SEMESTER -4

MATHEMATICS – 4 th semester

(All branches except Electrical, Electronics, Computer science, Information Technology and Applied Electronics)

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MAT 202	PROBABILITY,STATISTICS 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 techniques of parameter estimation and hypothesis testing. A brief course in numerical methods familiarises students with some basic numerical techniques for finding roots of equations, evaluationg 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	Perform statistical inferences concerning characteristics of a population based on attributes of samples drawn from the population
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 componets each of which may fail independently with probability 0.15. If the equipment is able to function properly when at least 3 of the componets 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 a (i) discrete random variable? (ii) 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 twise 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 parameter λ. Find $P(X + Y \leqslant 1)$

Course Outcome 3(CO3):

1. In a random sample of 500 people selected from the population of a city 60 were found to be left-handed. Find a 95% confidence interval for the proportion of left-handed people in the city population.

2. What are the types of errors involved in statistical hypothesis testing. Explain the level of risks associated with each type of error.

3. A soft drink maker claims that a majority of adults prefer its leading beverage over that of its main competitor's. To test this claim 500 randomly selected people were given the two beverages in random order to taste. Among them, 270 preferred the soft drink maker's brand, 211 preferred the competitor's brand, and 19 could not make up their minds. Determine whether there is sufficient evidence, at the 5% level of significance, to support the soft drink maker's claim against the default that the population is evenly split in its preference.

4. A nutritionist is interested in whether two proposed diets, *diet A* and *diet B* work equally well in providing weight-loss for customers. In order to assess a difference between the two diets, she puts 50 customers on diet A and 60 other customers on diet B for two weeks. Those on the former had weight losses with an average of 11 pounds and a standard deviation of 3 pounds, while those on the latter lost an average of 8 pounds with a standard deviation of 2 pounds. Do the diets differ in terms of their weight loss?

Course Outcome 4(CO4):

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

2. Compare Newton's divided difference method and Langrange'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 thorugh 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 (Statistical inference) **9 hours**

(Text-1:*Relevant topics* from sections-5.4,, 3.6, 5.1,7.2, 8.1, 8.3, 9.1-9.2,9.4)

Population and samples, Sampling distribution of the mean and proportion (for large samples only), Confidence interval for single mean and single proportions(for large samples only). Test of hypotheses: Large sample test for single mean and single proportion, equality of means and equality of proportions of two populations, small sample t-tests for single mean of normal population, equality of means (**only pooled t-test, for independent samples from two normal populations with equal variance**)

Module 4 (Numerical methods -I) **9 hours**

(Text 2- *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 2- *Relevant topics* from sections 20.3, 20.5, 21.1)

Solution of linear systems-Gauss-Siedal and Jacobi iteration methods. Curve fitting-method of least squares, fitting staright 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) 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. Sheldon M. Ross, *Introduction to probability and statistics for engineers and*

scientists, 4th edition, Elsevier, 2009.

3. T. Veera Rajan, *Probability, Statistics and Random processes,* Tata McGraw-Hill, 2008

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	**Statistical inference**	**9 hours**
3.1	Population and samples, Sampling distribution of single mean and single proportion(large samples)	1
3.2	Confidence interval for single mean and single proportions (large samples)	2
3.3	Hypothesis testing basics, large sample test for single proportion, single proportion	2
3.4	Large sample test for equality of means and equality of proportions of two populations	2

3.5	t-distribution and small sample t-test for single mean and pooled t-test for equality of means	2
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 method	2
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 methods	1

Model Question Paper

(2019 Scheme)

Reg No: ..... **Total Pages: 4**

Name: .....

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION

(Month & year)

Course Code: MAT

Course Name: PROBABILITY, STATISTICS AND NUMERICAL METHODS

(Common to all branches except (i) Electrical and Electronics, (ii) Electronics and Communication, (iii) Applied Electronics and Instrumentation (iv) Computer Science and Engineering (v) Information Technology)

Max Marks :100 Duration : 3 Hours

PART A

(Answer *all* questions. Each question carries 3 marks)

1. Suppose X is binomial random variable with parameters $n = 100$ and $p = 0.02$. Find $P(X < 3)$ using Poisson approximation to X. (3)

2. The diameter of circular metallic discs produced by a machine is a random variable with mean 6cm and variance 2cm. Find the mean area of the discs. (3)

3. Find the mean and variance of the continuous random variable X with probability density function (3)
$$f(x) = \begin{cases} 2x - 4, & 2 \le x \le 3 \\ 0 & \text{otherwise} \end{cases}$$

4. The random variable X is exponentially distributed with mean 3. Find $P(X > t + 3 | X > t)$ where t is any positive real number. (3)

5. The 95% confidence interval for the mean mass (in grams) of tablets produced by a machine is [0.56 0.57], as calculated from a random sample of 50 tablets. What do you understand from this statement? (3)

6. The mean volume of liquid in bottles of lemonade should be at least 2 litres. A sample of bottles is taken in order to test whether the mean volume has fallen below 2 litres. Give a null and alternate hypothesis for this test and specify whether the test would be one-tailed or two-tailed. (3)

7. Find all the first and second order forward and backward differences of y for the following set of (x, y) values: (0.5, 1.13), (0.6, 1.19), (0.7, 1.26), (0.8, 1.34) (3)

8. The following table gives the values of a function $f(x)$ for certain values of x. (3)

x	0	0.25	0.50	0.75	1
$f(x)$	1	0.9412	0.8	0.64	0.5

Evaluate $\int_0^1 f(x)dx$ using trapezoidal rule.

9. Explain the principle of least squares for determining a line of best fit to a given data (3)

10. Given the initial value problem $y' = y + x$, $y(0) = 0$, find $y(0.1)$ and $y(0.2)$ using Euler method. (3)

PART B
(Answer one question from each module)
MODULE 1

11. (a) The probability mass function of a discrete random variable is $p(x) = kx, x = 1, 2, 3$ where k is a positive constant. Find (i)the value of k (ii) $P(X \leq 2)$ (iii) $E[X]$ and (iv) var$(1 - X)$. (7)

    (b) Find the mean and variance of a binomial random variable (7)

OR

12. (a) Accidents occur at an intersection at a Poisson rate of 2 per day. what is the probability that there would be no accidents on a given day? What is the probability that in January there are at least 3 days (not necessarily consecutive) without any accidents? (7)

    (b) Two fair dice are rolled. Let X denote the number on the first die and $Y = 0$ or 1, according as the first die shows an even number or odd number. Find (i) the joint probability distribution of X and Y, (ii) the marginal distributions. (iii) Are X and Y independent ? (7)

MODULE 2

13. (a) The IQ of an individual randomly selected from a population is a normal distribution with mean 100 and standard deviation 15. Find the probability that an individual has IQ (i) above 140 (ii) between 120 and 130. (7)

    (b) A continuous random variable X is uniformly distributed with mean 1 and variance 4/3. Find $P(X < 0)$ (7)

OR

14. (a) The joint density function of random variables X and Y is given by (7)

$$f(x, y) = \begin{cases} e^{-(x+y)}, & x > 0, \quad y > 0 \\ 0 & \text{otherwise.} \end{cases}$$

    Find $P(X + Y \leq 1)$. Are X and Y independent? Justify.

    (b) The lifetime of a certain type of electric bulb may be considered as an exponential random variable with mean 50 hours. Using central limit theorem, find the approximate probability that 100 of these electric bulbs will provide a total of more than 6000 hours of burning time. (7)

MODULE 3

15. (a) The mean blood pressure of 100 randomly selected persons from a target population is 127.3 units. Find a 95% confidence interval for the mean blood pressure of the population. (7)

    (b) The CEO of a large electric utility claims that 80 percent of his 1,000,000 customers are very satisfied with the service they receive. To test this claim, the local newspaper surveyed 100 customers, using simple random sampling. Among the sampled customers, 73 percent say they are very satisfied. Based on these findings, do you think that the CEO is making a false claim of high satisfaction levels among his customers? Use a 0.05 level of significance. (7)

OR

16. (a) A magazine reported the results of a telephone poll of 800 adult citizens of a country. The question posed was: "Should the tax on cigarettes be raised to pay for health care reform?" The results of the survey were: Out of the 800 persons surveyed, 605 were non-smokers out of which 351 answered "yes" and the rest "no". Out of the remaining 195, who were smokers, 41 answered "yes" and the remaining "no". Is there sufficient evidence, at the 0.05 significance level, to conclude that the two populations smokers and non-smokers differ significantly with respect to their opinions? (7)

(b) Two types of cars are compared for acceleration rate. 40 test runs are recorded for each car and the results for the mean elapsed time recorded below: (7)

	Sample mean	Sample standard deviation
Car A	7.4	1.5
Car B	7.1	1.8

determine if there is a difference in the mean elapsed times of the two car models at 95% confidence level.

MODULE 4

17. (a) Use Newton-Raphson method to find a non-zero solution of $x = 2\sin x$. Start with $x_0 = 1$ (7)

(b) Using Lagrange's interpolating polynomial estimate $f(1.5)$ for the following data (7)

x	0	1	2	3
$y = f(x)$	0	0.9826	0.6299	0.5532

OR

18. (a) Consider the data given in the following table (7)

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

Estimate the value of $f(1.80)$ using newton's backward interpolation formula.

(b) Evaluate $\int_0^1 e^{-x^2/2}dx$ using Simpson's one-third rule, dividing the interval [0, 1] into 8 subintervals (7)

MODULE 5

19. (a) Using Gauss-Seidel method, solve the following system of equations (7)

$$20x + y - 2z = 17$$
$$3x + 20y - z = -18$$
$$2x - 3y + 20z = 25$$

(b) The table below gives the estimated population of a country (in millions) for during 1980-1995 (7)

year	1980	1985	1990	1995
population	227	237	249	262

Plot a graph of this data and fit an appropriate curve to the data using the method of least squares. Hence predict the population for the year 2010.

OR

20. (a) Use Runge-Kutta method of fourth order to find $y(0.2)$ given the initial value problem (7)

$$\frac{dy}{dx} = \frac{xy}{1+x^2}, \quad y(0) = 1$$

Take step-size, $h = 0.1$.

(b) Solve the initial value problem (7)

$$\frac{dy}{dx} = x + y, \quad y(0) = 0,$$

in the interval $0 \leq x \leq 1$, taking step-size $h = 0.2$. Calculate $y(0.2), y(0.4)$ and $y(0.6)$ using Runge-Kutta second order method, and $y(0.8)$ and $y(1.0)$ using Adam-Moulton predictor-corrector method.

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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

Model Question Paper

(**2019 Scheme**)

Reg No: ..... **Total Pages: 3**

Name: .....

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION

(Month & year)

Course Code: MAT 204

Course Name: PROBABILITY, RANDOM PROCESSES AND NUMERICAL METHODS

(For (i) Electrical and Electronics, (ii) Electronics and Communication, (iii) Applied Electronics and Instrumentation Engineering branches)

Max Marks :100 Duration : 3 Hours

PART A

(Answer *all* questions. Each question carries 3 marks)

1. Suppose X is binomial random variable with parameters $n = 100$ and $p = 0.02$. Find $P(X < 3)$ using Poisson approximation to X. (3)

2. The diameter of circular metallic discs produced by a machine is a random variable with mean 6cm and variance 2cm. Find the mean area of the discs. (3)

3. Find the mean and variance of the continuous random variable X with probability density function (3)
$$f(x) = \begin{cases} 2x - 4, & 2 \le x \le 3 \\ 0 & \text{otherwise} \end{cases}$$

4. The random variable X is exponentially distributed with mean 3. Find $P(X > t + 3 | X > t)$ where t is any positive real number. (3)

5. Give any two examples of a continuous time discrete state random processes. (3)

6. How will you calculate the mean, variance and total power of a WSS process from its autocorrelation function? (3)

7. Find all the first and second order forward and backward differences of y for the following set of (x, y) values: (0.5, 1.13), (0.6, 1.19), (0.7, 1.26), (0.8, 1.34) (3)

8. The following table gives the values of a function $f(x)$ for certain values of x. (3)

x	0	0.25	0.50	0.75	1
$f(x)$	1	0.9412	0.8	0.64	0.5

   Evaluate $\int_0^1 f(x)dx$ using trapezoidal rule.

9. Explain the principle of least squares for determining a line of best fit to a given data (3)

10. Given the initial value problem $y' = y + x$, $y(0) = 0$, find $y(0.1)$ and $y(0.2)$ using Euler method. (3)

PART B

(Answer one question from each module)

MODULE 1

11. (a) The probability mass function of a discrete random variable is $p(x) = kx, x = 1, 2, 3$ where k is a positive constant. Find (i)the value of k (ii) $P(X \leq 2)$ (iii) $E[X]$ and (iv) var$(1 - X)$. (7)

    (b) Find the mean and variance of a binomial random variable (7)

OR

12. (a) Accidents occur at an intersection at a Poisson rate of 2 per day. what is the probability that there would be no accidents on a given day? What is the probability that in January there are at least 3 days (not necessarily consecutive) without any accidents? (7)

    (b) Two fair dice are rolled. Let X denote the number on the first die and $Y = 0$ or 1, according as the first die shows an even number or odd number. Find (i) the joint probability distribution of X and Y, (ii) the marginal distributions. (iii) Are X and Y independent ? (7)

MODULE 2

13. (a) The IQ of an individual randomly selected from a population is a normal distribution with mean 100 and standard deviation 15. Find the probability that an individual has IQ (i) above 140 (ii) between 120 and 130. (7)

    (b) A continuous random variable X is uniformly distributed with mean 1 and variance 4/3. Find $P(X < 0)$ (7)

OR

14. (a) The joint density function of random variables X and Y is given by (7)

$$f(x, y) = \begin{cases} e^{-(x+y)}, & x > 0, \quad y > 0 \\ 0 & \text{otherwise.} \end{cases}$$

    Find $P(X + Y \leq 1)$. Are X and Y independent? Justify.

    (b) The lifetime of a certain type of electric bulb may be considered as an exponential random variable with mean 50 hours. Using central limit theorem, find the approximate probability that 100 of these electric bulbs will provide a total of more than 6000 hours of burning time. (7)

MODULE 3

15. (a) A random process $X(t)$ is defined by $X(t) = Y(t)\cos(\omega t + \Theta)$ where $Y(t)$ is a WSS process, ω is a constant and Θ is uniformly distributed in $[0, 2\pi]$ and is independent of $Y(t)$. Show that $X(t)$ is WSS (7)

    (b) Find the power spectral density of the random process $X(t) = a\sin(\omega_0 t + \Theta)$, ω_0 constant and Θ is uniformly distributed in $(0, 2\pi)$ (7)

OR

16. Cell-phone calls processed by a certain wireless base station arrive according to a Poisson process with an average of 12 per minute.

    (a) What is the probability that more than three calls arrive in an interval of length 20 seconds? (7)

    (b) What is the probability that more than 3 calls arrive in each of two consecutive intervals of length 20 seconds? (7)

MODULE 4

17. (a) Use Newton-Raphson method to find a non-zero solution of $x = 2\sin x$. Start with $x_0 = 1$ (7)

(b) Using Lagrange's interpolating polynomial estimate $f(1.5)$ for the following data (7)

x	0	1	2	3
$y = f(x)$	0	0.9826	0.6299	0.5532

OR

18. (a) Consider the data given in the following table (7)

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

Estimate the value of $f(1.80)$ using newton's backward interpolation formula.

(b) Evaluate $\int_0^1 e^{-x^2/2}dx$ using Simpson's one-third rule, dividing the interval [0, 1] into 8 subintervals (7)

MODULE 5

19. (a) Using Gauss-Seidel method, solve the following system of equations (7)

$$20x + y - 2z = 17$$
$$3x + 20y - z = -18$$
$$2x - 3y + 20z = 25$$

(b) The table below gives the estimated population of a country (in millions) for during 1980-1995 (7)

year	1980	1985	1990	1995
population	227	237	249	262

Plot a graph of this data and fit an appropriate curve to the data using the method of least squares. Hence predict the population for the year 2010.

OR

20. (a) Use Runge-Kutta method of fourth order to find $y(0.2)$ given the initial value problem (7)

$$\frac{dy}{dx} = \frac{xy}{1+x^2}, \quad y(0) = 1$$

Take step-size, $h = 0.1$.

(b) Solve the initial value problem (7)

$$\frac{dy}{dx} = x + y, \quad y(0) = 0,$$

in the interval $0 \le x \le 1$, taking step-size $h = 0.2$. Calculate $y(0.2), y(0.4)$ and $y(0.6)$ using Runge-Kutta second order method, and $y(0.8)$ and $y(1.0)$ using Adam-Moulton predictor-corrector method.

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CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MAT 206	GRAPH THEORY	BSC	3	1	0	4

Preamble: This course introduces fundamental concepts in Graph Theory, including properties and characterisation of graph/trees and graph theoretic algorithms, which are widely used in Mathematical modelling and has got applications across Computer Science and other branches in Engineering.

Prerequisite: The topics covered under the course Discrete Mathematical Structures (MAT 203)

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

CO 1	Explain vertices and their properties, types of paths, classification of graphs and trees & their properties. **(Cognitive Knowledge Level: Understand)**
CO 2	Demonstrate the fundamental theorems on Eulerian and Hamiltonian graphs. **(Cognitive Knowledge Level: Understand)**
CO 3	Illustrate the working of Prim's and Kruskal's algorithms for finding minimum cost spanning tree and Dijkstra's and Floyd-Warshall algorithms for finding shortest paths. **(Cognitive Knowledge Level: Apply)**
CO 4	Explain planar graphs, their properties and an application for planar graphs. **(Cognitive Knowledge Level: Apply)**
CO 5	Illustrate how one can represent a graph in a computer. **(Cognitive Knowledge Level: Apply)**
CO 6	Explain the Vertex Color problem in graphs and illustrate an example application for vertex coloring. **(Cognitive Knowledge Level: Apply)**

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

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

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests (%)**		**End Semester Examination (%)**
	1	**2**	
Remember	30	30	30
Understand	30	30	30
Apply	40	40	40
Analyse			
Evaluate			
Create			

Mark Distribution

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

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment Tests : 25 marks

Continuous Assessment Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks

First Internal Examination shall be preferably conducted after completing the first half of the syllabus and the Second Internal Examination shall be preferably conducted after completing remaining part of the syllabus.

There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly covered module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly covered module), each with 7 marks. Out of the 7 questions in Part B, a student should answer any 5.

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 anyone. Each question can have maximum 2 sub-divisions and carries 14 marks.

Syllabus

Module 1

Introduction to Graphs : Introduction- Basic definition – Application of graphs – finite, infinite and bipartite graphs – Incidence and Degree – Isolated vertex, pendant vertex and Null graph. Paths and circuits – Isomorphism, sub graphs, walks, paths and circuits, connected graphs, disconnected graphs and components.

Module 2

Eulerian and Hamiltonian graphs : Euler graphs, Operations on graphs, Hamiltonian paths and circuits, Travelling salesman problem. Directed graphs – types of digraphs, Digraphs and binary relation, Directed paths, Fleury's algorithm.

Module 3

Trees and Graph Algorithms : Trees – properties, pendant vertex, Distance and centres in a tree - Rooted and binary trees, counting trees, spanning trees, Prim's algorithm and Kruskal's algorithm, Dijkstra's shortest path algorithm, Floyd-Warshall shortest path algorithm.

Module 4

Connectivity and Planar Graphs : Vertex Connectivity, Edge Connectivity, Cut set and Cut Vertices, Fundamental circuits, Planar graphs, Kuratowski's theorem (proof not required), Different representations of planar graphs, Euler's theorem, Geometric dual.

Module 5

Graph Representations and Vertex Colouring : Matrix representation of graphs- Adjacency matrix, Incidence Matrix, Circuit Matrix, Path Matrix. Coloring- Chromatic number, Chromatic polynomial, Matchings, Coverings, Four color problem and Five color problem. Greedy colouring algorithm.

Text book:

1. Narsingh Deo, Graph theory, PHI,1979

Reference Books:

1. R. Diestel, *Graph Theory,* free online edition, 2016: diestel-graph-theory.com/ basic.html.
2. Douglas B. West, Introduction to Graph Theory, Prentice Hall India Ltd.,2001
3. Robin J. Wilson, Introduction to Graph Theory, Longman Group Ltd.,2010
4. J.A. Bondy and U.S.R. Murty. Graph theory with Applications

Sample Course Level Assessment Questions.

Course Outcome 1 (CO1):

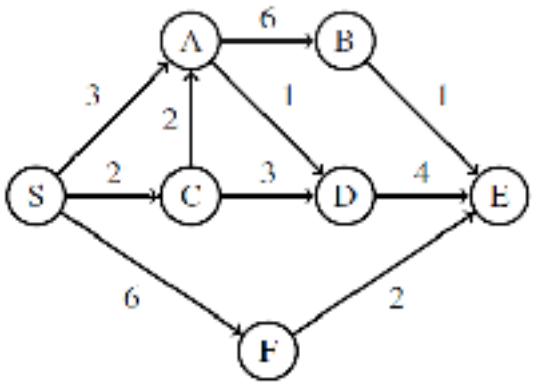
1. Differentiate a walk, path and circuit in a graph.
2. Is it possible to construct a graph with 12 vertices such that two of the vertices have degree 3 and the remaining vertices have degree 4? Justify
3. Prove that a simple graph with n vertices must be connected, if it has more than $\frac{(n-1)(n-2)}{2}$ edges.
4. Prove the statement: If a graph (connected or disconnected) has exactly two odd degree, then there must be a path joining these two vertices.

Course Outcome 2 (CO2):

1. Define Hamiltonian circuit and Euler graph. Give one example for each.
2. Define directed graphs. Differentiate between symmetric digraphs and asymmetric digraphs.
3. Prove that a connected graph G is an Euler graph if all vertices of G are of even degree.
4. Prove that a graph G of n vertices always has a Hamiltonian path if the sum of the degrees of every pair of vertices Vi, Vj in G satisfies the condition $d(Vi) + d(Vj) = n - 1$

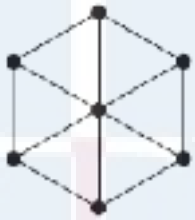
Course Outcome 3 (CO3):

1. Discuss the centre of a tree with suitable example.
2. Define binary tree. Then prove that number of pendant vertices in a binary tree is $\frac{(n+1)}{2}$
3. Prove that a tree with n vertices has $n - 1$ edges.
4. Explain Floyd Warshall algorithm.
5. Run Dijkstra's algorithm on the following directed graph, starting at vertex ***S***.



Course Outcome 4 (CO4):

1. Define edge connectivity, vertex connectivity and separable graphs. Give an example for each.
2. Prove that a connected graph with ***n*** vertices and e edges has $e - n + 2$ edges.
3. Prove the statement: Every cut set in a connected graph G must also contain at least one branch of every spanning tree of G.
4. Draw the geometrical dual ***(G*)*** of the graph given below, also check whether ***G*** and **G*** are self-duals or not, substantiate your answer clearly.



Course Outcome 5 (CO5):

1. Show that if ***A(G)*** is an incidence matrix of a connected graph ***G*** with ***n*** vertices, then rank of ***A(G)*** is ***n−1***.
2. Show that if ***B*** is a cycle matrix of a connected graph ***G*** with ***n*** vertices and ***m*** edges, then rank ***B = m−n+1***.
3. Derive the relations between the reduced incidence matrix, the fundamental cycle matrix, and the fundamental cut-set matrix of a graph ***G***.
4. Characterize simple, self-dual graphs in terms of their cycle and cut-set matrices.

Course Outcome 6 (CO6):

1. Show that an n vertex graph is a tree iff its chromatic polynomial is $Pn(\lambda) = \lambda(\lambda - 1)^{n-1}$
2. Prove the statement: "A covering g of a graph is minimal if g contains no path of length three or more."
3. Find the chromatic polynomial of the graph

Model Question paper

QP Code :

Total Pages: 4

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

IV SEMESTER B.TECH DEGREE EXAMINATION, MONTH and YEAR

Course Code: MAT 206

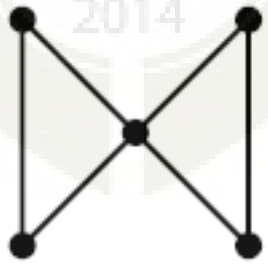
Course Name: GRAPH THEORY

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions, each carries3 marks. Marks

1	Construct a simple graph of 12 vertices with two of them having degree 1, three having degree 3 and the remaining seven having degree 10.	(3)
2	What is the largest number of vertices in a graph with 35 edges, if all vertices are of degree at least 3 ?	(3)
3	Define a Euler graph. Give an example of Eulerian graph which is not Hamiltonian	(3)
4	Give an example of a strongly connected simple digraph without a directed Hamiltonian path.	(3)
5	What is the sum of the degrees of any tree of ***n*** vertices?	(3)
6	How many spanning trees are there for the following graph	(3)



7 Show that in a simple connected planar graph ***G*** having ***V***-vertices, ***E***-edges, and no triangles ***E <= 3V - 6***. (3)

8 Let G be the following disconnected planar graph. Draw its dual G*, and the dual of the dual (G*)*. (3)

G

9 Consider the circuit matrix ***B*** and incidence matrix ***A*** of a simple connected graph whose columns are arranged using the same order of edges. Prove that every row of ***B*** is orthogonal to every row of ***A***? (3)

10 A graph is *critical* if the removal of any one of its vertices (and the edges adjacent to that vertex) results in a graph with a lower chromatic number. Show that K_n is critical for all $n > 1$. (3)

PART B

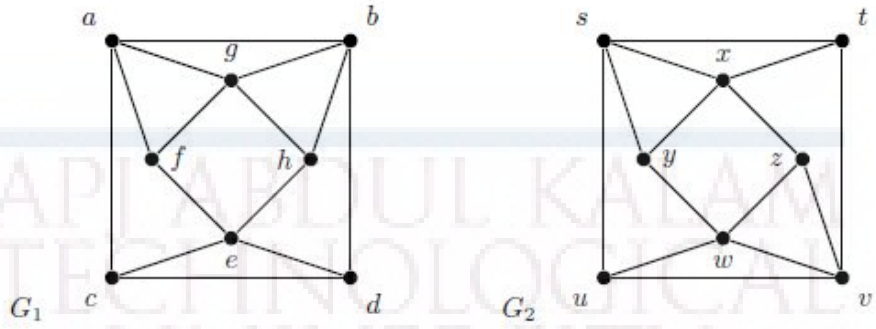
Answer any one Question from each module. Each question carries 14 Marks

11 a) Prove that for any simple graph with at least two vertices has two vertices of the same degree. (6)

b) Prove that in a complete graph with ***n*** vertices there are **(n-1)/2** edge disjoint Hamiltonian circuits and ***n >= 3*** (8)

OR

12 a) Determine whether the following graphs $G_1 = (V_1, E_1)$ and $G_2 = (V_2, E_2)$ are isomorphic or not. Give justification. (6)



b) Prove that a simple graph with n vertices and k components can have at most $(n-k)(n-k+1)/2$ edges (8)

13 a) Let S be a set of 5 elements. Construct a graph G whose vertices are subsets of S of size 2 and two such subsets are adjacent in G if they are disjoint. (8)

i. Draw the graph G.

ii. How many edges must be added to G in order for G to have a Hamiltonian cycle?

b) Let G be a graph with exactly two connected components, both being Eulerian. What is the minimum number of edges that need to be added to G to obtain an Eulerian graph? (6)

OR

14 a) Show that a k-connected graph with no hamiltonian cycle has an independent set of size $k + 1$. (8)

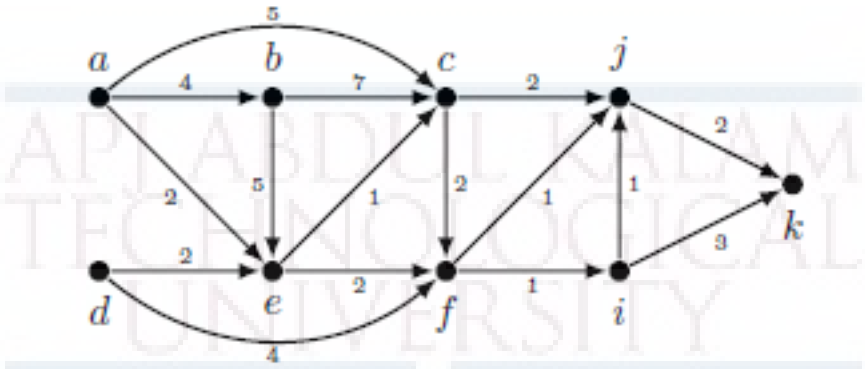
b) i. Let G be a graph that has exactly two connected components, both being Hamiltonian graphs. Find the minimum number of edges that one needs to add to G to obtain a Hamiltonian graph. (6)

ii. For which values of n the graph Q_n (hyper-cube on n vertices) is Eulerian.

15 a) A tree T has at least one vertex v of degree 4, and at least one vertex w of degree 3. Prove that T has at least 5 leaves. (5)

b) Write Dijkstra's shortest path algorithm. (9)

Consider the following weighted directed graph ***G***.



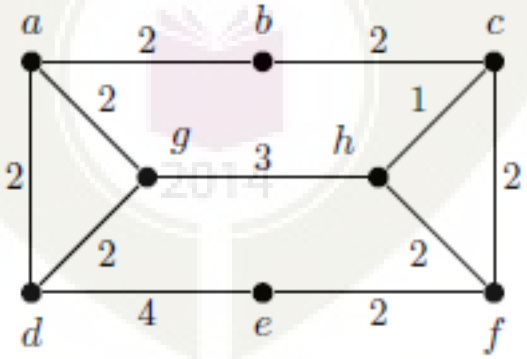
Find the shortest path between ***a*** and every other vertices in ***G*** using Dijkstra's shortest path algorithm.

OR

16 a) Define pendent vertices in a binary tree? Prove that the number of pendent vertices in a binary tree with ***n*** vertices is ***(n+1)/2.*** (5)

b) Write Prim's algorithm for finding minimum spanning tree. (9)

Find a minimum spanning tree in the following weighted graph, using Prim's algorithm.



Determine the number of minimum spanning trees for the given graph.

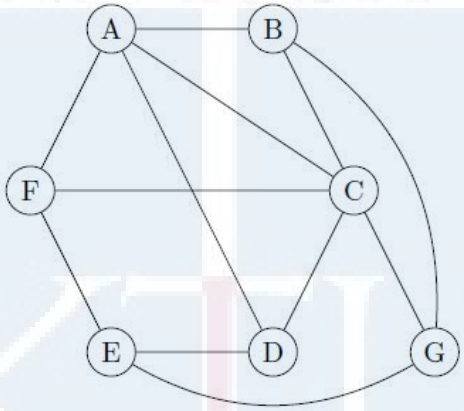
17 a) i. State and prove Euler's Theorem relating the number of faces, edges and vertices for a planar graph. (9)

ii. If G is a 5-regular simple graph and $|V| = 10$, prove that G is non-planar.

b) Let G be a connected graph and e an edge of G. Show that e is a cut-edge if and only if e belongs to every spanning tree. (5)

OR

18 a) State Kuratowski's theorem, and use it to show that the graph G below is not planar. Draw G on the plane without edges crossing. Your drawing should use the labelling of the vertices given. (9)



b) Let G be a connected graph and e an edge of G. Show that e belongs to a loop if and only if e belongs to no spanning tree. (5)

19 a) Define the circuit matrix $B(G)$ of a connected graph G with n vertices and e edges with an example. Prove that the rank of $B(G)$ is $e-n+1$ (7)

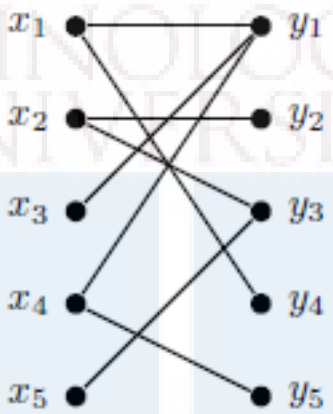
b) Give the definition of the chromatic polynomial $P_G(k)$. Directly from the definition, prove that the chromatic polynomials of W_n and C_n satisfy the identity $P_{Wn}(k) = k\, P_{Cn-1}\,(k-1)$. (7)

OR

20 a) Define the incidence matrix of a graph G with an example. Prove that the rank of an incidence matrix of a connected graph with n vertices is $n-1$. (4)

b) i. A graph G has chromatic polynomial $P_G(k) = k^4-4k^3+5k^2-2k$. How many vertices and edges does G have? Is G bipartite? Justify your answers.

ii. Find a maximum matching in the graph below and use Hall's theorem to show that it is indeed maximum.



(10)

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Assignments

Assignment must include applications of the above theory in Computer Science.

Teaching Plan		
No	Topic	No. of Lectures
1	**Module-I (Introduction to Graphs)**	**(8)**
1.	Introduction- Basic definition – Application of graphs – finite and infinite graphs, bipartite graphs,	1
2.	Incidence and Degree – Isolated vertex, pendent vertex and Null graph	1
3.	Paths and circuits	1
4.	Isomorphism	1
5.	Sub graphs, walks	1
6.	Paths and circuits	1
7.	Connected graphs.	1
8.	Disconnected graphs and components	1
2	**Module-II (Eulerian and Hamiltonian graphs)**	**(8)**
1.	Euler graphs	1
2.	Operations on graphs	1
3.	Hamiltonian paths and circuits	1
4.	Hamiltonian paths circuits	1
5.	Travelling salesman problem	1
6.	Directed graphs – types of digraphs,	1
7.	Digraphs and binary relation, Directed paths	1
8.	Fleury's algorithm	1
3	**Module-III (Trees and Graph Algorithms)**	(11)
1.	Trees – properties	1
2.	Trees – properties	1
3.	Trees – properties, pendent vertex	1
4.	Distance and centres in a tree	1

5.	Rooted and binary tree	1
6.	Counting trees	1
7.	Spanning trees, Fundamental circuits	1
8.	Prim's algorithm	1
9.	Kruskal's algorithm	1
10.	Dijkstra's shortest path algorithm	1
11.	Floyd-Warshall shortest path algorithm	1
4	**Module-IV (Connectivity and Planar Graphs)**	(9)
1.	Vertex Connectivity, Edge Connectivity	1
2.	Cut set and Cut Vertices	1
3.	Fundamental circuits	1
4.	Fundamental circuits	1
5.	Planar graphs	1
6.	Kuratowski's theorem	1
7.	Different representations of planar graphs	1
8.	Euler's theorem	1
9.	Geometric dual	1
5	**Module-V (Graph Representations and Vertex Colouring)**	(9)
1.	Matrix representation of graphs- Adjacency matrix, Incidence Matrix	1
2.	Circuit Matrix, Path Matrix	1
3.	Colouring- chromatic number,	1
4.	Chromatic polynomial	1
5.	Matching	1
6.	Covering	1
7.	Four colour problem and five colour problem	1

8.	Four colour problem and five colour problem	1
9.	Greedy colouring algorithm.	1

MATHEMATICS – (4 th semester)

(For Information Technology)

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MAT 208	PROBABILITY,STATISTICS AND ADVANCED GRAPH THEORY	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 techniques of parameter estimation and hypothesis testing. This course introduce fundamental concepts in Graph Theory, including properties and characterisation of Graph/Trees and Graph theoretic algorithms, which are widely used in Mathematical modelling and has got applications across **Information Technology**

Prerequisite: A basic course in one-variable and multi-variable calculus, knowledge of elementary set theory, matrices

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	Perform statistical inferences concerning characteristics of a population based on attributes of samples drawn from the population
CO 4	Understand the basic concept in Graph theory, Understand planar graphs and it's properties. Demonstrate the knowledge of fundamental concepts of matrix representation of graphs, Apply fundamental theorems on Eularian graphs and Hamiltonian graphs.
CO 5	Understand the basic concept in Trees,coloring of graphs. Apply coloring of graphs, Apply algorithm to find the minimum spanning tree

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 a (i) discrete random variable? (ii) 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. In a random sample of 500 people selected from the population of a city 60 were found to be left-handed. Find a 95% confidence interval for the proportion of left-handed people in the city population.

2. What are the types of errors involved in statistical hypothesis testing? Explain the level of risks associated with each type of error.

3. A soft drink maker claims that a majority of adults prefer its leading beverage over that of its main competitor's. To test this claim 500 randomly selected people were given the two beverages in random order to taste. Among them, 270 preferred the soft drink maker's brand, 211 preferred the competitor's brand, and 19 could not make up their minds. Determine whether there is sufficient evidence, at the 5% level of significance, to support the soft drink maker's claim against the default that the population is evenly split in its preference.

4. A nutritionist is interested in whether two proposed diets, *diet A* and *diet B* work equally well in providing weight-loss for customers. In order to assess a difference between the two diets, she puts 50 customers on diet A and 60 other customers on diet B for two weeks. Those on the former had weight losses with an average of 11 pounds and a standard deviation of 3 pounds, while those on the latter lost an average of 8 pounds with a standard deviation of 2 pounds. Do the diets differ in terms of their weight loss?

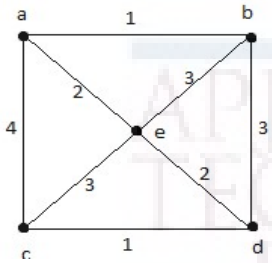
Course Outcome 4(CO4):

1. How many edges are there in a graph with ten vertices each of degree six?
2. Prove that a simple graph with n vertices must be connected, if it has more than $\frac{(n-1)(n-2)}{2}$ edges
3. Prove that a connected graph G is an Euler graph if all vertices of G are of even degree.
4. Use Kuratowski'stheorem to determine whether $K_{4,4}$ is planar.

Course Outcome 5 (CO5):

1. Prove that a tree with n vertices has $n - 1$ edges.
2. Find the chromatic number of $K_{m,n}$

3. Using graph model, how can the final exam at a university be scheduled so that no student has two exams at the same time?
4. Explain Prim's algorithm and use it to find the minimum spanning tree for the graph given below



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 (Statistical inference) **9 hours**

(Text-1:*Relevant topics from sections*-5.4, 3.6, 5.1, 7.2, 8.1, 8.3, 9.1-9.2,9.4)

Population and samples, Sampling distribution of the mean and proportion (for large samples only), Confidence interval for single mean and single proportions (for large samples only). Test of hypotheses: Large sample test for single mean and single proportion, equality of means and equality of proportions of two populations, small sample t-tests for single mean of normal population, equality of means (**only pooled t-test, for independent samples from two normal populations with equal variance**)

Module 4 (Advanced Graph theory -I) **9 hours**

(Text-2: *Relevant topics of sections* -10.1, 10.2, 10.3, 10.4, 10.5, 10.7)

Introduction- Basic definitions, Directed graphs, pseudo graph, multigraph, Graph models, Graph terminology-vertex degree, simple graph, Complete graphs, cycles, bipartite graph,

new graphs from old-union, complement, Representing graph-Adjacency matrix, Incidence Matrix , Isomorphism, Connectivity, path , cut vertices , cut edges ,connectedness in directed and undirected graphs, Counting paths between vertices-Euler paths and circuits , Fleury's algorithm**(proof of algorithm omitted)** , Hamiltonian paths and circuits. Ore's theorem, Planar graph, -Euler's formula on planar graphs, Kuratowski's theorem **(Proof of theorem omitted)**

Module 5 (Advanced Graph theory -II) (9 hours)

(Text-2: *Relevant topics* of *sections* –(10.8,11.1, 11.4, 11.5)

Graph colouring, dual graph, chromatic number, chromatic number of completegraphK_n, chromatic number of complete bipartite graph $K_{m,n}$, chromatic number of cycle C_n , Four color theorem, applications of graph colouring-scheduling and assignments

Trees-rooted trees, Properties of trees-level, height, balanced rooted tree, Spanning tree- basic theorems on spanning tree (**DFS, BFS algorithms and it's applicationsomitted**), Minimum spanning tree, Prim's algorithm and Kruskal's algorithm(**proofs of algorithms omitted)**

(9 hours)

Text Books

1. (Text-1) Jay L. Devore, *Probability and Statistics for Engineering and the Sciences*, 8th edition, Cengage, 2012
2. (Text-2) Kenneth H Rosen, *Discrete Mathematics and it's applications*, Tata Mc Graw Hill, 8 th Edition,

Reference Books

1. Hossein Pishro-Nik, *Introduction to Probability, Statistics and Random Processes*, Kappa Research, 2014 (Also available online at www.probabilitycourse.com)
2. Sheldon M. Ross, *Introduction to probability and statistics for engineers and scientists*, 4th edition, Elsevier, 2009.
3. T.Veera Rajan, *Probability, Statistics and Random processes,* Tata McGraw-Hill, 2008
4. Ralph P Grimaldi, *Discrete and Combinatorial Mathematics, An applied Introduction*, 4th edition, Pearson
5. C L Liu, *Elements of Discrete Mathematics*, Tata McGraw Hill, 4th edition,2017
6. NarasinghDeo, *Graph theory*, PHI, 1979
7. John Clark , Derek Allan Holton, *A first look at Graph Theory.*

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	**Statistical inference**	**9 hours**
3.1	Population and samples, Sampling distribution of single mean and single proportion(large samples)	1
3.2	Confidence interval for single mean and single proportions (large samples)	2
3.3	Hypothesis testing basics, large sample test for single mean, single proportion	2
3.4	Large sample test for equality of means and equality of proportions of two populations	2
3.5	t-distribution and small sample t-test for single mean and pooled t-test for equality of means	2
4	**Advanced Graph Theory -I**	**9 hours**
4.1	**Introduction**- Basic definition – Application of graphs Incidence	1

	and Degree – Isolated vertex, pendent vertex and Null graph	
4.2	Theorems connecting vertex degree and edges, bipartite graphs.	1
4.3	Adjacency matrix, incidence matrix, Isomorphism	1
4.4	Path, cut set, cut edges, Connectedness of directed and undirected graphs ,path isomorphism	2
4.5	Euler paths and circuits , Fleury's algorithm**(proof of algorithm omitted)** , Hamiltonian paths and circuits. Ore's theorem(proof omitted)	3
4.6	Planar graph, - Euler's theorem on planar graph , applications of Kuratowski's theorem	1
5	**Advanced Graph Theory -II**	**9 hours**
5.1	Graph colouring, dual graph	1
5.2	Chromatic number, chromatic number of K_n, $K_{m,n}$, C_n ,	2
5.3	Four colour theorem, applications of graph colouring-scheduling and assignments,	2
5.4	Trees-spanning trees-definition and example, minimum spanning tree,	2
5.5	Prim's algorithm and Kruskal's algorithm(**proofs of algorithms omitted)**	2

MODEL QUESTION PAPER (2019 Scheme)

Reg. No: ..... Total Pages: 4

Name : .....

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION (Month & year)

Course Code: MAT208

Course Name: PROBABILITY, STATISTICS AND ADVANCED GRAPH THEORY

(For Information Technology)

Max Marks:100Duration : 3 Hours

PART A (Answer all questions. Each question carries 3 marks)

1. Suppose X is a Poisson random variable find $P(X = 1) = P(X = 2)$ .Find the mean and variance. (3)
2. The diameter of a circular metallic discs produced by a machine is a random variable with mean 6cm and variance 2cm. Find the mean area of the discs. (3)
3. If the cumulative distribution of a continuous random variable is given by

$$F(x) = \begin{cases} 0 & x \leq 1 \\ 0.5 & 1 < x < 3, \\ 1 & x \geq 3 \end{cases}$$

find$P(X \leq 2)$(3)

4. The random variable X is exponentially distributed with mean 3. Find $P(X > t + 3|X > t)$ where t is any positive real number. (3)
5. The 95% confidence interval for the mean mass (in grams) of tablets produced by a machine is [0.56 0.57], as calculated from a random sample of 50 tablets. What do you understand from this statement? (3)
6. The mean volume of liquid in bottles of lemonade should be at least 2 litres. A sample of bottles is taken in order to test whether the mean volume has fallen below 2 litres. Give a null and alternate hypothesis for this test and specify whether the test would be one-tailed or two-tailed. (3)
7. Draw the graph represented by the following adjacency matrix

$$\begin{bmatrix} 1 & 2 & 1 \\ 2 & 0 & 0 \\ 0 & 2 & 2 \end{bmatrix}$$ (3)

8. Give an example of a graph which has a circuit that is (i) Eularian but not Hamiltonian(ii)Hamiltonian but not Eularian (iii) neither Eularian nor Hamiltonian (3)
9. Find the value of $\chi_2(K_3)$ (3)

10. How many non isomorphic spanning tree does K_3have ?. Justify your answer (3)

PART B (Answer one question from each module)

MODULE 1

11. (a) Verify that $p(x) = \left(\frac{8}{7}\right)\left(\frac{1}{2}\right)^x, x = 1, 2, 3$is a probability distribution. Find (i) $P(X \leq 2)$ (ii) $E[X]$ and (iii) $var(X)$. (7)

(b) Find the mean and variance of a binomial random variable (7)

OR

12. (a) Accidents occur at an intersection at a Poisson rate of 2 per day. What is the probability that there would be no accidents on a given day? What is the probability that in January there are at least 3 days (not necessarily consecutive) without any accidents? (7)

(b) Two fair dice are rolled. Let X denote the number on the first die and Y = 0 or 1, according as the first die shows an even number or odd number. Find (i) the joint probability distribution of X and Y, (ii) the marginal distributions. (iii) Are X and Y independent? (7)

MODULE 2

13. (a) The IQ of an individual randomly selected from a population is a normal distribution with mean 100 and standard deviation 15. Find the probability that an individual has IQ (i) above 140 (ii) between 120 and 130. (7)

(b) A continuous random variable X is uniformly distributed with mean 1 and variance 4/3. Find P(X < 0) (7)

OR

14. (a) Determine the value of c so that $f(x, y) = cxy$ for $0 < x < 3$, $0 < y < 3$ and $f(x, y) = 0$ otherwise satisfies the properties of a joint density function of random variables X and Y. Also find $P(X + Y \leq 1)$. Are X and Y independent? Justify your answer (7)

(b) The lifetime of a certain type of electric bulb may be considered as an exponential random variable with mean 50 hours. Using central limit theorem, find the approximate probability that 100 of these electric bulbs will provide a total of more than 6000 hours of burning time. (7)

MODULE 3

15. (a) The mean blood pressure of 100 randomly selected persons from a target population is 127.3units. Find a 95% confidence interval for the mean blood pressure of the population. (7)

(b) The CEO of a large electric utility claims that 80 percent of his 1,000,000 customers are very satisfied with the service they receive. To test this claim, the local newspaper surveyed 100 customers, using simple random sampling. Among the sampled customers, 73 percent say they are very satisfied. Based on these findings, do you think that the CEO is making a false claim of high satisfaction levels among his customers? Use a 0.05 level of significance. (7)

OR

16. (a) A magazine reported the results of a telephone poll of 800 adult citizens of a country. The question posed was: "Should the tax on cigarettes be raised to pay for health care reform?" The results of the survey were: Out of the 800 persons surveyed, 605 were non-smokers out of which 351 answered "yes" and the rest "no". Out of the remaining 195, who were smokers, 41 answered "yes" and the remaining "no". Is there sufficient evidence, at the 0.05 significance level, to conclude that the two populations smokers and non-smokers differ significantly with respect to their opinions?
(7)

(b) Two types of cars are compared for acceleration rate. 40 test runs are recorded for each car and the results for the mean elapsed time recorded below:

	Sample mean	Sample Standard Deviation
Car A	7.4	1.5
Car B	7.1	1.8

Determine if there is a difference in the mean elapsed times of the two car models at 95% confidence level. (7)

MODULE 4

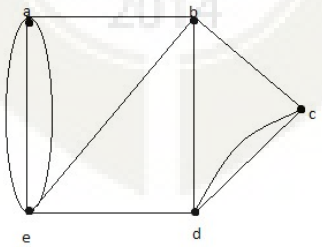
17. (a) Prove that an undirected graph has an even number of odd degree vertices (7)

(b)Show that a bipartite graph with an odd number of vertices does not have a Hamilton circuit (7)

OR

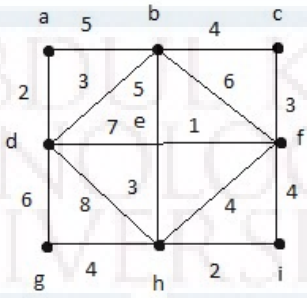
18. (a) Show that an edge in a simple graph is a cut edge if and only if this edge is not part of any simple circuit in the graph. (7)

(b) Use Fleury's algorithm to find an Euler circuit in the following graph (7)



MODULE 5

19. (a) Prove that a simple graph is a tree if and only if it is connected, but the deletion of any of it's edges produces a graph that is not connected (7)(b) Find the minimal spanning tree for the following graph by Prim's algorithm (7)



OR

20. (a)Show that a connected bipartite graph has a chromatic number of 2. (7)
(b) Prove that a full m-ary tree with l leaves has $n = \frac{ml-1}{m-1}$ vertices and $i = \frac{l-1}{m-1}$ internal vertices (7)

MAT 212	INTRODUCTION TO STOCHASTIC MODELS	CATEGORY	L	T	P	CREDIT
		BASIC SCIENCE COURSE	3	1	0	4

Preamble: This course introduces students to the modern theory of probability and its applications to modelling and analysis of stochastic systems, covering important models of random variables stochastic processes. These stochastic models have important applications in engineering and are indispensible tools in reliability theory, queueing theory and decision analysis.

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	Develop techniques to compute probabilities of discrete distributions and selectively apply them to solve real world problems
CO 2	Develop techniques to compute probabilities of continuous distributions and selectively apply them to solve real world problems
CO 3	Analyse joint distributions, correlations and collective behaviour of multiple random variables.
CO 4	Explore stochastic phenomena using appropriate tools and models like Poisson processes
CO 5	Develop Markov chain models of selected real world phenomena and analyse them using appropriate 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	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	35	35	35
Apply	35	35	35
Analyse	10	10	10
Evaluate	10	10	10
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. 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 componets each of which may fail independently with probability 0.15. If the equipment is able to function properly when at least 3 of the componets 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. Fit a Poisson distribution to the following data which gives the number of days (f) on which $x$number of accidents have occured in an accident-prone highway for a stretch of 500 days. Fit a Poisson distribution to the data and calculate the theoretical frequencies.

x	0	1	2	3	4	5	6	7	8
f	56	156	132	92	37	22	4	0	1

Course Outcome 2 (CO2)

1. What can you say about Insert Formula P(X=a)$P(X = a)$for any real number $a$when $X$is a (i) discrete random variable? (ii) 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 twise 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. State and prove the memoryless property of exponential random variable.

Course Outcome 3(CO3):

1. 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)
2. X and Y are independent random variables with X following an exponential distribution with parameter μ and Y following and exponential distribution with parameter λ. Find $P(X + Y \leqslant 1)$
3. Random variables X and $Y$are independent with X uniformly distributed in $(-2,2)$ and Y uniformly distributed in $(-1,1)$. If $U = X + Y$ and $V = X - Y$find $\mathrm{cov}(X, Y)$.
4. A communication channel is designed to transmit a sequence of signals. But due to noise in the transmission system each signal has a probability 0.02 of being received in error. If 1000 signals are transmitted, find using Central Limit Theorem the probability that at aleast 800 of them are received without error.

Course Outcome 4(CO4):

1. A random experiment consists of observing a busy traffic intersection continuously for one hour and counting the number of cars crossing the intesection from the start of the hour upto the current time. Classify this process and plot a possible sample function (realisation) of this process.
2. A random process $X(t)$ is defined by $a\cos(\omega t + \Theta)$where$a$ and ω are constants and Θ is uniformly distributed in $[0,2\pi]$. Show that $X(t)$ is WSS
3. Find the mean, variance and total power 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 probabilty that there would be utmost 2 disturbances in the first 4 minutes?

Course Outcome 5 (CO5):

1. Consider the experiment of sending a sequence of messages across a communication channel. Due to noise, there is a small probability p that the message may be received in error. Let X_n denote the number of messages received correctly upto and including the $n-$ thtransmission. Show that X_n is a homogeneous Markov chain. What are the transition probabilities~?

2. A survey conducted among consumers of two brands (A and B) of toothpastes revealed the following data; given that a person last purchased brand A, there is a 90% chance that her next purchase will be again brand A and given that a person last purchased brand B, there is an 80% chance that her next purchase will be again brand B. (i) If a person is currently a brand B purchaser, what is the probability that she will purchase brand A two purchases from now? (ii) What fraction of the consumers survayed purchase brand A? Brand B? (iii) It is estimated that a total of 1.2 crores of tooth paste units (of brand A and B combined) are purchased every year. On selling one unit of brand A tooth paste, the company earns a profit of Rs.2. For Rs.10 lakhs, an advertising firm guarantees to decrease from 10% to 5% the fraction of brand A customers who switch to brand B after a purchase. Should the company that makes brand A hire the advertising firm?

3. If $P$is the transition probability matrix of an ergodic chain, what happens to P^nas $n \to \infty$?

4. Give an example of transition probability matrix of a Markov chain in which all states are periodic of period 3.

Syllabus

Module 1 (Discrete probability distributions)

Discrete random variables and their probability distributions, Expectation, mean and variance, Binomial distribution, Poisson distribution, Poisson approximation to the binomial distribution, Geometric distribution, Fitting binomial and Poisson distributions.

Module 2 (Continuous probability distributions)

Continuous random variables and their probability distributions, Expectation, mean and variance, Uniform distribution-mean variance, exponential distribution-mean, variance, memory less property, Normal distribution-mean, variance, use of normal tables.

Module 3 (Joint distributions)

Joint distributions- discrete and continuous, marginal distributions, expectations involving multiple random variables, independence, correlations and covariance involving pairs of random variables, central limit theorem.

Module 4 (Stochastic processes)

Stochastic processes-definition and classification, mean, autocorrelation, cross correlations, wide sense stationary processes, Poisson process-distribution of inter-arrival times, splitting and merging properties.

Module 5 (Markov chains)

Discrete time Markov chain, transition probability matrix, Chapman-Kolmogorov theorem (without proof), Computation of transient probabilities, classification of states of finite-state chains,-irreducible and ergodic chains, steady-state probability distribution,

Text Books

1. SaeedGhahramani, Fundamentals of probability with stochastic processes, Pearson Education, Third edition, 2012
2. HosseinPishro-Nik, “Introduction to Probability, Statistics and Random Processes”, Kappa Research, 2014 (Also available online at www.probabilitycourse.com)

Reference Books

1. Sheldon M Ross, “Introduction to probability models”, Elsavier.
2. Geoffrey R. Grimmett and David R. Stirzaker, “Probability and random processes”, Oxford University Press
3. Oliver C. Ibe, “Fundamentals of Applied Probability and Random Processes”, Elsevier, 2005.
4. Sundarapandian, “Probability, Statistics and Queuing Theory”, Prentice-Hall Of India.

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**	
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	Geometricdistribution, distribution fitting	3
2	**Continuous Probability distributions**	
2.1	Continuous random variables and probability distributions, expected value, mean and variance (continuous)	3
2.2	Uniform distribution, exponential distribution, and normal distributions, mean and variance of these distributions, other properties	4
2.3	Normal distribution-mean, variance , use of normal tables	2
3	**Joint distributions**	
3.1	Discrete joint distributions, computation of probability, marginal distributions	2
3.2	Continuous joint distributions, computation of probability, marginal distributions	2
3.3	Independence of random variables, expectation involving more than one random variable	2
3.4	correlations and covariance involving pairs of random variables, central limit theorem	3
4	**Stochastic processes**	
4.1	Stochastic processes-definition and classification, mean, autocorrelation, cross correlations	3
4.2	wide sense stationary processes, properties	2
4.3	Poisson process, distribution of inter-arrival times	2

4.3	Splitting and merging of Poisson processes	2
5	**Discrete time Markov chains**	
5.1	Discrete time Markov chain, transition probability matrix, Chapman-Kolmogorov theorem	3
5.2	Computation of transient probabilities	2
5.3	classification of states of finite-state chains,-irreducible and ergodic chains	2
5.4	Steady state probability distribution of ergodic chains	2

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

MODEL QUESTION PAPER

FOURTH SEMESTER B.TECH DEGREE EXAMINATION

(Industrial Engineering)

INTRODUCTION TO STOCHASTIC MODELS

Max Marks :100 Duration : 3 Hours

PART A

(Answer *all* questions. Each question carries 3 marks)

1. Suppose X is binomial random variable with parameters $n = 100$ and $p = 0.02$. Find $P(X < 3)$ using Poisson approximation to X. (3)

2. The diameter of circular metallic discs produced by a machine is a random variable with mean 6cm and variance 2cm. Find the mean area of the discs. (3)

3. Find the mean and variance of the continuous random variable X with probability density function (3)
$$f(x) = \begin{cases} 2x - 4, & 2 \le x \le 3 \\ 0 & \text{otherwise} \end{cases}$$

4. The random variable X is exponentially distributed with mean 3. Find $P(X > t + 3|X > t)$ where t is any positive real number. (3)

5. Let X denote the height (in inches) and Y denote the weight (in pounds) of a randomly chosen indivdual. If the units of X and Y are changed to centimeters and kilograms respectively, how would it affect $\text{cov}(X, Y)$ and the correlation coefficient $\rho(X, Y)$? (3)

6. State giving reasons whether the relation $\text{var}(X + Y) = \text{var}(X) + \text{var}(Y)$ is true for random variables X and Y. (3)

7. Give an examle of a contiuous time discrete state random process, with non-constant mean function. (3)

8. $N(t)$ is a Poisson process with $P[N(2) = 0] = 0.1353$. Find $P[N(4) = 0]$ (3)

9. Consider the experiment of sending a sequence of messages across a communication channel. Due to noise, there is a small probability p that the message may be received in error. Let X_n denote the number of messages received correctly upto and including the n-th transmission. Is X_n a Markov chain ? Justify. (3)

10. The transition probability matrix of a Markov chain is $P = \begin{pmatrix} 0.3 & 0.7 \\ 0.4 & 0.6 \end{pmatrix}$. Find $P(X_3 = 2|X_1 = 1)$. (3)

PART B

(Answer one question from each module)

MODULE 1

11. (a) The probability mass function of a discrete random variable is $p(x) = kx, x = 1, 2, 3$ where k is a positive constant. Find (i)the value of k (ii) $P(X \le 2)$ (iii) $E[X]$ and (iv) $\text{var}(1 - X)$. (7)

    (b) Find the mean and variance of a binomial random variable (7)

OR

12. (a) Accidents occur at an intersection at a Poisson rate of 2 per day. what is the probability that there would be no accidents on a given day? What is the probability that in January there are at least 3 days (not necessarily consecutive) without any accidents? (7)

(b) A safety engineer feels that 35% of all industrial accidents in her plant are caused by failure of employees to follow instructions. She decides to look at the accident reports (selected randomly and replaced in the pile after reading) until she finds one that shows an accident caused by failure of employees to follow instructions. On average, how many reports would the safety engineer expect to look at until she finds a report showing an accident caused by employee failure to follow instructions? What is the probability that the safety engineer will have to examine at least three reports until she finds a report showing an accident caused by employee failure to follow instructions? (7)

MODULE 2

13. (a) Let X be a continuous random variable with density (7)

$$f(x) = \begin{cases} 0 & x < -1 \\ x & -1 \le x < 0 \\ ae^{-bx} & x \ge 0 \end{cases}$$

and expected value 1. Find the values of a and b. Also find var(X).

(b) The IQ of an individual randomly selected from a population is a normal distribution with mean 100 and standard deviation 15. Find the probability that an individual has IQ (i) above 140 (ii) between 120 and 130. (7)

OR

14. (a) A continuous random variable X is uniformly distributed with mean 1 and variance 4/3. Find $P(X < 0)$ (7)

(b) Suppose that the time between customer arrivals in a store is given by an exponential random variable X, such that the average time between arrivals is 2 minutes. Suppose you walk past the store and notice its empty. What is the probability from the time you walk past the store, the store remains empty for more than 5 minutes? (7)

MODULE 3

15. (a) Two fair dice are rolled. Let X denote the number on the first die and $Y = 0$ or 1, according as the first die shows an even number or odd number. Find (i) the joint probability distribution of X and Y, (ii) the marginal distributions. (iii) Are X and Y independent ? (7)

(b) The joint density function of random variables X and Y is given by (7)

$$f(x,y) = \begin{cases} e^{-(x+y)}, & x > 0, \quad y > 0 \\ 0 & \text{otherwise.} \end{cases}$$

Find $P(X + Y \le 1)$. Are X and Y independent? Justify.

OR

16. (a) Let X and Y be discrete random variables with joint probability mass function defined by (7)

$$f(x,y) = \begin{cases} \frac{1}{4}, & (x,y) \in \{(0,0),(1,1),(1,-1),(2,0)\} \\ 0 & \text{otherwise} \end{cases}$$

Find cov(X, Y) and interpret the result. Are X and Y independent ?

(b) The lifetime of a certain type of electric bulb may be considered as an exponential random variable with mean 50 hours. Using central limit theorem, find the approximate probability that 100 of these electric bulbs will provide a total of more than 6000 hours of burning time. (7)

MODULE 4

17. (a) A stochastic process is defined by $S_n = S_{n-1} + X_n (n = 1, 2, \ldots)$ where $S_0 = 0$ and X_i are independent random variables each taking values ± 1 with equall probability. Write any two possible realisations of this process. Also find the ensemble mean of the process. (7)

(b) A stochastic process $X(t)$ is defined by $X(t) = A\cos(\omega t) + B\sin(\omega t)$ where A and B are independent random variables with zero mean and equal variance. Show that $X(t)$ is stationary in the wide sense. (7)

OR

18. An insurance company models the arrival of insurance claims as a Poisson process with rate 60 per year.

(a) What is the probability that there are more than 3 claims in a one-month period ? What is the expected number and variance of the number of claims in a one-month period ? (7)

(b) The company estimates that the probability that an insurance claim is of more than Rs. 10 lakh is 0.2. What is the probability that there are more than 3 claims with claim amount more than Rs. 10 lakh during a 4-year period ?(Assume that the claim amounts are independent). (7)

MODULE 5

19. A survey conducted among consumers of two brands (A and B) of toothpastes reveal the following data; given that a person last purchased brand A, there is a 90% chance that her next purchase will be again brand A and given that a person last purchased brand B, there is an 80% chance that her next purchase will be again brand B,

(a) What percent of the consumers surveyed purchase brand A? brand B? (7)

(b) It is estimated that a total of 1.2 crores of tooth paste units (of brand A and B combined) are purchased every year. On selling one unit of brand A tooth paste, the company earns a profit of Rs. 2. For Rs. 10 lakhs, an advertising firm guarantees to decrease from 10% to 5% the fraction of brand A customers who switch to brand B after a purchase. Should the company that makes brand A hire the advertising firm? (7)

OR

20. (a) State the memoryless property of a Markov chain. Give one example each of a random process which is (i) a Markov chain (ii) not a Markov chain. In each case justify your claim mathematically. (7)

(b) The transition probability matrix of a discrete time Markov chain is (7)

$$P = \begin{bmatrix} 0 & 1 & 0 \\ 0.2 & 0 & 0.8 \\ 0 & 1 & 0 \end{bmatrix}$$

Classify the states as (i) periodic or aperiodic (ii) transient or recurrent. Also check whether the Markov chain is ergodic.

****

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

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)**

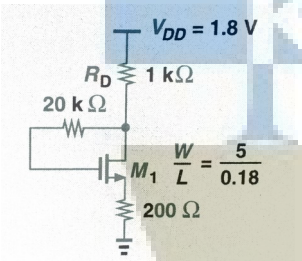
Course Code: ECT202

Course Name: ANALOG CIRCUITS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

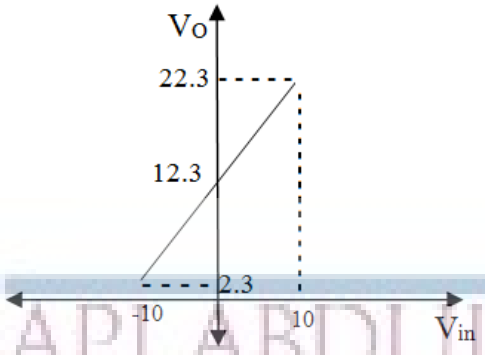
1	Design the first order RC high pass filter with cut off frequency 2Kz.	3	K3
2	Describe about the double ended clipping.	3	K2
3	Differentiate between DC and AC load lines.	3	K2
4	What is the significance of Miller effect on high frequency amplifiers?	3	K1
5	What are the effects of cascading in gain 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.

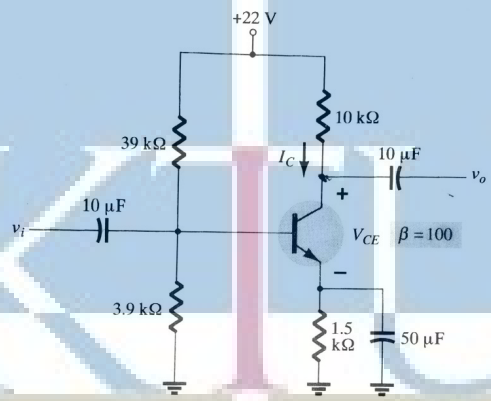
Module - I

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



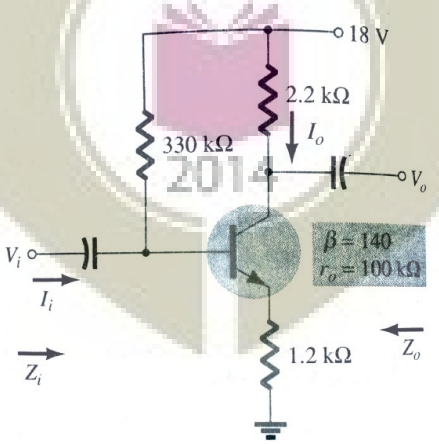
OR

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

ECT 206	COMPUTER ARCHITECTURE AND MICROCONTROLLERS*	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble: This course aims to impart knowledge of basic computer architecture and modern microcontrollers.

Prerequisite: ECT203 Logic Circuit Design

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

CO 1	Explain the functional units, I/O and memory management w.r.t a typical computer architecture.
CO 2	Distinguish between microprocessor and microcontroller.
CO 3	Develop simple programs using assembly language programming.
CO 4	Interface 8051 microcontroller with peripheral devices using ALP/Embedded C
CO 5	Familiarize system software and Advanced RISC Machine Architecture.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3											3
CO 2	3											3
CO 3	3		3		3							3
CO 4	3	3	3		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 Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

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

It is mandatory that a *course project* shall be undertaken by a student for this subject. The course project can be performed either as a hardware realization/simulation of a typical embedded system using Embedded C/ Assembly Language Programming. Instead of two assignments, two evaluations may be performed on the course project along with series tests, each carrying 5 marks. Upon successful completion of the project, a brief report shall be submitted by the student which shall be evaluated for 5 marks. The report has to be submitted for academic auditing. A few sample course projects are listed below:

Sample Course Projects

The below projects shall be done with the help of IDE for 8051/PIC/MSP/Arduino/Raspberry Pi-based interfacing boards/sensor modules.

1. Relay control
2. Distance measurement
3. Temperature measurement / Digital Thermometer
4. RF ID tags
5. Alphanumeric LCD display interface.
6. OLED display interfacing

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

SYLLABUS

Module 1: Computer Arithmetic and Processor Basics

Algorithms for binary multiplication and division. Fixed and floating-point number representation. Functional units of a computer, Von Neumann and Harvard computer architectures, CISC and RISC architectures. Processor Architecture – General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers. Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute, timing response, instruction sequencing and execution (basic concepts, datapath.

Module 2: 8051 Architecture

Microcontrollers and Embedded Processors. Architecture – Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts. Assembly Language Programming - Addressing Modes, Instruction set (Detailed study of 8051 instruction set is required).

Module 3: Programming and Interfacing of 8051

Simple programming examples in assembly language. Interfacing with 8051 using Assembly language programming: LED, Seven segment LED display. Programming in C - Declaring variables, Simple examples – delay generation, port programming, code conversion.

Interfacing of – LCD display, Keyboard, Stepper Motor, DAC and ADC -- with 8051 and its programming.

Module 4: Advanced Concepts

8051 Timers/Counters - Modes and Applications. Serial Data Transfer – SFRs of serial port, working, Programming the 8051 to transfer data serially. Introduction to ARM - ARM family, ARM 7 register architecture. ARM programmer's model. System software - Assembler, Interpreter, Compiler, Linker, Loader, Debugger.

Module 5: The Memory System

Types of memory - RAM, ROM. Memory Characteristics and Hierarchy. Cache memory – The basics of Caches, Mapping techniques, Improving Cache performance. Virtual memory – Overlay, Memory management, Address translation. Input/Output Organization – Introduction, Synchronous vs. asynchronous I/O, Programmed I/O, Interrupt driven I/O, Direct Memory Access.

Text Books

1. Muhammed Ali Mazidi & Janice Gilli Mazidi, R.D. Kinley, The 8051 microcontroller and Embedded System, Pearson Education, 2nd edition.
2. Subrata Ghoshal, Computer Architecture and Organization: From 8085 to Core2Duo and beyond, Pearson, 2011.
3. Steve Furber, ARM System - on-chip Architecture, Pearson Education

Reference Books

1. Mano M M, Computer System Architecture, 3rd Ed, Prentice Hall of India.
2. Computer organization and design: The Hardware/Software interface/David A. Patterson, John L. Hennessy. — 5th ed.
3. Computer Organisation V. Carl Hamacher, Zvonko G. Vranesic, Safwat G.Zaky.
4. John P Hayes, Computer Architecture and Organization, McGraw Hill.
5. Ramesh S Goankar, 8085 Microprocessor Architecture, Applications and Programming, Penram International, 5/e.
6. The 8051 Microcontrollers: Architecture Programming and Applications, K Uma Rao & Andhe Pallavi, Pearson, 2011.
7. Stallings W., Computer Organisation and Architecture, 5/e, Pearson Education.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures

1	**Computer Arithmetic and Processor Basics**	
1.1	Algorithms for binary multiplication and division	2
1.2	Fixed- and floating-point number representation in computers.	1
1.3	Functional units of a computer, Von Neumann and Harvard computer architectures, CISC and RISC architectures.	1
1.4	Processor Architecture – General internal architecture, Address bus, Data bus, control bus. Register set – status register, accumulator, program counter, stack pointer, general purpose registers.	2
1.5	Processor operation – instruction cycle, instruction fetch, instruction decode, instruction execute, timing response, instruction sequencing and execution (basic concepts), data path	3
	.	
2	**8051 Architecture**	
2.1	Microcontrollers and Embedded Processors and Applications	1
2.2	Architecture – Block diagram of 8051, Pin configuration, Registers, Internal Memory, Timers, Port Structures, Interrupts.	3
2.3	Addressing Modes of 8051	1
2.4	Instruction sets (Detailed study of 8051 instructions)	4
3	**Programming and Interfacing of 8051**	
3.1	Simple programming examples in assembly language.	2
3.2	Interfacing programming in Assembly language	2
3.3	Programming in C - Declaring variables, Simple examples – delay generation, port programming, code conversion.	3
3.4	Interfacing of 7 segment LCD display	1
3.5	Interfacing of Keyboard and stepper motor	2
3.6	Interfacing of DAC and ADC	2
4	**Advanced Concepts**	
4.1	8051 Timers/Counters - Modes and Applications	2
4.2	Serial Data Transfer – SFRs of serial port, working, Programming the 8051 to transfer data serially	2
4.3	Introduction to ARM - ARM family, ARM 7 register architecture. ARM programmer's model	2
4.4	System software - Assembler, Interpreter, Compiler, Linker, Loader, Debugger.	2
5	**Memory System**	
5.1	Types of memory - RAM, ROM. Memory Characteristics and Hierarchy	2
5.2	Cache memory – The basics of Caches, Mapping techniques, Improving Cache performance	2
5.3	Virtual memory – Overlay, Memory management, Address translation	2
5. 4	Input/Output Organization – Introduction, Synchronous vs. asynchronous I/O, Programmed I/O, Interrupt driven I/O, Direct Memory Access.	3

Simulation assignments

The following examples may be solved in C program

1. Program to convert the ASCII number into unpacked BCD.
2. Program to swap a number 0 x ab to 0 x ba, where a and b are hex digits.
3. Program to find the number of 1's in an 8-bit data item.
4. Program to display 'M' and 'E' on the LCD connected to 8051 using the BUSY FLAG.
5. Program to rotate a stepper motor 50^0 in the clock wise direction.
6. Program to toggle pin P1.4 every second using interrupts for a frequency of 22 MHz. Use timer 1 in mode 1.
7. Program to generate a square wave of 1 kHz with duty cycle 33%. Use timer 1 in interrupt mode with a crystal frequency of 11.0592 MHz.

Model Question Paper

A P J Abdul Kalam Technological University

Fourth Semester B Tech Degree Examination

Branch: Electronics and Communication

Course: ECT 206 COMPUTER ARCHITECTURE AND MICROCONTROLLERS

Time: 3 Hrs Max. Marks: 100

Part – A

*Answer all questions. Questions carry **3 marks** each.*

1. Represent 4946.278941 as a 32 bit number in IEEE 754 format.
2. Which is more important for the functioning of a basic processor, Program Counter or Stack Pointer. Justify your answer.
3. List the components of 8051 microcontroller.
4. Write the operations happening in the following instructions:
   ADD A, 56
   XCHD A, @R1
   DJNZ R6, LABEL
   DIV AB
   XRL A, #0FFh
   JB P1.2 LABEL
5. Write an embedded C program for 8051 microcontroller to continously rotate a stepper motor clockwise.
6. Write an embedded C program for 8051 microcontroller to blink P2.5 every 2 seconds
7. List the different modes and give corresponding uses of timers in 8051 microcontroller
8. Which are the SFRs used for serial communication in 8051 microcontroller. Give there functions.
9. Illustrate the memory hierarchy in a computer system.
10. Is ROM a random access memory? Justify your answer.

Part – B

Answer one question each from all modules

Module – 1

11. a) With an example explain the "shift and add" algorithm for multiplying two binary numbers. (5 marks)

    b) With relevant diagrams illustrate the functioning of a basic (non – pipelined) processor. (9 marks)

OR

12. a) Differentiate RISC and CISC architectures. (4 marks)

    b) Explain Instruction Cycle with a sample timing diagram (10 marks)

Module – 2

13. a) Illustrate the complete memory organisation of 8051 microcontroller (10 marks)

    b) Differentiate microprocessors and microcontrollers. (4 marks)

OR

14. a) Explain about the Addressing Modes of 8051 microcontroller with examples. (7 marks)

    b) Describe the classification of the Instruction Set of 8051 microcontroller with examples. (7 marks)

Module – 3

15. a) Write an embedded C program for 8051 microcontroller to read an analogue signal from an ADC and reproduce the same using a DAC (9 marks)

    b) Write an assembly language program for 8051 microcontroller to sort N number in ascending order. Assume that the numbers are stored in continuous locations starting from 0x4321 onwards. (5 marks)

OR

16. a) Write an embedded C program for 8051 microcontroller to repeatedly display the sequence 1,5,8,0,2,6,4,9,3,7 using a 7 – segment display with a delay of 1.5 seconds between each number. (9 marks)

    b) Write an assembly language program for 8051 microcontroller to find the cube of an 8 – bit number (5 marks)

Module – 4

17. a) Assume a switch is connected to pin PL7. Write a embedded C program for 8051 microcontroller to monitor its status and
    send two messages to serial port continuously as follows:
    SW=0 send "NO"
    SW=1 send "YES"
    Assume XTAL = 11.0592 MHz, 9600 baud, 8-bit data, and 1 stop bit. (10 marks)

    b) Describe the ARM 7 register architecture (4 marks)

OR

18. a) Write a embedded C program for 8051 microcontroller to send the message "Hello World !" to serial port. Assume a SW is connected to pin P1.2. Monitor its status and set the baud rate as follows:
SW = 0 , 4800 baud rate
SW = 1 , 9600 baud rate
Assume XTAL = 11.0592 Mhz, 8 – bit data, and 1 stop bit (10 marks)
b) Explain how a HLL program is executed as machine language in a processor (4 marks)

Module – 5

19. a) Differentiate synchronous and asynchronous I/O.
Which is more efficient with respect to processor utilisation? Justify your answer (8 marks)
b) Explain direct mapping of cache memory with an example (6 marks)

OR

20. a) Differentiate interrupt driven and programmed I/O.
Which is more efficient with respect to processor utilisation? Justify your answer (8 marks)
b) Explain about memory management using virtual memory. (6 marks)

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]

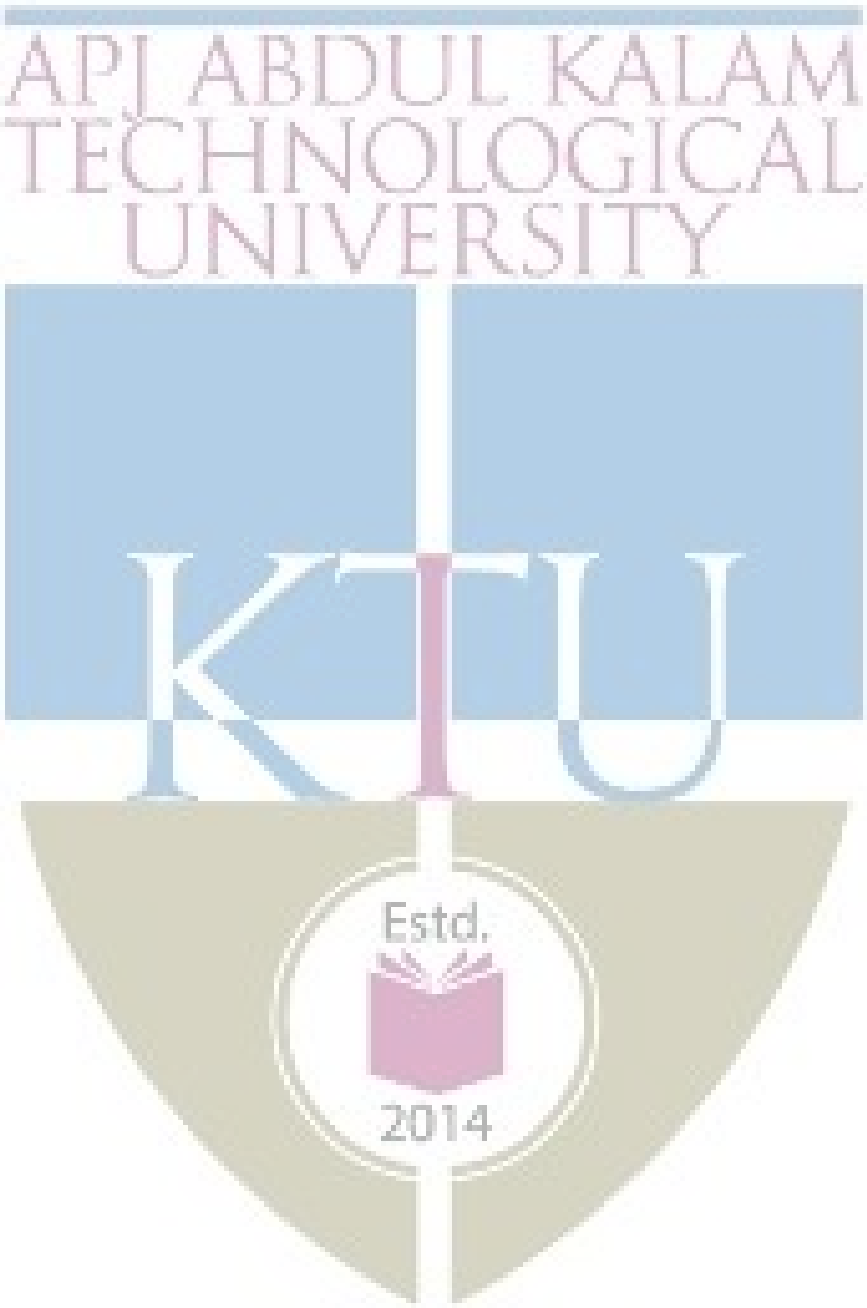
1. RC integrating and differentiating circuits (Transient analysis with different inputs and frequency response)
2. Clipping and clamping circuits (Transients and transfer characteristics)
3. RC coupled CE amplifier - frequency response characteristics
4. MOSFET amplifier (CS) - frequency response characteristics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



ECL 204	MICROCONTROLLER LAB	CATEGORY	L	T	P	CREDIT
		PCC	0	0	3	2

Preamble: This course aims to

(i) Familiarize the students with Assembly Language Programming of modern microcontrollers.

(ii) Impart the skills for interfacing the microcontroller with the help of Embedded C/Assembly Language Programming.

Prerequisite: Nil

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

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

Mapping of course outcomes with program outcomes

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

Assessment

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

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

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

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

(e) Record : 5 Marks

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

PART – A (At least 6 experiments are mandatory)

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

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

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

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

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