SEMESTER -4

SEMESTER IV

SLOT	COURSE NO.	COURSES	L-T-P	HOURS	CREDIT
A	MAT204	PROBABILITY, RANDOM PROCESS AND NUMERICAL METHODS	3-1-0	4	4
B	ECT202	ANALOG CIRCUITS	3-1-0	4	4
C	ECT204	SIGNALS AND SYSTEMS	3-1-0	4	4
D	AET206	MEASUREMENTS AND INSTRUMENTATION	3-1-0	4	4
E 1/2	EST200	DESIGN & ENGINEERING	2-0-0	2	2
	HUT200	PROFESSIONAL ETHICS	2-0-0	2	2
F	MCN202	CONSTITUTION OF INDIA	2-0-0	2	--
S	ECL202	ANALOG CIRCUITS AND SIMULATION LAB	0-0-3	3	2
T	AEL204	TRANSDUCERS AND MEASUREMENTS LAB	0-0-3	3	2
R/M/H	VAC	REMEDIAL/MINOR/HONOURS COURSE	3-1-0	4*	4
TOTAL				**26/30**	**22/26**

MATHEMATICS – 4

(For Electrical, Electronics and Applied Electronics)

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MAT 204	PROBABILITY, RANDOM PROCESSES AND NUMERICAL METHODS	BASIC SCIENCE COURSE	3	1	0	4

Preamble: This course introduces students to the modern theory of probability and statistics, covering important models of random variables and analysis of random processes using appropriate time and frequency domain tools. A brief course in numerical methods familiarises students with some basic numerical techniques for finding roots of equations, evaluating definite integrals solving systems of linear equations and solving ordinary differential equations which are especially useful when analytical solutions are hard to find.

Prerequisite: A basic course in one-variable and multi-variable calculus**.**

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

CO 1	Understand the concept, properties and important models of discrete random variables and, using them, analyse suitable random phenomena.
CO 2	Understand the concept, properties and important models of continuous random variables and, using them, analyse suitable random phenomena.
CO 3	Analyse random processes using autocorrelation, power spectrum and Poisson process model as appropriate.
CO 4	Compute roots of equations, evaluate definite integrals and perform interpolation on given numerical data using standard numerical techniques
CO 5	Apply standard numerical techniques for solving systems of equations, fitting curves on given numerical data and solving ordinary differential equations.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Let X denote the number that shows up when an unfair die is tossed. Faces 1 to 5 of the die are equally likely, while face 6 is twice as likely as any other. Find the probability distribution, mean and variance of X.

2. An equipment consists of 5 components each of which may fail independently with probability 0.15. If the equipment is able to function properly when at least 3 of the components are operational, what is the probability that it functions properly?

3. X is a binomial random variable $B(n,p)$with $n = 100$and $p = 0.1$. How would you approximate it by a Poisson random variable?

4. Three balls are drawn at random without replacement from a box containing 2 white, 3 red and 4 black balls. If X denotes the number of white balls drawn and Y denotes the number of red balls drawn, find the joint probability distribution of (X,Y)

Course Outcome 2 (CO2)

1. What can you say about $P(X = a)$for any real number $a$when $X$is (i) a discrete random variable? (ii) a continuous random variable?

2. A string, 1 meter long, is cut into two pieces at a random point between its ends. What is the probability that the length of one piece is at least twice the length of the other?

3. A random variable has a normal distribution with standard deviation 10. If the probability that it will take on a value less than 82.5 is 0.82, what is the probability that it will take on a value more than 58.3?

4. X and Y are independent random variables with X following an exponential distribution with parameter μ and Y following and exponential distribution with parameterλ. Find $P(X+Y \leqslant 1)$

Course Outcome 3(CO3):

1. A random process $X(t)$ is defined by $acos(\omega t+\Theta)$where a and ω are constants and Θ is uniformly distributed in$[0,2\pi]$. Show that $X(t)$ is WSS

2. How are the autocorrelation function and power spectral density of a WSS process are related to each other?

3. Find the power spectral density of the WSS random process $X(t)$, given the autocorrelation function $R_X(\tau)=9e^{-|\tau|}$

4. A conversation in a wireless ad-hoc network is severely disturbed by interference signals according to a Poisson process of rate $\lambda=0.01$ per minute. (a) What is the probability that no interference signals occur within the first two minutes of the conversation? (b) Given that the first two minutes are free of disturbing effects, what is the probability that in the next minute precisely 1 interfering signal disturbs the conversation? (c) Given that there was only 1 interfering signal in the first 3 minutes, what is the probability that there would be utmost 2 disturbances in the first 4 minutes?

Course Outcome 4(CO4):

1. Use Newton-Raphson method to find a real root of the equation $f(x)=e^{2x}-x-6$correct to 4 decimal places.

2. Compare Newton's divided difference method and Lagrange's method of interpolation.

3. Use Newton's forward interpolation formula to compute the approximate values of the function $f$at $x=0.25$from the following table of values of $x$and $f(x)$

x	0	0.5	1	1.5	2
f(x)	1.0000	1.0513	1.1052	1.1618	1.2214

4. Find a polynomial of degree 3 or less the graph of which passes through the points (-1, 3), (0,-4), (1,5) and (2,-6)

Course Outcome 5 (CO5):

1. Apply Gauss-Seidel method to solve the following system of equations
$$4x_1 - x_2 - x_3 = 3$$
$$-2x_1 + 6x_2 + x_3 = 9$$
$$-x_1 + x_2 + 7x_3 = -6$$

2. Using the method of least squares fit a straight line of the form $y = ax + b$to the following set of ordered pairs (x, y) :
(2,4), (3,5), (5,7), (7,10), (9,15)

3. Write the normal equations for fitting a curve of the form $y = a_0 + a_1x^2$to a given set of pairs of data points.

4. Use Runge-Kutta method of fourth order to compute $y(0.25)$and $y(0.5)$, given the initial value problem
$$y' = x + xy + y, y(0) = 1$$

Syllabus

Module 1 (Discrete probability distributions) 9 hours

(Text-1: *Relevant topics* from sections-3.1-3.4, 3.6, 5.1)

Discrete random variables and their probability distributions, Expectation, mean and variance, Binomial distribution, Poisson distribution, Poisson approximation to the binomial distribution, Discrete bivariate distributions, marginal distributions, Independent random variables, Expectation (multiple random variables)

Module 2 (Continuous probability distributions) 9 hours

(Text-1:*Relevant topics* from sections-4.1-4.4, 3.6, 5.1)

Continuous random variables and their probability distributions, Expectation, mean and variance, Uniform, exponential and normal distributions, Continuous bivariate distributions, marginal distributions, Independent random variables, Expectation (multiple random variables), i. i. d random variables and Central limit theorem (without proof).

Module 3 (Random Processes) 9 hours

(Text-2: *Relevant topics* from sections-8.1-8.5, 8.7, 10.5)

Random processes and classification, mean and autocorrelation, wide sense stationary (WSS) processes, autocorrelation and power spectral density of WSS processes and their properties, Poisson process-distribution of inter-arrival times, combination of independent Poisson processes(merging) and subdivision (splitting) of Poisson processes (**results without proof**).

Module 4 (Numerical methods -I) 9 hours

(Text 3- *Relevant topics* from sections 19.1, 19.2, 19.3, 19.5)

Errors in numerical computation-round-off, truncation and relative error, Solution of equations – Newton-Raphson method and Regula-Falsi method. Interpolation-finite differences, Newton's forward and backward difference method, Newton's divided difference method and Lagrange's method. Numerical integration-Trapezoidal rule and Simpson's 1/3rd rule (**Proof or derivation of the formulae not required for any of the methods in this module**)

Module 5 (Numerical methods -II) 9 hours

(Text 3- *Relevant topics* from sections 20.3, 20.5, 21.1)

Solution of linear systems-Gauss-Seidel and Jacobi iteration methods. Curve fitting-method of least squares, fitting straight lines and parabolas. Solution of ordinary differential equations-Euler and Classical Runge-Kutta method of second and fourth order, Adams-Moulton predictor-correction method (**Proof or derivation of the formulae not required for any of the methods in this module**)

Text Books

1. (Text-1) Jay L. Devore, *Probability and Statistics for Engineering and the Sciences*, 8th edition, Cengage, 2012
2. (Text-2) Oliver C. Ibe, *Fundamentals of Applied Probability and Random Processes,* Elsevier, 2005.
3. (Text-3) Erwin Kreyszig, *Advanced Engineering Mathematics*, 10 th Edition, John Wiley & Sons, 2016.

Reference Books

1. Hossein Pishro-Nik, *Introduction to Probability, Statistics and Random Processes*, Kappa Research, 2014 (Also available online at www.probabilitycourse.com)
2. V.Sundarapandian, *Probability, Statistics and Queueing theory*, PHI Learning, 2009
3. Gubner, *Probability and Random Processes for Electrical and Computer Engineers*, Cambridge University Press,2006.
4. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 36 Edition, 2010.

Assignments

Assignments should include specific problems highlighting the applications of the methods introduced in this course in physical sciences and engineering.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Discrete Probability distributions**	**9 hours**
1.1	Discrete random variables and probability distributions, expected value, mean and variance (discrete)	3
1.2	Binomial distribution-mean, variance, Poisson distribution-mean, variance, Poisson approximation to binomial	3
1.3	Discrete bivariate distributions, marginal distributions, Independence of random variables (discrete), Expected values	3
2	**Continuous Probability distributions**	**9 hours**
2.1	Continuous random variables and probability distributions, expected value, mean and variance (continuous)	2
2.2	Uniform, exponential and normal distributions, mean and variance of these distributions	4
2.3	Continuous bivariate distributions, marginal distributions, Independent random variables, Expected values, Central limit theorem.	3
3	**Random processes**	**9 hours**
3.1	Random process -definition and classification, mean , autocorrelation	2
3.2	WSS processes its autocorrelation function and properties	2
3.3	Power spectral density	2
3.4	Poisson process, inter-distribution of arrival time, merging and splitting	3
4	**Numerical methods-I**	**9 hours**
4.1	Roots of equations- Newton-Raphson, regulafalsi methods	2
4.2	Interpolation-finite differences, Newton's forward and backward formula,	3
4.3	Newton's divided difference method, Lagrange's method	2
4.3	Numerical integration-trapezoidal rule and Simpson's 1/3-rd rule	2
5	**Numerical methods-II**	**9 hours**
5.1	Solution of linear systems-Gauss-Siedal method, Jacobi iteration	2

	method	
5.2	Curve-fitting-fitting straight lines and parabolas to pairs of data points using method of least squares	2
5.3	Solution of ODE-Euler and Classical Runge-Kutta methods of second and fourth order	4
5.4	Adams-Moulton predictor-corrector method	1

SEMESTER -4

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MCN202	CONSTITUTION OF INDIA		2	0	0	NIL

Preamble:

The study of their own country constitution and studying the importance environment as well as understanding their own human rights help the students to concentrate on their day to day discipline. It also gives the knowledge and strength to face the society and people.

Prerequisite: Nil

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

CO 1	Explain the background of the present constitution of India and features.
CO 2	Utilize the fundamental rights and duties.
CO 3	Understand the working of the union executive, parliament and judiciary.
CO 4	Understand the working of the state executive, legislature and judiciary.
CO 5	Utilize the special provisions and statutory institutions.
CO 6	Show national and patriotic spirit as responsible citizens of the country

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

1 Discuss the historical background of the Indian constitution.

2 Explain the salient features of the Indian constitution.

3 Discuss the importance of preamble in the implementation of constitution.

Course Outcome 2 (CO2)

1 What are fundamental rights ? Examine each of them.

2 Examine the scope of freedom of speech and expression underlying the constitution.

3 The thumb impression of an accused is taken by the police against his will. He contends that this is a violation of his rights under Art 20(3) of the constitution. Decide.

Course Outcome 3(CO3):

1 Explain the powers of the President to suspend the fundamental rights during emergency.

2 Explain the salient features of appeal by special leave.

3. List the constitutional powers of President.

Course Outcome 4 (CO4):

1 Discuss the constitutional powers of Governor.

2 Examine the writ jurisdiction of High court.

3 Discuss the qualification and disqualification of membership of state legislature.

Course Outcome 5 (CO5):

1 Discuss the duties and powers of comptroller of auditor general.

2 Discuss the proclamation of emergency.

3 A state levies tax on motor vehicles used in the state, for the purpose of maintaining roads in the state. X challenges the levy of the tax on the ground that it violates the freedom of interstate commerce guaranteed under Art 301. Decide.

Course Outcome 6 (CO6):

1 Explain the advantages of citizenship.

2 List the important principles contained in the directive principles of state policy.

3 Discuss the various aspects contained in the preamble of the constitution

Model Question paper

PART A

(Answer all questions. Each question carries 3 marks)

1 Define and explain the term constitution.

2 Explain the need and importance of Preamble.

3 What is directive principle of state policy?

4 Define the State.

5 List the functions of Attorney general of India.

6 Explain the review power of Supreme court.

7 List the qualifications of Governor.

8 Explain the term and removal of Judges in High court.

9 Explain the powers of public service commission.

10 List three types of emergency under Indian constitution.

(10X3=30marks)

PART B

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

Module 1

11 Discuss the various methods of acquiring Indian citizenship.

12 Examine the salient features of the Indian constitution.

Module 2

13 A high court passes a judgement against X. X desires to file a writ petition in the supreme court under Art32, on the ground that the judgement violates his fundamental rights. Advise him whether he can do so.

14 What is meant by directive principles of State policy? List the directives.

Module3

15 Describe the procedure of election and removal of the President of India.

16 Supreme court may in its discretion grant special leave to appeal. Examine the situation.

Module 4

17 Discuss the powers of Governor.

18 X filed a writ petition under Art 226 which was dismissed. Subsequently, he filed a writ petition under Art 32 of the constitution, seeking the same remedy. The Government argued that the writ petition should be dismissed, on the ground of res judicata. Decide.

Module 5

19 Examine the scope of the financial relations between the union and the states.

20 Discuss the effects of proclamation of emergency.

(14X5=70marks)

Syllabus

Module 1 Definition, historical back ground, features, preamble, territory, citizenship.

Module 2 State, fundamental rights, directive principles, duties.

Module 3 The machinery of the union government.

Module 4 Government machinery in the states

Module 5 The federal system, Statutory Institutions, miscellaneous provisions.

Text Books

1 D D Basu, Introduction to the constitution of India, Lexis Nexis, New Delhi, 24e, 2019

2 PM Bhakshi, The constitution of India, Universal Law, 14e, 2017

Reference Books

1 Ministry of law and justice, The constitution of India, Govt of India, New Delhi, 2019.

2 JN Pandey, The constitutional law of India, Central Law agency, Allahabad, 51e, 2019

3 MV Pylee, India's Constitution, S Chand and company, New Delhi, 16e, 2016

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1**	
1.1	Definition of constitution, historical back ground, salient features of the constitution.	1
1.2	Preamble of the constitution, union and its territory.	1
1.3	Meaning of citizenship, types, termination of citizenship.	2
2	**Module 2**	
2.1	Definition of state, fundamental rights, general nature, classification, right to equality ,right to freedom , right against exploitation	2

2.2	Right to freedom of religion, cultural and educational rights, right to constitutional remedies. Protection in respect of conviction for offences.	2
2.3	Directive principles of state policy, classification of directives, fundamental duties.	2
3	**Module 3**	
3.1	The Union executive, the President, the vice President, the council of ministers, the Prime minister, Attorney-General, functions.	2
3.2	The parliament, composition, Rajya sabha, Lok sabha, qualification and disqualification of membership, functions of parliament.	2
3.3	Union judiciary, the supreme court, jurisdiction, appeal by special leave.	1
4	**Module 4**	
4.1	The State executive, the Governor, the council of ministers, the Chief minister, advocate general, union Territories.	2
4.2	The State Legislature, composition, qualification and disqualification of membership, functions.	2
4.3	The state judiciary, the high court, jurisdiction, writs jurisdiction.	1
5	**Module 5**	
5.1	Relations between the Union and the States, legislative relation, administrative relation, financial Relations, Inter State council, finance commission.	1
5.2	Emergency provision, freedom of trade commerce and inter course, comptroller and auditor general of India, public Services, public service commission, administrative Tribunals.	2
5.3	Official language, elections, special provisions relating to certain classes, amendment of the Constitution.	2

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
			2	0	0	2
EST 200	DESIGN AND ENGINEERING					

Preamble:

The purpose of this course is to

i) introduce the undergraduate engineering studentsthe fundamental principles of design engineering,

ii) make them understand the steps involved in the design process and

iii) familiarize them with the basic tools used and approaches in design.

Students are expected to apply design thinking in learning as well as while practicing engineering, which is very important and relevant for today. Case studies from various practical situations will help the students realize that design is not only concerned about the function but also many other factors like customer requirements, economics, reliability, etc. along with a variety of life cycle issues.

The course will help students to consider aesthetics, ergonomics and sustainability factors in designs and also to practice professional ethics while designing.

Prerequisite:

Nil. The course will be generic to all engineering disciplines and will not require specialized preparation or prerequisites in any of the individual engineering disciplines.

Course Outcomes:

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

CO 1	Explain the different concepts and principles involved in design engineering.
CO 2	Apply design thinking while learning and practicing engineering.
CO 3	Develop innovative, reliable, sustainable and economically viable designs incorporating knowledge in engineering.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Continuous Internal Evaluation (CIE) Pattern:

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

End Semester Examination (ESE) Pattern: There will be two parts; Part A and Part B.
Part A : 30 marks
part B : 70 marks
Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.
Part B contains 2 case study questions from each module of which student should answer any one. Each question carry 14 marks and can have maximum 2 sub questions.

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	5	5	10
Understand	10	10	20
Apply	35	35	70
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1): Appreciate the different concepts and principles involved in design engineering.

1. State how engineering design is different from other kinds of design

2. List the different stages in a design process.

3. Describedesign thinking.

4. State the function of prototyping and proofing in engineering design.

5. Write notes on the following concepts in connection with design engineering 1) Modular Design, 2) Life Cycle Design , 3) Value Engineering, 4) Concurrent Engineering, and 5) Reverse Engineering

6. State design rights.

Course Outcome 2 (CO2) Apply design thinking while learning and practicing engineering.

1. Construct the iterative process for design thinking in developing simple products like a pen, umbrella, bag, etc.

2. Show with an example how divergent-convergent thinking helps in generating alternative designs and then how to narrow down to the best design.

3. Describe how a problem-based learning helps in creating better design engineering solutions.

4. Discuss as an engineer, how ethics play a decisive role in your designs

Course Outcome 3(CO3): Develop innovative, reliable, sustainable and economically viable designs incorporating different segments of knowledge in engineering.

1. Illustratethe development of any simple product by passing through the different stages of design process

2. Show thegraphical design communication with the help of detailed 2D or 3D drawings for any simple product.

3. Describe how to develop new designs for simple products through bio-mimicry.

Model Question paper

Page 1 of 2

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION

Course Code: EST 200

Course Name: DESIGN AND ENGINEERING

Max. Marks: 100Duration: 3 Hours

PART A

Answer all questions, each question carries 3 marks
Use only hand sketches

(1)Write aboutthe basic design process.

(2) Describe how to finalize the design objectives.

(3) State the role of divergent-convergent questioning in design thinking.

(4) Discuss how to perform design thinking in a team managing the conflicts.

(5) Show how engineering sketches and drawings convey designs.

(6)Explain the role of mathematics and physics in design engineering process.

(7) Distinguish between project-based learning and problem-based learning in design engineering.

(8) Describe how concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?

(9) Show how designs are varied based on the aspects of production methods, life span, reliability and environment?

(10) Explain how economics influence the engineering designs?

(10x3 marks =30 marks)

Part B

Answer any ONE question from each module. Each question carry 14 marks

Module 1

(11) Show the designing of a wrist watch going through the various stages of the design process. Use hand sketches to illustrate the processes.

or

(12)Find the customer requirements for designing a new car showroom. Show how the design objectives were finalized considering the design constraints?

Module 2

(13)Illustrate the design thinking approach for designing a bag for college students within a limited budget. Describe each stage of the process and the iterative procedure involved. Use hand sketches to support your arguments.

or

(14)Construct a number of possible designs and then refine them to narrow down to the best design for a drug trolley used in hospitals. Show how the divergent-convergent thinking helps in the process. Provide your rationale for each step by using hand sketches only.

Module 3

(15) Graphically communicate the design of a thermo flask used to keep hot coffee. Draw the detailed 2D drawings of the same with design detailing, material selection, scale drawings, dimensions, tolerances, etc. Use only hand sketches.

or

(16)Describe the role of mathematical modelling in design engineering. Show how mathematics and physics play a role in designing a lifting mechanism to raise 100 kg of weight to a floor at a height of 10 meters in a construction site.

Module 4

(17) Show the development of a nature inspired design for a solar poweredbus waiting shed beside a highway. Relate between natural and man-made designs. Use hand sketches to support your arguments.

or

(18)Show the design of a simple sofa and then depict how the design changes when considering 1) aesthetics and 2) ergonomics into consideration. Give hand sketches and explanations to justify the changes in designs.

Module 5

(19)Examine the changes in the design of a foot wear with constraints of 1) production methods, 2) life span requirement, 3) reliability issues and 4) environmental factors. Use hand sketches and give proper rationalization for the changes in design.

or

(20)Describe the how to estimate the cost of a particular design using ANY of the following: i) a website, ii) the layout of a plant, iii) the elevation of a building, iv) anelectrical or electronic system or device and v) a car.

Show how economics will influence the engineering designs. Use hand sketches to support your arguments.

(5x14 marks =70 marks)

Syllabus

Module 1

Design Process:- Introduction to Design and Engineering Design, Defining a Design Process-:Detailing Customer Requirements, Setting Design Objectives, Identifying Constraints, Establishing Functions, Generating Design Alternatives and Choosing a Design.

Module 2

Design Thinking Approach:-Introduction to Design Thinking, Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. Design Thinking as Divergent-Convergent Questioning. Design Thinking in a Team Environment.

Module 3

Design Communication (Languages of Engineering Design):-Communicating Designs Graphically, Communicating Designs Orally and in Writing. Mathematical Modeling In Design, Prototyping and Proofing the Design.

Module 4

Design Engineering Concepts:-Project-based Learning and Problem-based Learning in Design.Modular Design and Life Cycle Design Approaches. Application of Bio-mimicry,Aesthetics and Ergonomics in Design. Value Engineering, Concurrent Engineering, and Reverse Engineering in Design.

Module 5

Expediency, Economics and Environment in Design Engineering:-Design for Production, Use, and Sustainability. Engineering Economics in Design. Design Rights. Ethics in Design

Text Books

1) YousefHaik, SangarappillaiSivaloganathan, Tamer M. Shahin, Engineering Design Process, Cengage Learning 2003, Third Edition, ISBN-10: 9781305253285,

2) Voland, G., Engineering by Design, Pearson India 2014, Second Edition, ISBN 9332535051

Reference Books

1.Philip Kosky, Robert Balmer, William Keat, George Wise, Exploring Engineering, Fourth Edition: An Introduction to Engineering and Design, Academic Press 2015, 4th Edition, ISBN: 9780128012420.

2. Clive L. Dym, Engineering Design: A Project-Based Introduction, John Wiley & Sons, New York 2009, Fourth Edition, ISBN: 978-1-118-32458-5

3. Nigel Cross, Design Thinking: Understanding How Designers Think and Work, Berg Publishers 2011, First Edition, ISBN: 978-1847886361

4. Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H., Engineering Design: A Systematic Approach, Springer 2007, Third Edition, ISBN 978-1-84628-319-2

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Module 1: Design Process**	
1.1	Introduction to Design and Engineering Design. *What does it mean to design something? How Is engineering design different from other kinds of design? Where and when do engineers design? What are the basic vocabularyin engineering design? How to learn and do engineering design.*	1
1.2	*Defining a Design Process*-: Detailing Customer Requirements. *How to do engineering design? Illustrate the process with an example. How to identify the customer requirements of design?*	1
1.3	*Defining a Design Process*-: Setting Design Objectives, Identifying Constraints, Establishing Functions. *How to finalize the design objectives? How to identify the design constraints? How to express the functions a design in engineering terms?*	1
1.4	*Defining a Design Process*-: Generating Design Alternatives and Choosing a Design. *How to generate or create feasible design alternatives? How to identify the "best possible design"?*	1
1.5	Case Studies:- Stages of Design Process. *Conduct exercises for designing simple products going through the different stages of design process.*	1
2	**Module 2: Design Thinking Approach**	
2.1	Introduction to Design Thinking *How does the design thinking approach help engineers in creating innovative and efficient designs?*	1
2.2	Iterative Design Thinking Process Stages: Empathize, Define, Ideate, Prototype and Test. *How can the engineers arrive at better designs utilizing the iterative design thinking process (in which knowledge acquired in the later stages can be applied back to the earlier stages)?*	1
2.3	Design Thinking as Divergent-Convergent Questioning. *Describe how to create a number of possible designs and then how to refine and narrow down to the 'best design'.*	1
2.4	Design Thinking in a Team Environment. *How to perform design thinking as a team managing the conflicts ?*	1
2.5	Case Studies: Design Thinking Approach. *Conduct exercises using the design thinking approach for*	1

	designing any simple products within a limited time and budget	
3	**Module 3: Design Communication (Languages of Engineering Design)**	
3.1	Communicating Designs Graphically. *How do engineering sketches and drawings convey designs?*	1
3.2	Communicating Designs Orally and in Writing. *How can a design be communicated through oral presentation or technical reports efficiently?*	1
	First Series Examination	
3.3	Mathematical Modelling in Design. *How do mathematics and physics become a part of the design process?*	1
3.4	Prototyping and Proofing the Design. *How to predict whether the design will function well or not?*	1
3.5	Case Studies: Communicating Designs Graphically. *Conduct exercises for design communication through detailed 2D or 3D drawings of simple products with design detailing, material selection, scale drawings, dimensions, tolerances, etc.*	1
4	**Module 4: Design Engineering Concepts**	
4.1	Project-based Learning and Problem-based Learning in Design. *How engineering students can learn design engineering through projects?* *How students can take up problems to learn design engineering?*	1
4.2	Modular Design and Life Cycle Design Approaches. *What is modular approach in design engineering? How it helps?* *How the life cycle design approach influences design decisions?*	1
4.3	Application of Bio-mimicry, Aesthetics and Ergonomics in Design. *How do aesthetics and ergonomics change engineering designs?* *How do the intelligence in nature inspire engineering designs? What are the common examples of bio-mimicry in engineering?*	1
4.4	Value Engineering, Concurrent Engineering, and Reverse Engineering in Design. *How do concepts like value engineering , concurrent engineering and reverse engineering influence engineering designs?*	1
4.5	Case Studies: Bio-mimicry based Designs. *Conduct exercises to develop new designs for simple*	1

	products using bio-mimicry and train students to bring out new nature inspired designs.	
5	**Module 5: Expediency, Economics and Environment in Design Engineering**	
5.1	Design for Production, Use, and Sustainability. *How designs are finalized based on the aspects of production methods, life span, reliability and environment?*	1
5.2	Engineering Economics in Design. *How to estimate the cost of a particular design and how will economics influence the engineering designs?*	1
5.3	Design Rights. *What are design rights and how can an engineer put it into practice?*	1
5.4	Ethics in Design. *How do ethics play a decisive role in engineering design?*	1
5.5	Case Studies: Design for Production, Use, and Sustainability. *Conduct exercises using simple products to show how designs change with constraints of production methods, life span requirement, reliability issues and environmental factors.*	1
Second Series Examination		

Code.	Course Name	L	T	P	Hrs	Credit
HUT 200	Professional Ethics	2	0	0	2	2

Preamble: To enable students to create awareness on ethics and human values.

Prerequisite: Nil

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

CO 1	Understand the core values that shape the ethical behaviour of a professional.
CO 2	Adopt a good character and follow an ethical life.
CO 3	Explain the role and responsibility in technological development by keeping personal ethics and legal ethics.
CO 4	Solve moral and ethical problems through exploration and assessment by established experiments.
CO 5	Apply the knowledge of human values and social values to contemporary ethical values and global issues.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO 1								2			2	
CO 2								2			2	
CO 3								3			2	
CO 4								3			2	
CO 5								3			2	

Assessment Pattern

Bloom's category	Continuous Assessment Tests		End Semester Exam
	1	2	
Remember	15	15	30
Understood	20	20	40
Apply	15	15	30

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	:	10 marks
Continuous Assessment Tests (2 Nos)	:	25 marks
Assignments/Quiz	:	15 marks

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

Course Level Assessment Questions

Course Outcome 1 (CO1):
1. Define integrity and point out ethical values.
2. Describe the qualities required to live a peaceful life.
3. Explain the role of engineers in modern society.

Course Outcome 2 (CO2)
1. Derive the codes of ethics.
2. Differentiate consensus and controversy.
3. Discuss in detail about character and confidence.

Course Outcome 3(CO3):
1. Explain the role of professional's ethics in technological development.
2. Distinguish between self interest and conflicts of interest.
3. Review on industrial standards and legal ethics.

Course Outcome 4 (CO4):
1. Illustrate the role of engineers as experimenters.
2. Interpret the terms safety and risk.
3. Show how the occupational crimes are resolved by keeping the rights of employees.

Course Outcome 5 (CO5):
1. Exemplify the engineers as managers.
2. Investigate the causes and effects of acid rain with a case study.
3. Explorate the need of environmental ethics in technological development.

Model Question paper

QP CODE: **Reg No:**_____

PAGES:3 **Name :**_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD/FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: HUT 200

Course Name: PROFESSIONAL ETHICS

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

(2019-Scheme)

PART A

(Answer all questions, each question carries 3 marks)

1. Define empathy and honesty.
2. Briefly explain about morals, values and ethics.
3. Interpret the two forms of self-respect.
4. List out the models of professional roles.
5. Indicate the advantages of using standards.
6. Point out the conditions required to define a valid consent?
7. Identify the conflicts of interests with an example?
8. Recall confidentiality.
9. Conclude the features of biometric ethics.
10. Name any three professional societies and their role relevant to engineers.

(10x3 = 30 marks)

PART B

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

MODULE I

11. a) Classify the relationship between ethical values and law?

b) Compare between caring and sharing. (10+4 = 14 marks)

Or

12. a) Exemplify a comprehensive review about integrity and respect for others.

b) Discuss about co-operation and commitment. (8+6 = 14 marks)

MODULE II

13.a) Explain the three main levels of moral developments, deviced by Kohlberg.

b) Differentiate moral codes and optimal codes. (10+4 = 14 marks)

Or

14. a) Extrapolate the duty ethics and right ethics.

b) Discuss in detail the three types of inquiries in engineering ethics (8+6 = 14 marks)

MODULE III

15.**a)** Summarize the following features of morally responsible engineers.

(i) Moral autonomy **(ii)** Accountability

b)Explain the rights of employees (8+6 = 14 marks)

Or

16. a) Explain the reasons for Chernobyl mishap ?

b) Describe the methods to improve collegiality and loyalty. (8+6 = 14 marks)

MODULE IV

17.a) Execute collegiality with respect to commitment, respect and connectedness.

b) Identify conflicts of interests with an example. (8+6 = 14 marks)

Or

18. a) Explain in detail about professional rights and employee rights.

b) Exemplify engineers as managers.

MODULE V

19.**a)** Evaluate the technology transfer and appropriate technology.

b) Explain about computer and internet ethics. (8+6 = 14 marks)

Or

20. a) Investigate the causes and effects of acid rain with a case study.

b) Conclude the features of ecocentric and biocentric ethics. (8+6 = 14 marks)

Syllabus

Module 1 – Human Values.

Morals, values and Ethics – Integrity- Academic integrity-Work Ethics- Service Learning- Civic Virtue- Respect for others- Living peacefully- Caring and Sharing- Honestly- courage-Cooperation commitment- Empathy-Self Confidence -Social Expectations.

Module 2 - Engineering Ethics & Professionalism.

Senses of Engineering Ethics - Variety of moral issues- Types of inquiry- Moral dilemmas –Moral Autonomy – Kohlberg's theory- Gilligan's theory- Consensus and Controversy-Profession and Professionalism- Models of professional roles-Theories about right action –Self interest-Customs and Religion- Uses of Ethical Theories.

Module 3- Engineering as social Experimentation.

Engineering as Experimentation – Engineers as responsible Experimenters- Codes of Ethics- Plagiarism- A balanced outlook on law - Challenges case study- Bhopal gas tragedy.

Module 4- Responsibilities and Rights.

Collegiality and loyalty – Managing conflict- Respect for authority- Collective bargaining- Confidentiality- Role of confidentiality in moral integrity-Conflicts of interest- Occupational crime- Professional rights- Employee right- IPR Discrimination.

Module 5- Global Ethical Issues.

Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics -Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors-Moral leadership.

Text Book

1. M Govindarajan, S Natarajan and V S Senthil Kumar, Engineering Ethics, PHI Learning Private Ltd, New Delhi,2012.
2. R S Naagarazan, A text book on professional ethics and human values, New age international (P) limited ,New Delhi,2006.

Reference Books

1. Mike W Martin and Roland Schinzinger, Ethics in Engineering,4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi,2014.
2. Charles D Fleddermann, Engineering Ethics, Pearson Education/ Prentice Hall of India, New Jersey,2004.
3. Charles E Harris, Michael S Protchard and Michael J Rabins, Engineering Ethics- Concepts and cases, Wadsworth Thompson Learning, United states,2005.
4. http://www.slideword.org/slidestag.aspx/human-values-and-Professional-ethics.

Course Contents and Lecture Schedule

SL.No	Topic	No. of Lectures 25
1	**Module 1 – Human Values.**	
1.1	Morals, values and Ethics, Integrity, Academic Integrity,Work Ethics	1
1.2	Service Learning, Civic Virtue, Respect for others, Living peacefully	1
1.3	Caring and Sharing, Honesty, Courage, Co-operation commitment	2
1.4	Empathy, Self Confidence, Social Expectations	1
2	**Module 2- Engineering Ethics & Professionalism.**	
2.1	Senses of Engineering Ethics, Variety of moral issues, Types of inquiry	1
2.2	Moral dilemmas, Moral Autonomy, Kohlberg's theory	1
2.3	Gilligan's theory, Consensus and Controversy,Profession& Professionalism, Models of professional roles, Theories about right action	2
2.4	Self interest-Customs and Religion, Uses of Ethical Theories	1
3	**Module 3- Engineering as social Experimentation.**	
3.1	Engineering as Experimentation, Engineers as responsible Experimenters	1
3.2	Codes of Ethics,Plagiarism, A balanced outlook on law	2
3.3	Challenger case study, Bhopal gas tragedy	2
4	**Module 4- Responsibilities and Rights.**	
4.1	Collegiality and loyalty, Managing conflict, Respect for authority	1
4.2	Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Conflicts of interest	2
4.3	Occupational crime, Professional rights, Employee right, IPR Discrimination	2
5	**Module 5- Global Ethical Issues.**	
5.1	Multinational Corporations, Environmental Ethics, Business Ethics, Computer Ethics	2
5.2	Role in Technological Development, Moral leadership	1
5.3	Engineers as Managers, Consulting Engineers, Engineers as Expert witnesses and advisors	2

SEMESTER -4

ECT202	ANALOG CIRCUITS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to develop the skill of analyse and design of different types of analog circuits using discrete electronic components.

Prerequisite: EST130 Basics of Electrical and Electronics Engineering

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

CO 1	Design analog signal processing circuits using diodes and first order RC circuit
CO 2	Analyse basic amplifiers using BJT and MOSFET
CO 3	Apply the principle of oscillator and regulated power supply circuits.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	20	20	20
Apply	K3	20	20	70
Analyse	K4			
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Design analog signal processing circuits using diodes and first order RC circuit.

1. For the given specification design a differentiator / integrator circuit.
2. For the given transfer characteristics design clipping / clamping circuit.
3. Design first order RC low-pass / high-pass circuit for the given specification.

Course Outcome 2 (CO2): Analyse basic amplifiers using BJT.

1. For the given transistor biasing circuit, determine the resistor values, biasing currents and voltages.
2. Design a RC coupled amplifier for a given gain.
3. Analyse the frequency response of BJT RC coupled amplifier using hybrid π model.

Course Outcome 2 (CO2): Analyse basic amplifiers using MOSFET.

1. Perform DC analysis of MOSFET circuits.
2. Design a common source amplifier.
3. Deduce the expression for voltage gain of CS stage with diode-connected load.

Course Outcome 2 (CO2): Analyse basic feedback amplifiers using BJT and MOSFET

1. Deduce the expression for voltage gain, input impedance and output impedance of the four feedback amplifier topologies.
2. Design practical discrete amplifiers for the four feedback amplifier topologies.

Course Outcome 3 (CO3): Apply the principle of oscillator and regulated power supply.

1. Design oscillator using BJT to generate sine wave for the given frequency.
2. Deduce the expression for maximum efficiency of class B power amplifiers.
3. Illustrate the DC and AC load line in transformer coupled class A power amplifiers.
4. Design voltage regulator for the given specifications.

SYLLABUS

Module 1:

Wave shaping circuits: First order RC differentiating and integrating circuits, First order RC low pass and high pass filters.

Diode Clipping circuits - Positive, negative and biased clipper. Diode Clamping circuits - Positive, negative and biased clamper.

Transistor biasing: Need, operating point, concept of DC load line, fixed bias, self bias, voltage divider bias, bias stabilization.

Module 2:

BJT Amplifiers: RC coupled amplifier (CE configuration) – need of various components and design, Concept of AC load lines, voltage gain and frequency response.

Small signal analysis of CE configuration using small signal hybrid-pi model for mid frequency and low frequency. (gain, input and output impedance).

High frequency equivalent circuits of BJT, Miller effect, Analysis of high frequency response of CE amplifier.

Module 3:

MOSFET amplifiers: MOSFET circuits at DC, MOSFET as an amplifier, Biasing of discrete MOSFET amplifier, small signal equivalent circuit. Small signal voltage and current gain, input and output impedance of CS configuration. CS stage with current source load, CS stage with diode-connected load.

Multistage amplifiers - effect of cascading on gain and bandwidth. Cascode amplifier.

Module 4 :

Feedback amplifiers: Effect of positive and negative feedback on gain, frequency response and distortion. The four basic feedback topologies, Analysis of discrete BJT circuits in voltage-series and voltage-shunt feedback topologies - voltage gain, input and output impedance.

Oscillators: Classification, criterion for oscillation, Wien bridge oscillator, Hartley and Crystal oscillator. (working principle and design equations of the circuits; analysis of Wien bridge oscillator only required).

Module 5:

Power amplifiers: Classification, Transformer coupled class A power amplifier, push pull class B and class AB power amplifiers, complementary-symmetry class B and Class AB power amplifiers, efficiency and distortion (no analysis required)

Regulated power supplies: Shunt voltage regulator, series voltage regulator, Short circuit protection and fold back protection, Output current boosting.

Text Books

1. Robert Boylestad and L Nashelsky, “Electronic Devices and Circuit Theory”, 11/e Pearson, 2015.
2. Sedra A. S. and K. C. Smith, “Microelectronic Circuits”, 6/e, Oxford University Press, 2013.

Reference Books

1. Razavi B., “Fundamentals of Microelectronics”, Wiley, 2015
2. Neamen D., “Electronic Circuits, Analysis and Design”, 3/e, TMH, 2007.
3. David A Bell, “Electronic Devices and Circuits”, Oxford University Press, 2008.
4. Rashid M. H., “Microelectronic Circuits - Analysis and Design”, Cengage Learning, 2/e,2011
5. Millman J. and C. Halkias, “Integrated Electronics”, 2/e, McGraw-Hill, 2010.

Course Contents and Lecture Schedule

No	Topic	No. of lectures
1	**Wave shaping circuits**	
1.1	Analysis and design of RC differentiating and integrating circuits	2
1.2	Analysis and design of First order RC low pass and high pass filters	2
1.3	Clipping circuits - Positive, negative and biased clipper	1
1.4	Clamping circuits - Positive, negative and biased clamper	1
	Transistor biasing	
1.5	Need of biasing, operating point, bias stabilization, concept of load line	1
	Design of fixed bias, self bias, voltage divider bias.	2
2	**BJT Amplifiers**	
2.1	Classification of amplifiers, RC coupled amplifier (CE configuration) – need of various components and design, Concept of AC load lines.	2
2.2	Small signal analysis of CE configuration using small signal hybrid π model for mid frequency. (gain, input and output impedance).	3
2.3	High frequency equivalent circuits of BJT, Miller effect, Analysis of high frequency response of CE amplifier. voltage gain and frequency response	4
3	**MOSFET amplifiers**	
3.1	MOSFET circuits at DC, MOSFET as an amplifier, Biasing of discrete MOSFET amplifier,	2
3.2	Small signal equivalent circuit. Small signal voltage and current gain, input and output impedances of CS configuration.	3

3.3	CS stage with current source load, CS stage with diode-connected load.	2
3.4	**Multistage amplifiers** - effect of cascading on gain and bandwidth. Cascode amplifier.	2
4	**Feedback amplifiers**	
4.1	Properties of positive and negative feedback on gain, frequency response and distortion.	1
4.2	Analysis of the four basic feedback topologies	2
4.3	Analysis of discrete circuits in each feedback topologies -voltage gain, input and output impedance	3
	Oscillators	
4.4	Classification, criterion for oscillation	1
	Wien bridge oscillator, Hartley and Crystal oscillator. (working principle and design equations of the circuits; analysis not required).	2
5	**Power amplifiers**	
5.1	Classification, Transformer coupled class A power amplifier	1
5.2	push pull class B and class AB power amplifiers, complementary-symmetry class B and Class AB power amplifiers, efficiency and distortion (no analysis required)	3
	Linear Regulated power supplies	
5.3	Principle of Linear Regulated power supplies, Shunt voltage regulator	1
5.4	Series voltage regulator, Short circuit protection and fold back protection, Output current boosting	2

Assignment:

Atleast one assignment should be simulation of different types of transistor amplifiers on any circuit simulation software.

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

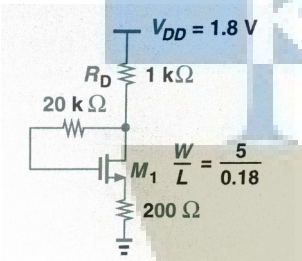
Course Code: ECT202

Course Name: ANALOG CIRCUITS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

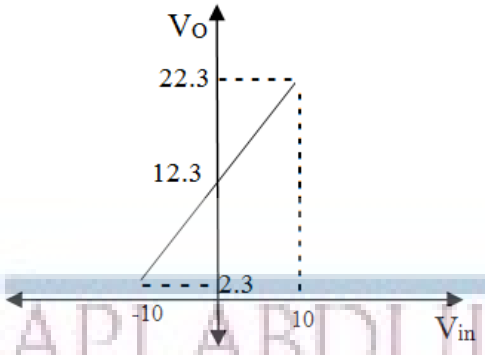
1	Design the first order RC high pass filter with cut off frequency 2Kz.	3	K3
2	Describe about the double ended clipping.	3	K2
3	Differentiate between DC and AC load lines.	3	K2
4	What is the significance of Miller effect on high frequency amplifiers?	3	K1
5	What are the effects of cascading in gain and bandwidth of an amplifier?	3	K1
6	Calculate the drain current if $\mu_n C_{ox}$ = 100 μA/V^2, V_{TH} = 0.5V and λ = 0 in the following circuit. 	3	K3
7	Illustrate the effect of negative feedback on bandwidth and gain of the amplifier.	3	K2
8	Explain the criteria for an oscillator to oscillate.	3	K1
9	How to eliminate cross over distortion in class-B power amplifier?	3	K2
10	What is line regulation and load regulation in the context of a voltage regulator?	3	K2

PART – B

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

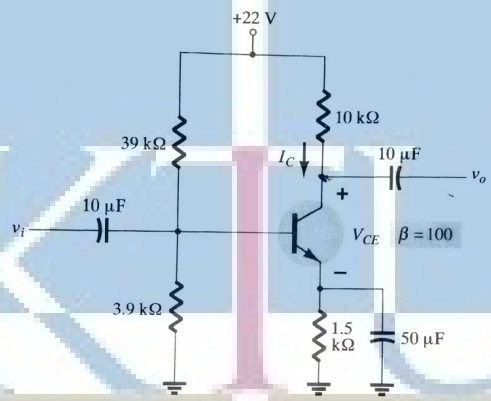
Module - I

11	a	Design a differentiator circuit for a square wave signal with Vpp=10 and frequency 10KHz.	6	CO1 K3
	b.	Design a clamper circuit to get the following transfer characteristics, assuming voltage drop across the diodes 0.7V.	8	CO1 K3



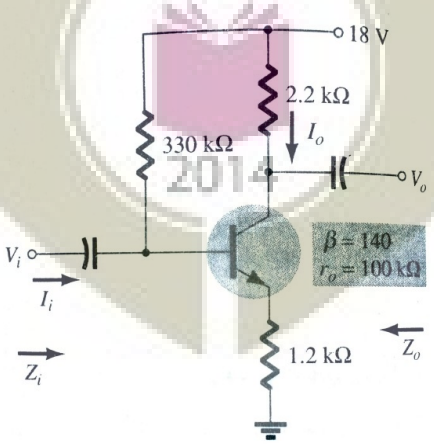
OR

12 a	Explain the working of an RC differentiator circuit for a square wave input with period T. Sketch its output waveform for RC ≫ T, RC ≪ T and RC = T.	5	K2 CO1
b.	With reference to the following circuit, draw the load line and mark the Q point of the Silicon BJT transistor.	9	K3 CO2



Module - II

13	For the following RC coupled amplifier determine r_e , Z_i , Z_o and A_v .	14	K3 CO2



OR

14	a	Draw the high frequency hybrid π model of BJT in CE configuration and explain the significance of each parameter.	6	K2 CO2
	b	Analyse BJT RC coupled amplifier in CE configuration at high frequency using hybrid π model.	8	K2 CO2

Module - III

15	a	Draw the circuit of a common source amplifier using MOSFET. Derive the expressions for voltage gain and input resistance from small signal equivalent circuit.	7	K2 CO2
	b.	How wide bandwidth is obtained in Cascode amplifier ?	7	K2 CO2

OR

16		Draw the CS stage with current source load and deduce the expression for voltage gain of the amplifier	14	K3 CO2

Module - IV

17		Give the block schematic of current-series feedback amplifier configuration and deduce the expression for gain, input impedance and output impedance with feedback. Design a practical circuit for this current-series feedback amplifier.	14	K3 CO2

OR

18	a	Design wein-bridge oscillator using BJT to generate 1KHz sine wave.	8	K3 CO3
	b	Explain the working principle of crystal oscillator	6	K2 CO3

Module - V

19		Illustrate the working principle of complementary-symmetry class B power amplifiers and deduce the maximum efficiency of the circuit	14	K2 CO2

OR

20		Design a discrete series voltage regulator with short circuit protection for regulated output voltage 10V and maximum current 100mA.	14	K3 CO3

Simulation Assignments (ECT202)

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

1. Design and simulate a voltage series feedback amplifier based on BJT/ MOSFET. Observe the input and output signals. Plot the AC frequency response. Observe the Nyquits plot and understand its stability
2. Design and simulate a voltage shunt feedback amplifier based on BJT/ MOSFET. Observe the input and output signals. Plot the AC frequency response. Observe the Nyquits plot and understand its stability
3. Design and simulate series voltage regulator for output voltage $V_O = 10V$ and output current $I_O = 100mA$ with and without short circuit protection and to test the line and load regulations.
4. Design and simulate Wien bridge oscillator for a frequency of $5\,kHz$. Run a transient simulation and observe the output waveform.
5. Design and simulate Colpitts oscillator for a frequency of $455\,kHz$. Run a transient simulation and observe the output waveform.
6. Design and simulate a current series feedback amplifier based on BJT. Observe the input and output signals. Plot the AC frequency response. Observe the Nyquits plot and understand its stability
7. Design and simulate Hartley oscillator for a frequency of $455\,kHz$. Run a transient simulation and observe the output waveform.
8. Design and simulate clipping circuits that clips the $10\,V$ input sinusoid
   - at $+3.5\,V$ and at $-4.2\,V$
   - at $+2.5\,V$ and at $+4.2\,V$
   - at $-2.5\,V$ and at $-4.2\,V$

   with Si diodes

ECT 204	SIGNALS AND SYSTEMS	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This couse aims to lay the foundational aspects of signals and systems in both continuous time and discrete time, in preparation for more advanced subjects in digital signal processing, image processing, communication theory and control systems.

Prerequisite: Nil

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

CO 1	Apply properties of signals and systems to classify them
CO 2	Represent signals with the help of series and transforms
CO 3	Describe orthogonality of signals and convolution integral.
CO 4	Apply transfer function to compute the LTI response to input signals.
CO 5	Apply sampling theorem to discretize continuous time signals

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark distribution

Total	CIE	ESE	ESE Duration

Marks			
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1) : Apply properties of signals and systems to classify them

1. Check whether the following systems are stable, causal, linear, and time-invariant (a) y[n] = x[2n] (b) $y(t) = x^2(t) + 3$ (c) y[n] = nx[n]
2. Plot (a) u(t-1) + u(1-t) (b) u(t-1) – u(t+1) (c) sinc(t/T) (d) r(t) – r(t-2) – 2u(t-2)

Course Outcome 2 (CO2) : Represent signals with the help of series and transforms

1. Compute the Fourier transform of (a) x(t) = 1, -T/2 < t < T/2, and 0 elsewhere (b) x(t) = 1 - (|t|/T), -T < t < T, and 0 elsewhere
2. Show that a square wave has only odd harmonics.
3. State and prove Parsevals theorem

Course Outcome 3 (CO3) : Describe orthogonality of signals and convolution integral.

1. Show that δ(t-a) and δ(t-b), a ≠ b are orthogonal
2. Define convolution of x(t) and h(t)

Course Outcome 4 (CO4) : Apply transfer function to compute the LTI response to input signals.

1. Give the frequency response of a first-order low pass filter. What is the 3-dB cut off frequency?
2. What is the signficance of linear phase response?

Course Outcome 5 (CO5) : Apply sampling theorem to discretize continuous time signals

1. Derive the interpolation formula for finite-energy band-limited signals from its samples.

SYLLABUS

Elementary signals, Continuous time and Discrete time signals and systems, Signal operations, Differential equation representation, Difference equation representation, Continuous time LTI Systems, Discrete time LTI Systems, Correlation between signals, Orthogonality of signals, Frequency domain representation, Continuous time Fourier series, Continuous time Fourier transform, Using Laplace transform to characterize Transfer function, Stability and Causility using ROC of Transfer transform, Frequency response, Sampling, Aliasing, Z transform, Inverse Z transform, Unilateral Z-transform, Frequency domain representation of discrete time signals, Discrete time Fourier series and discrete time Fourier transform (DTFT), Analysis of discrete time LTI systems using the above transforms.

Text Books

1. Alan V. Oppenheim and Alan Willsky, Signals and Systems, PHI, 2/e, 2009

2. Simon Haykin, Signals & Systems, John Wiley, 2/e, 2003

Reference Books

1. Anand Kumar, Signals and Systems, PHI, 3/e, 2013.

2. B P. Lathi, Priciples of Signal Processing & Linear systems, Oxford University Press.

3. Gurung, Signals and System, PHI.

4. Mahmood Nahvi, Signals and System, Mc Graw Hill (India), 2015.

5. P Ramakrishna Rao, Shankar Prakriya, Signals and System, MC Graw Hill Edn 2013.

6. Rodger E. Ziemer, Signals & Systems - Continuous and Discrete, Pearson, 4/e, 2013

Course Contents and Lecture Schedule

Module	Topic	Number of lecture hours
I	Elementary Signals, Classification and representation of continuous time and discrete time signals, Signal operations	4
	Continuous time and discrete time systems – Classification, Properties.	3
	Representation of systems: Differential equation representation of continuous time systems. Difference equation representation of discrete systems.	2
	Continuous time LTI systems and convolution integral.	2

	Discrete time LTI systems and linear convolution.	2
	Stability and causality of LTI systems.	2
	Correlation between signals, Orthogonality of signals.	1
II	Frequency domain representation of continuous time signals - continuous time Fourier series and its properties.	4
	Continuous time Fourier transform and its properties. Convergence and Gibbs phenomenon	3
	Review of Laplace Transform, ROC of Transfer function, Properties of ROC, Stability and causality conditions.	3
	Relation between Fourier and Laplace transforms.	1
III	Analysis of LTI systems using Laplace and Fourier transforms. Concept of transfer function, Frequency response, Magnitude and phase response.	4
	Sampling of continuous time signals, Sampling theorem for lowpass signals, aliasing.	3
IV	Frequency domain representation of discrete time signals, Discrete time fourier series for discrete periodic signals. Properties of DTFS.	4
	Discrete time fourier transform (DTFT) and its properties. Analysis of discrete time LTI systems using DTFT. Magnitude and phase response.	5
V	Z transform, ROC , Inverse transform, properties, Unilateral Z transform.	3
	Relation between DTFT and Z-Transform, Analysis of discrete time LTI systems using Z transforms, Transfer function. Stability and causality using Z transform.	4

Simulation Assignments (ECT 204)

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

1. Generate the following discrete signals
   - Impulse signal
   - Pulse signal and
   - Triangular signal
2. Write a function to compute the DTFT of a discrete energy signal. Test this function on a few signals and plot their magnitude and phase spectra.
3. - Compute the linear convolution between the sequences $x = [1, 3, 5, 3]$ with $h = [2, 3, 5, 6]$. Observe the stem plot of both signals and the convolution.
   - Now let $h = [1, 2, 1]$ and $x = [2, 3, 5, 6, 7]$. Compute the convolution between h and x.
   - Flip the signal x by 180° so that it becomes $[7, 6, 5, 3, 2]$. Convolve it with h. Compare the result with the previous result.
   - Repeat the above two steps with $h = [1, 2, 3, 2, 1]$ and $h = [1, 2, 3, 4, 5, 4, 3, 2, 1]$
   - Give your inference.
4. - Write a function to generate a unit pulse signal as a summation of shifted unit impulse signals
   - Write a function to generate a triangular signal as a convolution between two pulse signals.
5. - Relaize a continuous time LTI system with system response

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

   . One may use *scipy.signal.lti* package in Python.
   - Make it into a discrete system (possibly with *scipy.signal.cont2discrete*)
   - Observe the step response in both cases and compare.

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B Tech Degree Examination

Course: ECT 204 Signals and Systems

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

PART A

Answer All Questions

1	Differentiate between energy and power signal with example.	(3)	K_2
2	Test if the signals $x_1[n] = [1, -2, 3, 1]$ and $x_2[n] = [-1, 2, 1, 2]$ are orthogonal.	(3)	K_3
3	Compute the Fourier transform of $x(t) = \delta(t) + 0.5\delta(t-1)$	(3)	K_2
4	Write the Fourier series for $x(t) = A\cos 2\pi f_c t$ and use it to plot its line spectrum	(3)	K_2
5	Explain the transfer function of an LTI system in the s- domain.	(3)	K_1
6	What is the discrete frequency resulting when a $2\,kHz$ signal is sampled by an $8\,kHz$ sampling signals?	(3)	K_2
7	Give three properties of the ROC pertaining to Z-transform.	(3)	K_1
8	Compute the DTFT of $x[n] = \delta[n] - 2\delta[n-1] + 0.5\delta[n-3]$	(3)	K_3
9	Write the transfer function $H(z)$ of an LTI system described by $$y[n] = 0.3y[n-1] + 0.1y[n-2] + x[n] + 0.2x[n-1]$$	(3)	K_2
10	Give the relation between DTFT and Z transform	(3)	K_2

PART B

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

Module I

11(A)	Test if the following systems are stable and time invariant i. $y[n] = \cos x[n]$ ii. $y[n] = x[n] - x[n-1]$	(8)	K_3
11(B)	Classify the following signals are energy and power signals i. $x[n] = 0.8^n U[n]$ ii. $x[n] = U[n] - U[n-10]$ iii. $x[n] = \cos 2\pi f_0 n$	(6)	K_3

OR

12(A)	Compute the convolution between $U[t] - U[t-5]$ with itself.	(7)	K_3
12(B)	Compute the output of the LTI system with input $x[n] = [1, -1, 2, -2]$ and impulse response $h[n] = [1, 2, 1]$	(7)	K_3

Module II

13(A)	Compute the Fourier transform of the triangular signal $x(t) = A[1 - \frac{\lvert t \rvert}{T}]$	(8)	K_3
13(B)	Compute the Fourier series of a half wave rectified sinusoid with period T and amplitude A	(6)	K_3

OR

14(A)	Compute the Laplace transforms of i. $x(t) = 2e^{-t}U[t] + 0.5e^{-3t}U[t]$ i. $x(t) = 2e^{-3t}\cos 4tU[t]$	(8)	K_3
14(B)	Compute the Fourier transform of a rectangukar pulse with unit amplitude and width T and centred around origin. Plot the Fourier tranform in the frequency domain.	(6)	K_3

Module III

15(A) Define sampling theorem. Determine the Nyquist rate and Nyquist interval for the signal (6) K_2

$$x(t) = \cos \pi t + 3 \sin 2\pi t + \sin 4\pi t$$

15(B) Analyze and characterize the LTI system $x(t)$ using Laplace Transform (8) K_2

$$x(t) = \frac{2}{3}e^{-t}u(t) + \frac{1}{3}e^{2t}u(t)$$

OR

16(A) Obtain the response of an LTI system with impulse response $h(t) = \delta(t)$ with input signal $x(t) = e^{-at}u(t)$ using Fourier transform (6) K_2

16(B) Explain spectral aliasing and the need for anti-aliasing filter with an example spectrum (8) K_2

Module IV

17(A) Describe the magnitude response and phase response of a discrete LTI system with the help of DTFTs. (7) K_2

17(B) Compute the magnitude response of an LTI system described by (7) K_2

$$y[n] = 0.1y[n-1] + 0.1y[n-3] + x[n] + 0.2x[n-1] + 0.1x[n-2]$$

in terms of the DTFTs

OR

18 An LTI system has impulse response $h[n] = (\frac{1}{4})^n U[n]$. Use DTFT to compute the output for each of the following inputs: (i) $x[n] = (\frac{3}{4})^n U[n]$ (ii) $x[n] = (n+1)(\frac{1}{4})^n U[n]$ (iii) $x[n] = (-1)^n$. (14) K_2

Module V

19(A) Compute the inverse Z transform of (7) K_3

$$H(z) = \frac{1}{(1-\frac{1}{2}z^{-1})(1-\frac{1}{5}z^{-1})}$$

for all possible ROCs

19(B) Compute the inverse Z transform of (7) K_3

$$H(z) = cos(\alpha z^{-1})$$

for all possible ROCs

OR

20 Compute the Z-transform with ROC of

i. $x[n] = (\frac{1}{3})^n U[n]$ (4) K_3

ii. $x[n] = n(\frac{1}{3})^n U[n]$ (5) K_3

iii. $x[n] = \sum_{i=-\infty}^{n} (\frac{1}{3})^i U[i]$ (5) K_3

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

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

Prerequisite: NIL

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

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

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	70
Apply	10	10	10
Analyse			
Evaluate			
Create			

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 5 questions with 4 questions (not exceeding 2 questions from each module). Part B contains 2 questions from each module out of which one to be answered. Each question carries 10 mark and can have 2 to 3 sub-divisions.

Course Level Assessment Questions

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

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

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

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

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

Syllabus

Module 1

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

Module 2

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

Module 3

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

Module 4

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

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

Module 5

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

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

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

Text Books

Text books

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

Reference books

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

Course Contents and Lecture Schedule

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

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

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET206

Program: Applied Electronics and Instrumentation Engineering

Course Name: Measurements and Instrumentation

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

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

PART-B

Answer any one question from each module

Module I

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

Module II

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

Module III

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

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

Module IV

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

Module V

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

ECL 202	ANALOG CIRCUITS AND SIMULATION LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This course aims to

(i) familiarize students with the Analog Circuits Design through the implementation of basic Analog Circuits using discrete components.

(ii) familiarize students with simulation of basic Analog Circuits.

Prerequisite: Nil

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

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

Mapping of course outcomes with program outcomes

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

Assessment

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks

Continuous Assessment : 30 marks

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

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

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

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

Part A : List of Experiments using discrete components [Any Six experiments mandatory]

1. RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
2. Clipping and clamping circuits (Transients and transfer characteristics)
3. RC coupled CE amplifier - frequency response characteristics
4. MOSFET amplifier (CS) - frequency response characteristics
5. Cascade amplifier – gain and frequency response
6. Cascode amplifier -frequency response
7. Feedback amplifiers (current series, voltage series) - gain and frequency response
8. Low frequency oscillators –RC phase shift or Wien bridge
9. Power amplifiers (transformer less) - Class B and Class AB
10. Transistor series voltage regulator (load and line regulation)

PART B: Simulation experiments [Any Six experiments mandatory]

The experiments shall be conducted using open tools such as QUCS, KiCad or variants of SPICE.

1. RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
2. Clipping and clamping circuits (Transients and transfer characteristics)
3. RC coupled CE amplifier - frequency response characteristics
4. MOSFET amplifier (CS) - frequency response characteristics
5. Cascade amplifier – gain and frequency response
6. Cascode amplifier – frequency response

7. Feedback amplifiers (current series, voltage series) - gain and frequency response
8. Low frequency oscillators – RC phase shift or Wien bridge
9. Power amplifiers (transformer less) - Class B and Class AB
10. Transistor series voltage regulator (load and line regulation)

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

Preamble: This course aims to

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

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

Prerequisite: Nil

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

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

Mapping of course outcomes with program outcomes

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

Assessment

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

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

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

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

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

Part A (At least 8 experiments are mandatory)

1 Determination of characteristics optical transducers using LDR

2. Determination of characteristics of LVDT

3 Measurement of strain and load using strain gauge

4. Level measurement using capacitive/resistive transducer

5 Determination of characteristics of RTD

6 Determination of characteristics of thermocouple

7 Determination of characteristics of thermistor

8. Determination of pressure using strain gauge/piezoelectric pickup

9. Determination of sound pressure level using sound level meter

10. Calibration of pressure gauge using dead weight tester

11 Measurement of speed using photoelectric pickup

12 Measurement of speed using stroboscope

13 Determination of characteristics of hall effect transducer

14 Measurement of displacement using inductive transducer

15 Determination of characteristics of capacitive displacement transducer

16. Pressure measurement using U-tube manometer

17 Study of loading effect in potentiometer

18. Measurement of frequency and phase using Lissajous figures

Part B (At least 4 experiments are mandatory)

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

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

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

* Manual has to be prepared by the college

SEMESTER -4

MINOR

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

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

Prerequisite: AET251 Introduction to Signals and Systems

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

CO 1	Explain how digital signals are obtained from continuous time signals.
CO 2	Apply Fourier transform in the analysis of signals
CO 3	Implement digital filters
CO 4	Explain the practical limitations in DSP implementations
CO 5	Explain the structure of a DSP processor.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Discrete Signals and Sampling Theorem

1. Define a digital signal. Give the frequency range of digital signal. Explain the sampling theorem and show graphically how samples are generated from a continuous timesignal.

2. What should be the minimum frequency to sample a 2.5kHz analog signal? Explain graphically how the continuous time signal is reconstructed from samples.

Course Outcome 2 (CO2): Application of Fourier Transform

1. Give the expression for DFT of an N-point sequence. Compute the 10 point DFT of aunit impulse sequence.

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

Course Outcome 3 (CO3): Implementation of Digital Filters

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

2. Design an IIR Butterworth filter for passband frequency 5kHz and stopband frequency 10kHz. The stop band and passs band attenuations are 0.1 respectively.

Course Outcome 4 (CO4): Practical Limitations of Digital Filters

1(A). Explain the limit cycle oscillations in IIR filters

(B) Explain the effects of coefficient quantization in IIR filters

2. (A) Explain the effects of round of noise in digital filters
2(B) Explain the fixed and floating point arithmetic used in DSP processors.

Course Outcome 5 (CO5): Structure of Digital Signal Processors

1(A). Explain the function of the MAC unit in a DSP

(B) Explain the differences between Harvard and Von Neumann architecture.

2. Draw the internal structure of a floating point processor and explain its functional block

Syllabus

Module 1: Signal ProcessingFundamentals
Discrete-time and digital signals. Basic elements of digital processing system- ADC, DAC and Nyquist rate. Frequency aliasing due to sampling. Need for anti-aliasing filters. Discrete Time Fourier Transforms – Properties. Computation of spectrum.

Module 2: Discrete Fourier Transform – Properties and Application
Discrete Fourier transform - DFT as a linear transformation, Properties - circular convolution. Filtering of long data sequences - FFT-Radix-2 DIT and DIF algorithms. Computational complexity of DFT and FFT -application.

Module 3: Digital Filters
Digital FIR Filter: Transfer function - Difference equation, Linear phase FIR filter, Concept of windowing, Direct form and cascade realization of FIR and IIR filters. Digital IIR Filters - Transfer function, Difference equation. Direct and parallel Structures. Design of analogue Butterworth filters, Analog frequency transformations, Impulse invariance method. Bilinear transformation, Analog prototype to digital transformations.

Module 5: Finite word length effects in digital filters and DSP Hardware
Fixed point arithmetic, Floating point arithmetic, Truncation and Rounding, Quantization error in ADC, Overflow error, Product round off error, Scaling , Limit cycle oscillation.

General and special purpose hardware for DSP: Computer architectures for DSP – Harvard, pipelining, MAC, special instruction, replication, on chip cache. General purpose digital signal processors (TMS 320 family) - Implementation of digital filtering on dsp processor. Special purpose DSP hardware

Text Books
1. Proakis, J.G. & Manolakis, D.G., “Digital Signal Processing: Principles, Algorithms,& Applications”, 3/e Prentice Hall of India,1996.
2. Ifeachor, E.C., & Jervis, B.W., “Digital Signal Processing: A Practical Approach”,2/e, Pearson Education Asia,2002.
3. Chen, C.T., “Digital Signal Processing: Spectral Computation & Filter Design”, Oxford Univ. Press, 2001.
Reference Books
1.Mitra, S.K., “Digital Signal Processing: A Computer-Based Approach”, McGraw Hill, NY,1998
2.Monson H Hayes, Schaums outline: Digital SignalProcessing.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Signal Processing Fundamentals**	
1.1	Overview of signals. Frequency elements of DSP sytems	2
1.2	Conversion of analog signals to digital signals, Sampling theorem, reconstruction ADC and DAC , spectra and antialiasing filter	3
1.3	DTFT properties, spectrum	3
2	**DFT**	
2.1	DFT from DTFT, DFT as a linear transformation. W matrix. Properties of DFT, Computational challenges.	3

2.2	FFT for comptational advantage, Radix -2 DIT and Dif algorith, in place computation. Bit reversal permutation. complexity	4
2.3	Filtering of long sequences	2
3	**Digital Filters**	
3.1	Model of FIR and IIR filters. Direct form I and II of FIR filter, simple FIR design	4
3.2	IIR filter, design of Butterworth filter, Direct and parallel realization	4
3.3	Analog to digital transformation, impulse invariance and bilinear transformation.	4
4	**Finite Word-length Effects**	
4.1	Number representation Truncation - Rounding - Quantization error in ADC - Overflow error- product round off error - Scaling - Limit cycle oscillation.	3
4.2	Truncation-Rounding - Quantization error in ADC - Overflow error - product round off error - Scaling - Limit cycleoscillation.	4
5	**DSP Architecture**	
5.1	Von Neumann and Harvard architecture, Comparison	2
5.2	Data paths of fixed and floating point DSP processors. Functions of various blocks Architecture of a typical DSP processor	4
5.3	Implementation of systems on DSP chip	3

Simulation Assignments (AET282)

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

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

- 3. Computethelinearconvolutionbetweenthesequences$x$=[1,3,5, 3]with$h$=[2,3,5,6]. Observe the stem plot of both signals and theconvolution.
- Nowlet$h$=[1,2,1]and$x$=[2,3,5,6,7].Computetheconvolutionbetween$h$a nd$x$.
- Flip the signal x by 180 ˚so that it becomes [7, 6, 5, 3, 2]. Convolve it

with h. Compare the result with the previousresult.

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

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

5.
- Realize a continuous time LTI system with systemresponse

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

. One may use *scipy.signal.lti* package in Python.

- Make it into a discrete system (possibly with*scipy.signal.cont2discrete*)
- Observe the step response in both cases andcompare.

6.
- Download a vibration signal in *.wav*format.
- Loadthissignalintoanarray.Onemayusethe*scipy.io.wavfile*moduleinPyt hon.
- understand the sampling rate of thissignal.
- Plot and observe the vibration signalwaveform.
- Compute the absolute squared value of the FFT of the vibrationsignal.
- Plotitandobservethespectralcomponentsinthediscretefrequencydomain.
- Multiply prominent discrete frequencies by the sampling rate and observe and appreciate the major frequency components in Hz.

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B. Tech. Degree

Examination Branch: Electronics

and Communication

Course:AET282 Introduction to Digital Signal Processing

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

PART A

Answer All Questions

1	Define frequency of a discrete signal and identify its range.	(3)	K_1
2	State Nyquist sampling theorem for low pass signals and the formula for signal reconstruction.	(3)	K_3
3	Explain why DFT operation is alinear transformation.	(3)	K_2
4	Explain how FFT reduces the computational complexity ofDFT.	(3)	K_2
5	Write the expresssion for the Hamming window and plotit.	(3)	K_1
6	Give the expression for bilinear tranformation and explain the term frequency warping.	(3)	K_2
7	Explain the quantization errorinADCs.	(3)	K_2
8	Explainthe1sand2s complementrepresentationofnumbersin DSP processor.	(3)	K_2
9	Compare floating point and fixed point data paths in a DSP processor.	(3)	K_2
10	Explain function ofabarrelshifterinaDSPprocessor.	(3)	K_2

PART B

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

Module I

11(A)	Explain how analog signals are converted to digital signals.	(10)	K_2
11(B)	What all digital frequencies are obtained when a 1 kHz signal is sampled by 4 kHz and 8 kHz impulse trains?	(4)	K_3

OR

12(A)	Give the expression for DTFT. Compute the DTFT of the signal $x[n]$ = [1, −1, 1, −1]	(8)	K_3
12(B)	Explain how sampling affects the spectrum of the signal and the need of antialiasing filter	(6)	K_3

using radix-2 DIFalgorithm

Module II

13(A)	Give the radix-2 decimation in time algorithm for 8-point FFT computation	(10)	K_3
13(B)	How is in place computation applied in FFT algorithms?	(4)	K_3

OR

14(A)	Find the DFT of the sequence $x(n)$ = {1,2,3,4,4,3,2,1}	(10)	K_3
14(B)	How is bit reverse addressing used in FFT	(4)	K_3

Module III

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

OR

16(A) Implement the FIR filter $h[n]$ = [1, 2, 4, 6, 4, 2,1] with mini- mum multipliers in directform (6) K_3

16(B) Design an IIR Butterworth filter for passband frequency 5 kHz and stopband frequency 10 kHz. The stop bandand passs band attenuations are 0.1respectively. (8) K_3

Module IV

17(A) Explain the limit cycle oscillations in IIR filters (6) K_3

17(B) Derive the quantization noise power in an ADC (8) K_3

OR

18(A) Find the output noise variance of a first order system with transferfunction (8) K_3

$$H(z) = \frac{1}{1 - az^{-1}}$$

that is driven by a zero mean white Gaussian noise of vari- ance σ^2

18(B) Explain the fixed and floating point arithmetic used in DSP processors. (6) K_3

Module V

19	Draw and explain the functional blocks in a floating point DSPprocessor.	(14)	K_2

OR

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

AET284	Introduction to Analog Circuits	CATEGORY	L	T	P	CREDITS
		VAC	3	1	0	4

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

Prerequisite: EST130 Basics of Electrical and Electronics Engineering

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

CO 1	Analyze simple circuits using diodes, resistors and capacitors
CO 2	Build amplifier and oscillator circuits
CO 3	Develop Power supplies, D/A and A/D convertors for various applications
CO4	Develop and analyze circuits using operational amplifiers and explain concepts of PLL.

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark distribution

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

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1): Realize simple circuits using diodes, resistors and capacitors.

1. For the given specification design a differentiator and integrator circuit.
2. For the given input waveform and circuit, draw the output waveform and transfer characteristics.
3. ExplaintheworkingofRCdifferentiatorandintegratorcircuitsandsketchtheoutput waveform for different time periods.

Course Outcome 2 (CO2): Design amplifier and oscillator circuits.

1. For the given transistor biasing circuit, determine the resistor values, biasing currents and voltages.
2. Explain the construction, principle of operation, and characteristics of MOSFETs.
3. Design a RC coupled amplifier for a given gain.
4. Design a Hartley oscillator to generate a given frequency.

Course Outcome 3 (CO3): Design Power supplies, D/A and A/D convertors for various applications.

1. Design a series voltage regulator.
2. For the regulator circuit, find the output voltage and current through the zenerdiode.
3. Ina10bitDAC,foragivenreferencevoltage,findtheanalogoutputforthegivendigital input.

Course Outcome 4 (CO4): Design circuits using operational amplifiers for various applications

1. For the given difference amplifier, find the output voltage.
2. Derive the expression for frequency of oscillation of Wien bridge oscillator using op-amp.
3. Realize a summing amplifier to obtain a given outputvoltage.

SYLLABUS

Module 1:

Wave shaping circuits: Sinusoidal and non-sinusoidal wave shapes, Principle and working of RC differentiating and integrating circuits, Clipping circuits - Positive, negative and biased clipper. Clamping circuits - Positive, negative and biased clamper.

Transistor biasing: Introduction, operating point, concept of load line, thermal stability (derivation not required), fixed bias, self bias, voltage divider bias.

Module 2:

MOSFET: Structure, Enhancement and Depletion types, principle of operation and characteristics.

Amplifiers: Classification of amplifiers, RC coupled amplifier – design and working, voltage gain and frequency response. Multistage amplifiers - effect of cascading on gain and bandwidth.

Feedback in amplifiers: Effect of negative feedback on amplifiers.

MOSFET Amplifier: Circuit diagram, design and working of common source MOSFET amplifier.

Module 3:

Oscillators: Classification, criterion for oscillation, Wien bridge oscillator, Hartley and Crystal oscillator. (design equations and working of the circuits; analysis not required).

Regulated power supplies: Review of simple zener voltage regulator, series voltage regulator, 3 pin regulators-78XX and 79XX, DC to DC conversion, Circuit/block diagram and working of SMPS.

Module 4 :

Operational amplifiers: Characteristics of op-amps(gain, bandwidth, slew rate, CMRR, offset voltage, offset current), comparison of ideal and practical op-amp(IC741), applications of op-amps-scale changer, sign changer, adder/summing amplifier, subtractor, integrator, differentiator, Comparator, Instrumentation amplifier.

Module 5:

Integrated circuits: D/A and A/D convertors – important specifications, Sample and hold circuit, R-2R ladder type D/A convertors, Flash and sigma-delta type A/D convertors, Basics of PLL.

Text Books

1. Robert Boylestad and L Nashelsky, Electronic Devices and Circuit Theory, Pearson, 2015.
2. Salivahanan S. and V. S. K. Bhaaskaran, Linear Integrated Circuits, Tata McGraw Hill,2008.

Reference Books

1. David A Bell, Electronic Devices and Circuits, Oxford University Press,2008.
2. Neamen D., Electronic Circuits, Analysis and Design, 3/e, TMH,2007.
3. Millman J. and C. Halkias, Integrated Electronics, 2/e, McGraw-Hill, 2010.
4. Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, PHI,2000.
5. K.Gopakumar, Design and Analysis of Electronic Circuits, Phasor Books, Kollam,2013.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Wave shaping circuits**	
1.1	Sinusoidal and non-sinusoidal wave shapes	1
1.2	Principle and working of RC differentiating and integrating circuits	2
1.3	Clipping circuits - Positive, negative and biased clipper	1
1.4	Clamping circuits - Positive, negative and biased clamper	1
	Transistor biasing	
1.5	Introduction, operating point, concept of load line	1
	Thermal stability, fixed bias, self bias, voltage divider bias.	3
2	**Field effect transistors**	
2.2	MOSFET- Structure, Enhancement and Depletion types, principle of operation and characteristics	2
	Amplifiers	
2.3	Classification of amplifiers, RC coupled amplifier - design and working voltage gain and frequency response	3
2.4	Multistage amplifiers - effect of cascading on gain and bandwidth	1
2.5	Feedback in amplifiers - Effect of negative feedback on amplifiers	1
	MOSFET Amplifier- Circuit diagram, design and working of common source MOSFET amplifier	2
3	**Oscillators**	
3.1	Classification, criterion for oscillation	1
3.2	Wien bridge oscillator, Hartley and Crystal oscillator	3
	Regulated power supplies	
3.3	simple zener voltage regulator, series voltage regulator line and load regulation	3
3.4	3 pin regulators-78XX and 79XX	1
3.5	DC to DC conversion, Circuit/block diagram and working of SMPS	1
4	**Operational amplifiers**	
4.1	Differential amplifier	2
4.2	characteristics of op-amps(gain, bandwidth, slew rate, CMRR, offset voltage, offset current), comparison of ideal and practical op-amp(IC741)	2
4.3	applications of op-amps- scale changer, sign changer, adder/summing amplifier, subtractor, integrator, differentiator	3

4.4	Comparator, Schmitt trigger, Linear sweep generator	3

5	Integrated circuits	
5.1	D/A and A/D convertors – important specifications, Sample and hold circuit	1
5.2	R-2R ladder type D/A convertors	2
5.3	Flash and successive approximation type A/D convertors	2
5.4	Circuit diagram and working of Timer IC555, astable and monostable multivibrators using 555, Basics of PLL	3

Assignment:

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

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET284

Program: Applied Electronics and Instrumentation Engineering

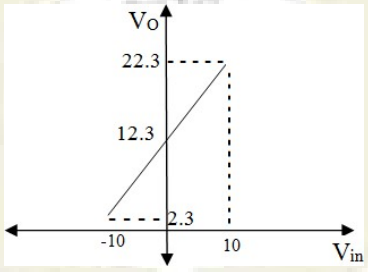
Course Name: Introduction to Analog Circuits

Max.Marks: 100 Duration: 3Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1. Design a clamper circuit to get the following transfer characteristics assuming voltage drop across the diode s 0.7V K3



2. Give the importance of biasing in transistors? Mention significance of operating point. K2

3. What is line regulation and load regulation in the context of a voltage regulator? Explain with equation for percentage of regulation:- K2

4. Compare the features of FET with BJT:- K2

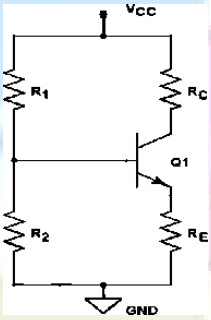
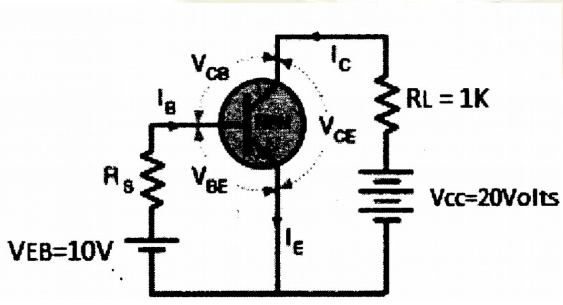
5. What is the effect of cascading in gain and bandwidth of amplifier? K3

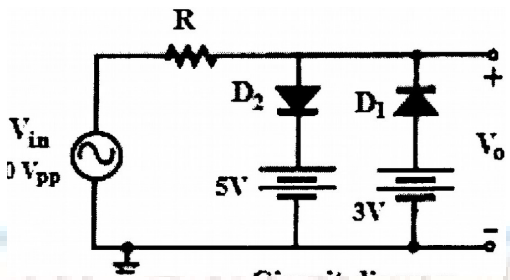
6	Discuss about simple zener shunt voltage regulator:-	K2
7	Realize a circuit to obtain Vo= -2V1+3V2+4V3 using operational amplifier. Use minimum value of resistance as 10KΩ.	K3
8	Design a monostable multivibrator using IC 555 timer for a pulse period of 1 ms.	K3
9	Describe the working of a Flash type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

PART – B

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

Module – I

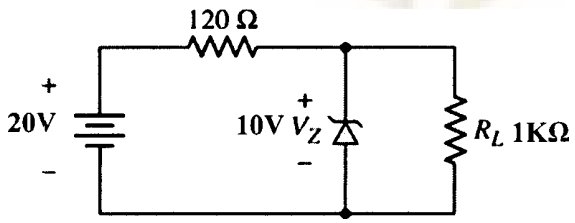
11. a)	Design a differentiator circuit for a square wave signal with Vpp=10 and frequency 10KHz.	5	CO1	K3
11. b)	Consider a self-biasing circuit shown in figure below with Vcc=20V, Rc=1.5KΩ, which is operated at Q-point (Vce=8V, Ic=4mA), If hFE=100, find R1, R2 and Re. Assume VBE=0.7V. 	9	CO2	K3
	OR			
12.a)	Explain the working of an RC differentiator circuit for a square wave input with period T. Sketch its output waveform for RC >>T , RC<< T and RC = T.	5	CO1	K3
12.b)	With reference to the following circuit, draw the load line and mark the Q point of a Silicon transistor operating in CE mode based on the following data (β=80, R_s=47KΩ, R_L=1KΩ, neglect I_{CBO}) 	5	CO2	K3

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

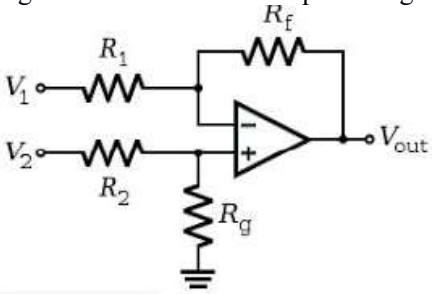
Module – II

13 a)	With neat sketches, explain the construction, principle of operation and characteristics of an N-channel enhancement MOSFET:-	9	CO2	K2
13 b)	Draw the circuit of an RC coupled amplifier and explain the function of each element:-	5	CO2	K2
	OR			
14 a)	Draw the circuit of a common source amplifier using MOSFET. Derive the expressions for voltage gain and input resistance:-	9	CO2	K2
14 b)	Sketch the frequency response of an RC coupled amplifier and write the reasons for gain reduction in both ends.	5	CO2	K2

Module – III

15 a)	Design a Hartley oscillator to generate a frequency of 150KHz.	5	CO2	K3
15 b)	Draw the circuit of a series voltage regulator. Explain its working when the input voltage as well as load current varies. Design a circuit to deliver 5V, 100mA maximum load current:-	9	CO3	K3
	OR			
16 a)	With neat diagram and relevant equations explain the working of wein bridge oscillator using BJT:-	7	CO2	K2
16 b)	Derive the expression for the frequency of oscillation of Wien bridge oscillator using BJT	4	CO2	K2
16 c)	For the circuit shown below, find the ouput voltage across RL and current through the zener diode:- 	3	CO3	K3

Module – IV

17 a)	With circuit, relevant equations and waveforms explain the working of a Schmit trigger using op-amp:-	9	CO4	K2
17 b)	The difference amplifier shown in the figure have R1=R2=5KΩ, RF=10KΩ, Rg=1KΩ. Calculate the output voltage. 	5	CO4	K3
	OR			
18 a)	With circuits and equations show that an op-amp can act as integrator, differentiator, adder and subtractor.	9	CO4	K2
18 b)	What do you mean by differential amplifier? With neat sketches, explain the working of an open loop OP-AMP differential amplifier.	5	CO4	K2

Module – V

19 a)	Explain the working of R-2R ladder type DAC. In a 10 bit DAC, reference voltage is given as 15V. Find analog output for digital input of 1011011001.	10	CO3	K3
19 b)	With neat diagram explain the working of IC555 timer.	4	CO4	K3
	OR			
20 a)	A 4-bit R-2R ladder type DAC having R= 10 kΩ and VR= 10 V. Find its resolution and output voltage for an input 1101.	4	CO4	K3
20 b)	Design an astable multivibrator using IC 555 timer for a frequency of 1KHz and a duty cycle of 70%.Assume c=0.1μF.F.	5	CO4	K3
20 c)	Draw the circuit diagram of a simple sample and hold circuit and explain the necessity of this circuit in A to D conversion.	5	CO4	K2

Simulation Assignments (AET284)

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

1. Design and simulate RC coupled amplifer. Observe the input and output signals. Plot the AC frequency response and understand the variation of gain at high frequencies. Observe the effect of negative feedback by changing the capacitor across the emitter resistor.
2. Design and simulate Wien bridge oscillator for a frequency of 10 kHz. Run a transient simulation and observe the output waveform.
3. rent IO = 100mA with and without short circuit protection and to test the line and load regulations.
4. Design and implement differential amplifier and measure its CMRR. Plot its transfer characteristics.
5. Design and simulate non-inverting amplifier for gain 5. Observe the input and output signals. Run the ac simulation and observe the frequency response and 3− db bandwidth.
6. Design and simulate a 3 bit flash type ADC. Observe the output bit patterns and transfer characteristics
7. Design and simulate R − 2R DAC ciruit.
8. Design and implement Schmitt trigger circuit for upper triggering point of +8 V and a lower triggering point of −4 V using op-amps.

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

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

Prerequisite: NIL

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

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

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	70
Apply	10	10	10
Analyse			
Evaluate			
Create			

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 5 questions with 4 questions (not exceeding 2 questions from each module). Part B contains 2 questions from each module out of which one to be answered. Each question carries 10 mark and can have 2 to 3 sub-divisions.

Course Level Assessment Questions

Course Outcome 1 (CO1):differentiate and explain in detail the concepts of accuracy, precision sensitivity, resolution?

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

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

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

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

Syllabus

Module 1

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

Module 2

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

Module 3

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

Module 4

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

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

Module 5

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

Text Books

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

Reference books

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

Course Contents and Lecture Schedule

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

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

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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

Course Code: AET286

Program: Applied Electronics and Instrumentation Engineering

Course Name: INTRODUCTION TO INDUSTRIAL INSTRUMENTATION

Max.Marks: 100 Duration: 3Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

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

PART-B

Answer any one question from each module

Module I

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

Module II

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

Module III

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

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

Module IV

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

Module V

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

SEMESTER -4

HONOURS

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

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

Prerequisite: NIL

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

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

Mapping of course outcomes with program outcomes

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

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	30	30	70
Apply	10	10	10
Analyse			
Evaluate			
Create			

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 5 questions with 4 questions (not exceeding 2 questions from each module). Part B contains 2 questions from each module out of which one to be answered. Each question carries 10 mark and can have 2 to 3 sub-divisions.

Course Level Assessment Questions

Course Outcome 1 (CO1): What are the reasons for the existence of different operational standards for instruments

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

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

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

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

Syllabus

Module 1

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

Module 2

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

Module 3

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

Module 4

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

Module 5

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

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

Text Books

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

Reference books

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

Course Contents and Lecture Schedule

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

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

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

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

MODEL QUESTION PAPER

AET 292- INSTRUMENTATION SYSTEM DESIGN

TIME: 3HR **MARKS:100**

PART A

(Answer ALL Questions. Each Carries 3 marks)

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

PART-B

Answer any one question from each module

Module I

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

Module II

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

Module III

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

	desirable characteristics?			

Module IV

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

Module V

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

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

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

Prerequisite: Basic concept of logic circuit design

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

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

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

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

Course Level Assessment Questions

Course Outcome 1 (CO1):

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

Course Outcome 2 (CO2)

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

Course Outcome 3(CO3):

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

Course Outcome 4 (CO4):

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

Course Outcome 5 (CO5):

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

Course Outcome 6 (CO6):

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

Model Question paper

QPCODE: PAGES:3

RegNo:_____

Name :_____

APJABDULKALAMTECHNOLOGICALUNIVERSITYFIRSTSEMESTERB.TECHDEGREEEXAMINATION, MONTH &YEAR

Course Code: **AET 294**

Course Name: System Design Using Verilog

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

PART A

Answer all Questions. Each question carries 3 Marks

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

(10x3=30)

Part B

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

11. Explain the following

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

OR

12. (a) Explain different levels of design description in verilog.**(10)**
(b) Explain a) White space b) strengths **(4)**

13. (a) Write Verilog module for a delay flip flop **(6)**
(b)Write about i) array of instances of primitive
ii) model structures with an example. **(8)**

OR

14. (a)Write notes on tristate gates. Give the relevant syntax, logic diagrams and excitation tables.**(10)**
(b)What is array of Instances of primitives? **(4)**

15. (a) Explain with an example showing how 'while' construct is used **(6)**
(b) Design a counter module and test bench to illustrate the use of WAIT. **(8)**

OR

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

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

17. (a)Discuss the basic transistor switches **(6)**
(b)Design a Mod 10 up counter using Behavioural modelling **(8)**

OR

18. (a)Explain the Strength Contention with Trireg Nets. **(7)**
(b) Explain cross coupled NOR latch. **(7)**

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

OR

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

Syllabus

Module 1

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

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

Module 2

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

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

Module 3

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

Module 4

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

Module 5

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

Text Books

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

Reference books

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

Course Contents and Lecture Schedule

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

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

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

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

Prerequisite: NIL

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

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

Mapping of course outcomes with program outcomes

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

Assessment Pattern

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

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10marks

Continuous Assessment Test(2numbers) : 15marks

Assignment/Quiz/Courseproject : 15marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 5 questions with 4 questions (not exceeding 2 questions from each module). Part B contains 2 questions from each module out of which one to be answered. Each question carries 10 mark and can have 2 to 3 sub-divisions.

Course Level Assessment Questions

Course Outcome 1 (CO1): Abstract algebra

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

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

Course Outcome 2 (CO2): Solution to linear system

1) Find the inverse of B without finding the determinant

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

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

$$x_1 + x_2 - 2x_3 + 4x_4 = 5$$
$$2x_1 + 3x_2 - 3x_3 + x_4 = 3$$
$$3x_1 + 3x_2 - 4x_3 - 2x_4 = 1$$

Course Outcome 3(CO3): Linear transformation

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

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

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

Course Outcome 4 (CO4): Inner product

1) Define inner product space

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

Course Outcome 5 (CO5): Eigen values

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

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

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

.

Syllabus

Module 1

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

Module 2

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

Module 3

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

Module 4

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

Module 5

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

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

Text books

1) G.F.Simmons, Topology and Modern Analysis , McGraw Hill

2) Frazier, Michael W. An Introduction to Wavelets through Linear Algebra, Springer Publications.

Reference Books

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

2) Reichard Bronson, Academic Press

Course Contents and Lecture Schedule

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

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

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B. Tech. Degree Examination

Branch: Electronics and Communication

Course:AET296 Linear Algebra

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

PART A

Answer All Questions

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

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

PART B

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

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

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