic data types, Modules, Recursive data types.

User defined data types, Records, Stacks, Queues, Binary trees, Constructors, Destructors.

Module 5 (6 Hrs)

Functor, Applicative functor, Monad

Programming with actions: Functions vs actions, Basics of input / output, the do notation, interacting with the command line and lazy I/O, File I/O.

No	Topic	No. of Lectures
1	**Introduction to Functional Programming**	
1.1	Programming language paradigms, imperative style programming, comparison of programming paradigms	1
1.2	Functional programming, Functions - Mathematical concepts and terminology	1
1.3	Lambda calculus	1
1.4	Function definitions, programs as functions, Functional programming Languages	1
1.5	Haskell basics, GHCi interpreter	1
2	**Haskell basics**	
2.1	Expressions and evaluation, Lazy evaluation	1
2.2	let expressions, scopes, Basic data types in Haskell	1
2.3	operators, infix operators, associativity and precedence, Arithmetic	1

	functions	
2.4	types, definitions, currying and uncurrying, type abstraction.	1
2.5	Function definitions, pattern matching, Guards	1
2.6	anonymous functions, higher order functions, Recursion	1
3	**Data types: tuples and lists**	
3.1	Tuples , Lists: building lists, decomposing lists	1
3.2	functions on lists, built-in functions on lists	1
3.3	primitive and general recursion over lists	1
3.4	infinite lists	1
3.5	Strings: functions on strings	1
3.6	Polymorphism and overloading	1
3.7	conditional polymorphism	1
4	**User defined data types**	
4.1	Type classes, Algebraic data types, Modules	1
4.2	Recursive data types	1
4.3	User defined data types, Records	1
4.4	Stacks, Queues	1
4.5	Binary trees	1
4.6	Constructors, Destructors	1
5	**Programming with actions**	
5.1	Functor, Applicative functor,	1
5.2	Monad	1
5.3	Programming with actions: Functions vs actions, Basics of input / output, the do notation	1
5.4	interacting with the command line and lazy I/O	1
5.5	File I/O	2

Reference Books

[1] Richard Bird, “Introduction to functional programming using Haskell', second edition, Prentice hall series in computer science

[2] Bryan O'Sullivan, Don Stewart, and John Goerzen, “Real World Haskell”

[3] Richard Bird, "Thinking Functionally with Haskell", Cambridge University Press, 2014

[4] Simon Thompson, "Haskell: The Craft of Functional Programming", Addison-Wesley, 3rd Edition, 2011

[5] H. Conrad Cunningham, "Notes on Functional Programming with Haskell", 2014

[6] Graham Hutton, "Programming in Haskell", Cambridge University Press, 2nd Edition, 2016

[7] Alejandro Serrano Mena, "Practical Haskell: A Real-World Guide to Functional Programming", 3rd Edition, Apress, 2022

[8] Miran Lipovaca, "Learn You a Haskell for Great Good!: A Beginner's Guide", No Starch Press, 2011

223AGE010	REUSE AND RECYCLE TECHNOLOGY	CATEGORY	L	T	P	CREDIT
		AUDIT COURSE	3	0	0	-

Preamble: "Reuse and Recycle Technology" typically focuses on sustainable practices and technologies aimed at reducing waste, conserving resources, and promoting environmental responsibility.

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

CO 1	Explain the principles and technologies behind waste reduction, resource conservation, and sustainable practices
CO 2	Describe and Analyze waste generation and management.
CO 3	Apply the knowledge of various reuse strategies and their application in different industries and Analyze various recycling technologies
CO 4	Appraise the methods of E-waste management and Eco friendly packaging
CO 5	Comprehend Environmental Regulations and Policies**,** Understand the importance of environmental regulations and policies in addressing environmental challenges

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1			3			
CO 2				3		
CO 3				3		
CO 4					3	
CO 5			3			

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	60%
Apply	20%
Analyse	20%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Course based task : 15 marks
Seminar/Quiz : 15 marks
Test paper, 1 no. : 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern: 60 marks

The examination will be conducted by the respective College. The examination willbe for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

Model Question paper

AUDIT COURSE

223AGE010 - REUSE AND RECYCLE TECHNOLOGY

Answer any five full questions, each carries 12 marks.

1.	(a) What are the 3 pillars of sustainability? *(b)* What is sustainable waste management? What makes sustainable waste management so important?	5 7
2.	(a)How do the three categories of municipal solid waste differ? *(b)* Discuss the municipal waste collection and management?	5 7
3.	(a)Explain the major differences between Reuse and Recycle? *(b)* Give an overview of recycling technologies used for any two materials. Discuss the Process involved.	5 7
4.	(a)What are the common source of E-waste *(b)* What are the challenges and opportunities in E-waste management	5 7
5.	(a)What is the case law for waste recycling in India *(b)* Discuss sustainable packaging and its environmental impacts	5 7
6.	Explain the various environmental regulations in India for addressing Environmental challenges	12
7.	a) Give examples of water reuse technologies in circular economy b) How can we reduce e-waste with sustainable solutions	5 7

Syllabus

Module	Content	Hours	Semester Exam Marks (%)
I	**Introduction to Sustainability**, Understanding sustainability and its importance, The three pillars of sustainability: Environmental, Social, and Economic. Biodiversity conservation, Climate change and mitigation Sustainable resource management.	**6**	**20**
II	**Waste Management,** Definition and classification of waste, Waste Generation and Composition**,** Waste Collection and Transportation, Waste Segregation and Sorting. Waste Disposal Methods Historical perspectives on waste management, The three Rs: Reduce, Reuse, and Recycle.	**6**	**20**
III	**Recycling and Reuse:** Importance of reuse, Application of reuse in various industries, Challenges and opportunities in reuse, Overview of recycling technologies, Circular economy, Sorting and processing of recyclable materials, Advanced recycling methods. Emerging technologies in recycling.	**6**	**20**
IV	**E-waste Recycling,** Challenges and environmental impact of electronic waste, E-waste recycling methods and regulations, Sustainable electronics design, **Sustainable Packaging,** Packaging materials and their environmental impact, Eco-friendly packaging alternatives, Packaging design for sustainability	**6**	**20**
V	**Environmental Regulations and Policies,** Understand the importance of environmental regulations and policies in addressing environmental challenges, National and international waste and recycling regulations, Compliance and enforcement, Industry standards and certifications	**6**	**20**

Course Plan

No	Topic	No. of Lectures
1	**Introduction to Sustainability (6)**	
1.1	Understanding sustainability and its importance	1
1.2	The three pillars of sustainability: Environmental, Social, and Economic.	3
1.3	Biodiversity conservation, Climate change and mitigation	1
1.4	Sustainable resource management	1
2	**Waste Management (6)**	
2.1	Definition and classification of waste	1
2.2	Waste Generation and Composition	1
2.3	Waste Collection and Transportation.	1
2.4	Waste Segregation and Sorting.	1
2.5	Waste Disposal Methods	1
2.6	Historical perspectives on waste management, The three Rs: Reduce, Reuse, and Recycle.	1
3	**Recycling and Reuse (6)**	
3.1	Importance of reuse, Examples of reuse in various industries.	1
3.2	Challenges and opportunities in reuse	1
3.3	Overview of recycling technologies, Sorting and processing of recyclable materials	2
3.4	Advanced recycling methods	1
3.5	Emerging technologies in recycling.	1
4	**E-waste Recycling (6)**	
4.1	Challenges and environmental impact of electronic waste	1
4.2	E-waste recycling methods and regulations	1
4.3	Sustainable electronics design	1
4.4	Packaging materials and their environmental impact	1
4.5	Eco-friendly packaging alternatives	1
4.6	Packaging design for sustainability	1
5	**Environmental Regulations and Policies (6)**	
5.1	Importance of environmental regulations and policies in addressing environmental challenges	2
5.2	National and international waste and recycling regulations	2
5.3	Industry standards and certifications, Compliance and enforcement	2

Reference Books

1. Sustainable Engineering: Concepts, Design and Case Studies, David T. Allen, Pearson Publication.
2. A Comprehensive Book on Solid Waste Management with Application, Dr. H.S. Bhatia , Misha Books, 2019
3. "Cradle to Cradle: Remaking the Way We Make Things" by William McDonough and Michael Braungart.
4. "Recycling of Plastic Materials" edited by Vijay Kumar Thakur
5. E-waste: Implications, Regulations and Management in India and Current Global Best Practices, Rakesh Johri, TERI
6. "Sustainable Packaging", Subramanian Senthilkannan Muthu , Springer Nature.
7. **I**ndian Environmental Law: Key Concepts and Principles " Orient Black swan Private Limited, New Delhi.

223AGE012	EXPERT SYSTEMS	CATEGORY	L	T	P	CREDIT
		AUDIT COURSE	3	0	0	-

Preamble: The course aims to provide an understanding of the basic concepts of Artificial Intelligence (AI) and Expert Systems. The course also covers the knowledge representation in expert systems, classes of expert systems, applications of expert systems.

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

CO 1	Explain the concepts of Artificial Intelligence and different ways of knowledge representations.
CO 2	Explain the components of expert systems, development stages of expert systems and tools available for expert system design.
CO 3	Apply the concept of knowledge representation in expert systems
CO 4	Differentiate the classes of expert systems and examine properties of existing systems

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO 1	1		2	1	2	2	
CO 2	1		1	3	2	2	
CO 3	1		1	2	2	2	
CO 4	2		2	2	3	2	

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	60%
Apply	20%
Analyse	20%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Course based task (Project/Assignments/Simulations/Case studies): 15 marks

Seminar/Quiz : 15 marks

Test paper, 1 no. : 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:**60 marks**

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 mark.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER M.TECH DEGREE EXAMINATION, MARCH 2024		
Course Code: 223AGE012		
Course Name: EXPERT SYSTEMS		
Max. Marks: 60	Duration: 2.5 Hours	
Answer any five full questions, each carries 12 marks.		
1	a) What are the types of AI? Explain with examples .	6
	b) What do you mean by knowledge in AI and explain the different ways of knowledge representation used in AI?	6
2.	a) Write note on semantic network.	6
	b) What are Predicates? Explain its syntax and semantics.	6
3.	a) Write notes on different tools available for expert system design.	6
	b). What are the different stages in the development of an expert system?	6
4.	a) Illustrate Conceptual Dependencies with an example.	6
	b) Illustrate with an example the Structured Knowledge representation of an Expert System.	6
5.	a) What do you mean by Frame based Expert System? Explain	6
	b)Explain the architecture of MYCIN	6
6.	a)Explain Fuzzy based expert systems	6
	b) Explain the neural network based expert systems	6
7.	a) Explain any two applications of expert systems?	6
	b)What are the limitations of expert system ? Explain	6

Syllabus

Module	Content	Hours	Semester Exam Marks (%)
I	Overview of Artificial Intelligence (AI): Definition & Importance of AI. Knowledge general concepts: Definition and Importance of knowledge, Knowledge-Based Systems, Knowledge organization, Knowledge Manipulation and acquisition. Knowledge Representation: Introduction, Syntax and Semantics- Propositional logic and predicate logic.	**6**	**20**
II	Basic concepts of expert systems-Introduction to expert systems, Components of expert systems. Features of Expert System, Stages in the development of expert system, Types of tools available for expert system design	**6**	**20**
III	Knowledge representation in expert systems: Structured Knowledge representation: Graphs, Frames and related structures, Associative networks, Conceptual dependencies, Examples of structured knowledge representation.	**6**	**20**
IV	Classes of expert systems: Rule-based expert systems, Example- MYCIN, Frame-based expert system, terminologies, IF-THEN structure. Fuzzy and Neural network based expert systems(basic concepts)	**7**	**20**
V	Currents trends in expert systems, Advantages and limitations of expert systems, Applications of expert systems.	**5**	**20**

Course Plan

No	Topics	No. of Lectures
1	**Overview of Artificial Intelligence& Knowledge general concepts**	
1.1	Definition & Importance of AI	1
1.2	Definition and Importance of Knowledge,	1
1.3	Knowledge-Based Systems, Knowledge Organization	1
1.4	Knowledge Manipulation and acquisition	1
1.5	Knowledge Representation: Introduction, Syntax and Semantics	1
1.6	Propositional logic and predicate logic	1
2	**Basic concepts of expert systems**	
2.1	Introduction to Expert System, Components of expert systems	2
2.2	Features of Expert System, Stages in the development of expert system	2
2.3	Types of tools available for expert system design	2
3	**Knowledge representation in expert systems**	
3.1	Structured Knowledge representation	1
3.2	Graphs, Frames and Related Structures	2
3.3	Associative Networks, Conceptual Dependencies	2
3.4	Examples of structured knowledge representation	1
4	**Classes of expert systems**	
4.1	A rule-based expert system -Introduction	1
4.2	MYCIN	1
4.3	IF-THEN structure	1
4.4	Frame-based expert system	2
4.5	Fuzzy based expert systems	1
4.6	Neural network based expert systems	1
5	**Currents trends and applications of expert systems**	
5.1	Currents trends of expert systems	2
5.2	Advantages and limitations of expert systems	1
5.3	Applications of expert systems	2

Reference Books

1. E. Rich & K. Knight - Artificial Intelligence, 2/e, TMH, New Delhi, 2005.
2. P.H. Winston - Artificial Intelligence, 3/e, Pearson Edition, New Delhi, 2006.
3. D.W. Rolston - Principles of AI & Expert System Development, TMH, New Delhi
4. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE) ", McGraw Hill – 2010
5. Dan W Patterson, 'Introduction to Artificial intelligence and Expert systems', Prentice Hall of India Pvt. Ltd,2007
6. Russel (Stuart), 'Artificial Intelligence- Modern approach, Pearson Education series in AI', 3rd Edition, 2009.
7. I. Gupta, G. Nagpal · Artificial Intelligence and Expert Systems, Mercury Learning and Information -2020

223AGE011	SYSTEM MODELLING	CATEGORY	L	T	P	CREDIT
		AUDIT COURSE	3	0	0	-

Preamble: Study of this course provides the learners a clear understanding of fundamental concepts in simulation and modelling. This course covers the different statistical models, importance of data collection and various types of simulations. The course helps the learners to find varied applications in engineering, medicine and bio-technology.

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

CO 1	Analyse the requirement and find appropriate tool for simulation.
CO 2	Differentiate the different statistical models.
CO 3	Discuss the different techniques for generating random numbers.
CO 4	Analyse the different methods for selecting the different input models..
CO 5	Discuss the different measures of performance and their estimation

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1	2		1	1	2	
CO 2	2		1	1	1	
CO 3	1					
CO 4	1		1	1		
CO 5	2		1	1	1	

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	60%
Apply	20%
Analyse	20%

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern:

Course based task (Project/Assignments/Simulations/Case studies): 15 marks
Seminar/Quiz: 15 marks
Test paper, 1 no.: 10 marks
Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

Model Question paper

AUDIT COURSE

223AGE001 – SYSTEM MODELLING

Answer any five questions Each carries 12 marks

PART A

1. a. Discuss the advantages and disadvantages of simulation. (5marks)

   b. What are the areas of applications of simulation (7 marks)

2. a.A bus arrives every 20 minutes at a specified stop beginning at 6:40 A.M. and continuing until 8:40 A.M. A certain passenger does not know the schedule, but arrives randomly (uniformly distributed) between 7:00A.M. and 7:30 A.M. every morning. What is the probability that the passenger waits more than 5 minutes for a bus? (5 marks)
   b. A production process manufactures computer chips on the average at 2% nonconforming. Every day, a random sample of size 50 is taken from the process. If the sample contains more than two nonconforming chips, the process will be stopped. Compute the probability that the process is stopped by the sampling scheme. (7 marks)

3. a.Discuss the different types of tests for random numbers. (5 marks)

   b. Generate random numbers using multiplicative congruential method with X0 = 5, a 11, and m = 64. (7 marks)

4. a. What are the different methods of data collection. (4marks)

   b. Records pertaining to the monthly number of job-related injuries at an underground coalrnine were
   being studied by a federal agency. The values for the past 100 months were as follows:

Injuries per Month	Frequency of Occurrence
0	35
1	40
2	13
3	6
4	4
5	1
6	1

(a) Apply the chi-square test to these data to test the hypothesis that the underlying distribution is Poisson. Use the level of significance α== 0.05.
(b) Apply the chi-square test to these data to test the hypothesis that the distribution is Poisson with mean 1.0. Again let α = 0.05. ·
c) What are the differences between parts (a) and (b), and when might each case arise? (8 marks)

5. a.What is the difference between validation and verification.(5 marks)
   b. Discuss the different measures of performance and their estimation(7 marks)
6. a. Discuss the different methods of parameter estimation(5 marks)
   b. With an example, describe the Poisson process.(7 marks)
7. a. Distinguish between discrete and continuous systems(5 marks)
   b.What are the different components of a simulation system(7 marks)

Syllabus

Module	Content	Hours	Semester Exam Marks (%)
I	When simulation is the appropriate tool. Advantages and disadvantages of Simulation; Areas of application, Systems and system environment; Components of a system; Discrete and continuous systems, Model of a system; Types of Models, Discrete-Event System Simulation, Steps of a simulation study.	**6**	**20**
II	Review of terminology and concepts, Useful statistical models, Discrete distributions. Continuous distributions, Poisson process, Empirical distributions. (basic idea only)	**6**	**20**
III	Properties of random numbers; Generation of pseudo-random numbers, Techniques for generating random numbers, Tests for Random Numbers	**6**	**20**
IV	Data Collection; Identifying the distribution with data, Parameter estimation, Goodness of Fit Tests, Fitting a non-stationary Poisson process, Selecting input models without data, Multivariate and Time-Series input models.	**6**	**20**
V	Measures of performance and their estimation, Output analysis for terminating simulations, Output analysis for steady-state simulations, Verification, calibration and validation	**6**	**20**

Course Plan

No	Topic	No. of Lectures
1	**Introduction**	
1.1	When simulation is the appropriate tool	1
1.2	Advantages and disadvantages of Simulation;	1
1.3	Areas of application, Systems and system environment;	1
1.4	Components of a system; Discrete and continuous systems,	1
1.5	Model of a system; Types of Models,	1
1.6	Discrete-Event System Simulation ,Steps of a simulation study	1
2	**Statistical Models in Simulation**	
2.1	Review of terminology and concepts, Empirical distributions. (basic idea only)	1
2.2	Useful statistical models,	1
2.3	Discrete distributions.	1
2.4	Continuous distributions,.	1
2.5	Poisson process	1
2.6	Empirical distributions	1
3	**Random Number Generation**	
3.1	Properties of random numbers;	1
3.2	Generation of pseudo-random numbers,	
3.3	Techniques for generating random numbers	1
3.4	Techniques for generating random numbers(cont)	1
3.5	Tests for Random Numbers	1
3.6	Tests for Random Numbers(cont)	1
4	**Input Modelling**	
4.1	Data Collection;	1
4.2	Identifying the distribution with data.	1
4.3	Parameter estimation, Goodness of Fit Tests	1
4.4	Fitting a non-stationary Poisson process	1
4.5	Selecting input models without data,	1
4.6	Multivariate and Time-Series input models	1
5	**Measures of Performance and their Estimation**	
5.1	Measures of performance and their estimation	1
5.2	Measures of performance and their estimation(cont)	1
5.3	Output analysis for terminating simulations	1
5.4	Output analysis for steady-state simulations	1
5.5	Verification, calibration and validation	1
5.6	Verification, calibration and validation(cont)	1

Textbooks:

1. Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol: Discrete-Event System Simulation, 5th Edition, Pearson Education, 2010.

Reference Books:

1. Lawrence M. Leemis, Stephen K. Park: Discrete – Event Simulation: A First Course, Pearson Education, 2006.

2. Averill M. Law: Simulation Modeling and Analysis, 4 th Edition, Tata McGraw-Hill, 2007

3. System Modelling and Response by Ernest O. Doebelin

4. Averill M Law, "Simulation Modeling and Analysis",McGraw-Hill Inc,2007 Geoffrey Gorden, "System Simulation",Prentice Hall of India,1992.

223AGE009	Principles of Automation	CATEGORY	L	T	P	CREDIT
		CREDIT COURSE	3	0	0	0

Preamble:

This course deals in detail with the various aspects of automation such as sensors, actuators, controllers, mechanical and electrical elements and their integration for automating new and existing manufacturing and process industries and applications. This course will be beneficial to students in designing automation schemes for industries and to design automated systems

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

CO 1	Explain the fundamentals of sensor systems and to choose a suitable sensor system for the given application based on the evaluation of the constraints.
CO 2	Explain the fundamentals of signal conditions and to design a suitable signal conditioning scheme for given application.
CO 3	Describe the characteristics of various actuator systems and to decide the right type of actuator for the given application.
CO 4	Describe the importance of an industrial robot and fundamentals of numerical control in automation.
CO 5	Explain the fundamentals of controllers used in industrial automation and to construct simple automation schemes by ladder logic programs.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	2		2	2	2		
CO 2	2		2	2	2		
CO 3	2		2	2	2		
CO 4	2		2	2	2		
CO 5	2		2				

Assessment Pattern

Bloom's Category	End Semester Examination
Understand	70 %
Apply	30 %

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation Pattern: 40 marks

Course based task (Project/Assignments/Simulations/Case studies): 15 marks

Seminar/Quiz: 15 marks

Test paper, 1 no.: 10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination Pattern:**60 marks**

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

Model Question Paper

223AGE009 Principles of Automation

Time 2.5 Hrs Marks 60

Answer any five questions Each carries 12 marks

1. (a) Differentiate the static and dynamic characteristics of a temperature sensor and explain how it affects the selection of a suitable temperature sensor. (6 marks)
   (b) Explain the working of a strain-gauge. (6marks)

2. (a) Explain why anti-aliasing filters are used in analog to digital converters. (3 marks)
   (b) Design a first order low pass filter with a cutoff frequency of 2 kHz. (9 marks)

3. (a) What are the factors to consider while deciding choosing between hydraulic, pneumatic or electrical actuation systems for an automation scheme? (4 marks)
   (b) Explain the working of a three-way pressure reducing valve. (4 marks)
   (c) Explain the working of solenoids. In what applications would you use a Solenoid valve. (4 marks)

4. (a) Explain the principle of the Touch sensor and also mention how they are used in robots. (5 marks)
   (b) Explain the basic terminologies in robotic system and also explain the components of robotic system. (7 marks)

5. (a)With neat schematic explain the architecture of the PLC. (6 marks)
   (b) Explain the use of an up-down counter in PLC with a suitable example. (6 marks)

6. (a) Write short note on SCADA. What is difference PLC and SCADA? (3 marks)

   (b)Construct a ladder logic for controlling a process tank as per the logic given below;
   i.The tank should be filled by a valve V1 when low level float switch L1 is ON and an external input S1 is received.

ii.V1 should be closed when the liquid level reaches a high-level float switch L2.
iii. An agitator motor should be turned on after a delay of 5sec after L2 is triggered.
iv. After agitating for 30mins, contents of the tank should be emptied by opening another valve V2.
v. The temperature should be maintained at 70℃ using a thermostat T1 and Heater H (9 marks)

7. (a) Explain the levels of Automation. (6 marks)
(b) Explain the working of Flow sensor (6 marks)

Syllabus and Course Plan

No	Topics	No. of Lectures
1	**Introduction to Industrial Automation**	
1.1	Basic Elements of an Automated System, Levels of Automation	2
1.2	Hardware components for Automation: Sensors, classification, Static and dynamic behaviour of sensors.	2
1.3	Basic working principle of different sensors: Proximity sensors, Temperature sensors, flow sensors, Pressure sensors, Force sensors. Position sensors	4
2	**Signal conditioning**	
2.1	Need for signal conditioning, Types of signal conditioning.	2
2.2	Signal conditioning using operational amplifier-Amplifier (Inverting and Non-inverting) and Filter circuits (Basic concepts). Design of first order low pass filter.	2
2.3	Signal conditioning for data acquisition systems, anti-aliasing filters, Analog–Digital Conversions, Analog-to-Digital Converters (ADC)- Steps in analog-to-digital conversion, Successive Approximation Method, Digital-to-Analog Converters (DAC)- Steps in digital to analog conversion, Zero-order and first order data hold circuits	4
3	**Actuators**	
3.1	Types of actuators- mechanical, electrical, pneumatic and hydraulic actuators. (Basic working principle)	2
3.2	Mechanical systems for motion conversion, transmission systems	3
3.3	Solenoids, Electric and stepper motors control.	3
4	**Robotics and Automated Manufacturing Systems**	
4.1	Robot Anatomy and Related Attributes: Joints and Links, Common Robot Configurations, Joint Drive Systems, Sensors in Robotics (Basic concepts)	3
4.2	Robot Control Systems, Applications of Industrial Robots- Material handling	4
4.3	Fundamentals of Numerical control (NC) Technology	1
5	**Discrete Control and Programmable Logic Controllers**	

5.1	Discrete Process Control: Logic and Sequence control	2
5.2	Ladder Logic Diagrams, Programmable Logic Controllers: Components of the PLC, PLC Operating Cycle, Programming the PLC (Basic concepts only)	4
5.3	Introduction to Distributed control system (DCS) and Supervisory Control and Data Acquisition Systems (SCADA)	2

Reference Books

1. Mikell Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 5th Edition, Pearson, 2019.
2. Yoram Koren, "Computer Control of Manufacturing Systems",TataMcGraw Hill Edition2005.
3. S. R. Deb; Sankha Deb. Robotics Technology and Flexible Automation, Second Edition McGraw-Hill Education: New York, 2010.
4. W. Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" - PrenticeHall- 2013 - 5th Edition.
5. Doebelin, E.O. and Manic, D.N., "Measurement Systems: Applications and Design", 7th Edition, McGraw Hill, 2019.
6. Krishna Kant, Computer Based Industrial Control-, EEE-PHI,2nd edition,2010.
7. Nathan Ida, Sensors, Actuators, and Their Interfaces- A multidisciplinary introduction, 2nd Edition, IET Digital Library, 2020.
8. Salivahanan, S., and VS Kanchana Bhaaskaran. Linear integrated circuits. McGraw-Hill Education, 2nd edition, 2014.
9. Petruzella, Frank D. Programmable logic controllers. Tata McGraw-Hill Education, 2005
10. Chapman and Hall, "Standard Handbook of Industrial Automation", Onsidine DM C & Onsidine GDC", NJ, 1986

223AGE002	FORENSIC ENGINEERING	CATEGORY	L	T	P	CREDIT
		Audit Course	3	0	0	-

Preamble: This course explores various aspects of Forensic Engineering and different methods ,tools and procedures used by Engineers to investigate and analyze . The students will learn to develop their awareness in Forensic Engineering .

Pre-requisite: Nil

Course Outcomes:

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

CO 1	Identify the fundamental aspects of forensic Engineering
CO 2	Apply forensic Engineering in Practical work flow and Investigation
CO 3	Apply methods and analysis in Forensic Investigation
CO 4	Develop practical strategies and standards of Investigation
CO 5	Create an awareness in criminal cases and create Engineering expertise in court room on forensic Engineering

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7
CO 1	2	2	3	3	3	3	
CO 2	2	2	3	3	3	3	1
CO 3	3	3	3	3	3	3	1
CO 4	3	3	3	3	3	3	1
CO 5	3	3	3	3	3	3	

Assessment Pattern

Bloom's Category	Continuous Internal Evaluation	End Semester Examination
Apply	40 %	60 %
Analyse	40 %	40 %
Evaluate	20 %	

Mark distribution

Total Marks	CIE	ESE	ESE Duration
100	40	60	2.5 hours

Continuous Internal Evaluation: 40 marks

Course based task :15marks

Seminar/Quizz :15marks

Test paper :10 marks

Test paper shall include minimum 80% of the syllabus.

End Semester Examination: 60 marks

The examination will be conducted by the respective College. The examination will be for 150 minutes and will contain 7 questions, with minimum one question from each module of which student should answer any five. Each question can carry 12 marks.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD SEMESTER M. TECH DEGREE EXAMINATION

Course Code: 223AG002

Course Name: FORENSIC ENGINEERING

Max. Marks: 60 **Duration: 2.5 Hours**

PART A

		Answer any 5 questions, each question carries 12 marks.	**Marks**
1.	(a)	What are the uses of forensic engineering in legal laws ?	(7)
	(b)	Discuss the professional responsibility of a forensic Engineer .	(5)
2.	(a)	What are the steps in preliminary on site Investigation ?	(7)
	(b)	With suitable examples, explain photo cataloguing?	(5)
3.	(a)	Discuss STEP method .	(7)
	(b)	Explain root cause Analysis	(5)
4.	(a)	Detail about EDAX Method.	(7)
	(b)	Enlist the uses of NDT in forensic Analysis with example	(5)
5.	(a)	Differentiate NFPA & FMV Standards	(7)
	(b)	Briefly discuss the term Email Phishing ?	(5)
6.		Define the responsibility and duty of a forensic expert in the court.	(12)
7.		Explain Forensic Engineering workflow with examples	(12)

Syllabus and Course Plan

Module No	Topic	No. of Lectures (Hours)
1	**Module 01: Introduction to Forensic Engineering (6 Hours)**	
1.1	Forensic Engineering-Definition, Investigation Pyramid, Eyewitness Information, Role in Legal System	2
1.2	Scientific Method-Applying scientific methods in Forensic Engineering-Engineer as expert Witness-Scientific methods and legal system	2
1.3	Qualification of Forensic Engineer-Technical- Knowledge- Oral-written-Communication- other skills-Personality Characteristics	1
1.4	Ethics and professional responsibilities.	1
2	**Module 02: Forensic Engineering Workflow and Investigation Methods (6 Hours)**	
2.1	Forensic Engineering Workflow-Team &planning-preliminary onsite investigation. Sampling-selection of sample-collection- packing-sealing of samples.	2
2.2	Source and type of evidence - Paper documentation- digital documentation-electronic data. Physical Evidence-Collection of photograph-cataloguing -Recognizing the Evidence-organizing-Evidence Analysis -Reporting	2
2.3	Investigation Methods- Cause and Causal mechanism analysis-Time and event sequence-STEP method. Human Factors, Human errors - Analysis of Operative Instruction and working Procedures	2
3	**Module 03: Physical Product Failure & Analytical Methods (6 Hours)**	
3.1	Introduction to typical Forensic Engineering Tool box-NDT, Crack detection and human eye -Hardness testing- and Destructive testing Methods with case studies	2
3.2	Indirect stress strain Analysis-Brittle lacquer technique, Contact Radiography-Metallography-EDAX method	1
3.3	Forensic Optical Microscopy-Examination- Magnification-USB Microscopy -Wifi Enabled microscopy -Reflected microscopy	2
3.4	Novel Tools and System -Contour Method-Flash Thermography-Thermographic signal reconstruction (TSR)-Electromagnetically induced acoustic Emission (EMAE)-Pulsed Eddy Current (PEA)-Theory only	1
4	**Module 04: Cyber Forensic , Civil ,Electrical Accidents & Standards (6 Hours)**	
4.1	Basics of Digital & Cyber forensics: Technical concepts; labs and tools; collecting evidence Operating System Forensic basics with - Windows, Linux -Mobile Forensic-Anti forensics-Malware- Web attack forensics with Email Crimes-Cyber Laws	3
4.2	Different types of Forensic accident investigations- Civil Engineering-Structural- Road accidents -Fire accidents - Water related accidents-Electrical accidents and Investigation methods	2
4.3	Protocol for forensic Investigations-Standard guides-scope significance -use -procedures- reports. Standards – ASTM standards -FMV Standards -SAE Standards -Relevant Standards -NFPA Standards -International Standards	1

5	**Module 05: Engineer in the Court room& Criminal Cases (6 Hours)**	
5.1	Role of an Engineering Expert-Report-pre trial meetings-Alternative dispute resolution-Single joint expert. Engineer in the court room	2
5.2	Criminal Cases-Introduction-Counterfeit coins-fraudulent road accidents-Fraudulent Insurance claims.	2
5.3	Cyber Crimes and Cases- SIM Swapping -ATM Cloning-Microsoft Internal Spam- Intellectual property cases.	2

Reference Books

1. Colin R Gagg, *Forensic EngineeringThe Art &Craft of a failure detective* , Taylor & Francis Publishing, 2020
2. Luca Fiorentini ,Luca Marmo *Principles of Forensic Engineering Applied to Industrial Accidents* , Wiley, 2019
3. Harold Franck, Darren Franck , *Forensic Engineering Fundamentals* ,Taylor & Francis publishing 2013
4. Randall K Noon , *Forensic Engineering Investigation*, CRC press limited , 2001
5. Stephen E Petty , *Forensic Engineering: Damage assessment for residential and commercial structures* CRC press 2nd edition , 2017
6. Joshua B Kardon , *Guideliness for forensic Engineering practice* , ASCE, 2012
7. Richard W. Mclay and Robert N. Anderson, *Engineering standards for forensic Applications* , Academic Press; 1st edition 2018
8. Max M Houck ,*Forensic Engineering (Advanced forensic Science),* Academic press 1st edition 2017
9. Niranjan Reddy - Practical Cyber Forensics. *An Incident-based Approach to Forensic Investigations-Apress (2019)*
10. Peter Rhys Lewis, Ken Reynolds, Colin Gagg - *Forensic Materials Engineering Case Studies-CRC Press (2003) (1)*

INTERNSHIP

A student shall opt for carrying out the Internship at an Industry/Research Organization or at another institute of higher learning and repute (Academia). The organization for Internship shall be selected/decided by the students on their own with prior approval from the faculty advisor/respective PG Programme Coordinator/Guide/Supervisor. Every student shall be assigned an internship Supervisor/Guide at the beginning of the Internship. The training shall be related to their specialisation after the second semester for a minimum duration of six to eight weeks. On completion of the course, the student is expected to be able to develop skills in facing and solving the problems experiencing in the related field.

Objectives

- Exposure to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
- Provide possible opportunities to learn understand and sharpen the real time technical / managerial skills required at the job.
- Exposure to the current technological developments relevant to the subject area of training.
- Create conducive conditions with quest for knowledge and its applicability on the job.
- Understand the social, environmental, economic and administrative considerations that influence the working environment.
- Expose students to the engineer's responsibilities and ethics.

Benefits of Internship

Benefits to Students

- An opportunity to get hired by the Industry/ organization.
- Practical experience in an organizational setting & Industry environment.
- Excellent opportunity to see how the theoretical aspects learned in classes are integrated into the practical world. On-floor experience provides much more professional experience which is often worth more than classroom

teaching.

- Helps them decide if the industry and the profession is the best career option

  to pursue.
- Opportunity to learn new skills and supplement knowledge.
- Opportunity to practice communication and teamwork skills.
- Opportunity to learn strategies like time management, multi-tasking etc in an industrial setup.
- Makes a valuable addition to their resume.
- Enhances their candidacy for higher education/placement.
- Creating network and social circle and developing relationships with industry people.
- Provides opportunity to evaluate the organization before committing to a full time position.

Benefits to the Institute

- Build industry academia relations.
- Makes the placement process easier.
- Improve institutional credibility & branding.
- Helps in retention of the students.
- Curriculum revision can be made based on feedback from Industry/

  students.
- Improvement in teaching learning process.

Benefits to the Industry

- Availability of ready to contribute candidates for employment.
- Year round source of highly motivated pre-professionals.
- Students bring new perspectives to problem solving.
- Visibility of the organization is increased on campus.

- Quality candidate's availability for temporary or seasonal positions and projects.
- Freedom for industrial staff to pursue more creative projects.
- Availability of flexible, cost-effective workforce not requiring a long-term employer commitment.
- Proven, cost-effective way to recruit and evaluate potential employees.
- Enhancement of employer's image in the community by contributing to the educational enterprise.

Types of Internships

- Industry Internship with/without Stipend
- Govt / PSU Internship (BARC/Railway/ISRO etc)
- Internship with prominent education/research Institutes
- Internship with Incubation centres /Start-ups

Guidelines

- All the students need to go for internship for minimum duration of 6 to 8 weeks.
- Students can take mini projects, assignments, case studies by discussing it with concerned authority from industry and can work on it during internship.
- All students should compulsorily follow the rules and regulations as laid by industry.
- Every student should take prior permissions from concerned industrial authority if they want to use any drawings, photographs or any other document from industry.
- Student should follow all ethical practices and SOP of industry.
- Students have to take necessary health and safety precautions as laid by the industry.
- Student should contact his /her Guide/Supervisor from college on weekly basis to communicate the progress.
- Each student has to maintain a diary/log book
- After completion of internship, students are required to submit
    - Report of work done
    - Internship certificate copy
    - Feedback from employer / internship mentor
    - Stipend proof (in case of paid internship).

Total Marks 100: The marks awarded for the Internship will be on the basis of (i) Evaluation done by the Industry (ii) Students diary (iii) Internship Report and (iv) Comprehensive Viva Voce.

Continuous Internal Evaluation: 50 marks

Student's diary - 25 Marks

Evaluation done by the industry - 25 Marks

Student's Diary/ Daily Log: The main purpose of writing daily diary is to cultivatethe habit of documenting and to encourage the students to search for details. It develops the students' thought process and reasoning abilities. The students should record in the daily training diary the day to day account of the observations,

impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily training diary should be signed after every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and got ratified on the day of his visit. Student's diary will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary
- Adequacy & quality of information recorded
- Drawings, design, sketches and data recorded
- Thought process and recording techniques used
- Organization of the information.

The format of student's diary

Name of the Organization/Section:

Name and Address of the Section Head:

Name and Address of the Supervisor:

Name and address of the student:

Internship Duration: From ..... To .....

Brief description about the nature of internship:

Day	Brief write up about the Activities carried out: Such as design, sketches, result observed, issues identified, data recorded, etc.
1	
2	
3	

Signature of Industry Supervisor *Signature of Section Head/HR Manager*

Office Seal

Attendance Sheet

Name of the Organization/Section:

Name and Address of the Section Head:

Name and Address of the Supervisor:

Name and address of the student:

Internship Duration: From ..... To .....

Month & Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	...
Month & Year																					
Month & Year																					

Signature of Industry Supervisor *Signature of Section Head/HR Manager*

Office Seal

Note:

- Student's Diary shall be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.
- Attendance Sheet should remain affixed in daily training diary. Do not remove or tear it off.
- Student shall sign in the attendance column. Do not mark 'P'.
- Holidays should be marked in red ink in the attendance column. Absent should be marked as 'A' in red ink.

Evaluation done by the Industry (Marks 25)

Format for Supervisor Evaluation of Intern

Student Name :_____ Date:_____

Supervisor Name :_____ Designation:_____

Company/Organization :_____

Internship Address: _____

Dates of Internship: From_____ To _____

Please evaluate intern by indicating the frequency with which you observed the following parameters:

Parameters **Marks**	Needs improvement (0 – 0.25 mark)	Satisfactory (0.25 – 0.50 mark)	Good (0.75 mark)	Excellent (1 mark)
Behavior				
Performs in a dependable Manner				
Cooperates with coworkers and supervisor				
Shows interest in work				
Learns quickly				
Shows initiative				
Produces high quality work				
Accepts responsibility				
Accepts criticism				
Demonstrates organizational skills				
Uses technical knowledge and expertise				
Shows good judgment				
Demonstrates creativity/originality				
Analyzes problems effectively				
Is self-reliant				
Communicates well				
Writes effectively				
Has a professional attitude				
Gives a professional appearance				
Is punctual				
Uses time effectively				

Overall performance of student

Intern (Tick one) : Needs improvement (0 - 0.50 mark) / Satisfactory (0.50 – 1.0 mark) / Good (1.5 mark) / Excellent (2.0 mark)

Additional comments, if any (2 marks) :

Signature of Industry Supervisor *Signature of Section Head/HR Manager*

Office Seal

End Semester Evaluation (External Evaluation): 50 Marks

Internship Report	-	25 Marks
Viva Voce	-	25 Marks

Internship Report: After completion of the internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period and should be submitted to the faculty Supervisor. The student may contact Industrial Supervisor/ Faculty Mentor for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor, Programme Coordinator and Faculty Mentor.

The Internship report (25 Marks) will be evaluated on the basis of following criteria:

- Originality
- Adequacy and purposeful write-up
- Organization, format, drawings, sketches, style, language etc.
- Variety and relevance of learning experience
- Practical applications, relationships with basic theory and concepts taught in the course

Viva Voce (25 Marks) will be done by a committee comprising Faculty Supervisor, PG Programme Coordinator and an external expert (from Industry or research/academic Institute). This committee will be evaluating the internship report also.

RESEARCH PROJECT/DISSERTATION

Research Project: Students choosing track 2 shall carry out the research project in their parent Institution only under the guidance of a supervisor assigned by the DLAC.

Dissertation: All categories of students in track 1 are to carry out the dissertation in the Institute they are studying or can work either in any CSIR/Industrial R&D organization/any other reputed Institute which have facilities for dissertation work in the area proposed.

Mark Distribution:

Phase 1: Total marks: 100, only CIA