Techno India NJR Institute of Technology

Course File

Session 2021-22

Advanced Engineering Mathematics

(3EC201)

For Techno India NJR Institute of Technology
पंकज पोरवाल
Dr. Pankaj Kumar Porwal
(Principal)

Dr. Kalpana Fatawat
(Associate Professor)
Department of Computer Science

3EC2-01: Advance Engineering Mathematics-I

3 Credits | **Max. Marks: 150 (IA:30, ETE:120)**
3L:0T:0P | **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Numerical Methods – 1:** Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Gauss's forward and backward interpolation formulae. Stirling's Formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange's formulae. Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.	10
2	**Numerical Methods – 2:** Numerical solution of ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge- Kutta method of fourth order for solving first and second order equations. Milne's and Adam's predicator-corrector methods. Solution of polynomial and transcendental equations-Bisection method, Newton-Raphson method and Regula-Falsi method.	8
3	**Laplace Transform:** Definition and existence of Laplace transform, Properties of Laplace Transform and formulae, Unit Step function, Dirac Delta function, Heaviside function, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs by Laplace transforms method.	10
4	**Fourier Transform:** Fourier Complex, Sine and Cosine transform, properties and formulae, inverse Fourier transforms, Convolution theorem, application of Fourier transforms to partial ordinary differential equation (One dimensional heat and wave equations only).	7
5	**Z-Transform:** Definition, properties and formulae, Convolution theorem, inverse Z-transform, application of Z-transform to difference equation.	5
	Total	40

Office of Dean Academic Affairs
Rajasthan Technical University, Kota

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Course Overview:

In this 47-hour course, students will learn the concepts of Advance Mathematics and its applications in different branches of Computer Science. How it is fruitful in classifying and analyzing the data will also be emphasized.

Course Outcomes:

CO. NO.	Cognitive Level	Course Outcome
1	Knowledge	To learn the concepts and principles of Random variable and Probability distribution
2	Application	Students are able to apply different prob. Dist. To identify and solve real life problem.
3	Analysis	To learn the formulation of different mathematical problems into optimization problems and application in Engineering field.
4	Application	Apply the principles of optimization using differential calculus
5	Synthesis	Student able to formulate real life problem into LPP, transformation and assignment problem.

CO. NO.	Cognitive Level	Course Outcome
1	Application	Apply the concept of various distributions in the study of different partial differential equations i.e. heat, wave etc. and apply the optimization techniques to non-linear problems.
2	Knowledge	To describe the concept of random variable.
3	Analysis	Analysis of different partial differential equation i.e. heat, wave etc.
4	Synthesis	Application of Transportation and Assignment method in real world problems.

Prerequisites:

- Understanding of basic Statistics
- Understanding of basic high-school mathematics.
- Aware of basic matrices operations.

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Advanced Engineering Mathematics Year of study: 2017-18															
Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO236.1	3	1	0	2	2	0	0	0	0	0	1	2	0	0	0
CO236.2	2	2	2	2	0	0	0	0	0	0	1	2	0	0	0
CO236.3	3	2	1	0	0	0	0	0	0	2	1	2	0	0	0
CO236.4	2	1	2	2	2	2	0	0	2	0	1	0	0	0	0
CO236.5	2	1	1	2	2	0	0	0	0	0	1	0	0	0	0
C236 (AVG)	2.40	1.40	1.20	1.60	1.20	0.40	0.00	0.00	0.40	0.40	1.00	1.20	0.00	0.00	0.00

Course Coverage Module Wise:

Lecture plan based on Unit 1

Lecture Sl. No.	Topic
1	Student is able to grasp type of variables.
2	Student becomes familiar different types of probability distribution.
3	Student is able to grasp the concept of moments.
4	Student should be able to identify the generating functions.
5	Student becomes familiar with Kurtosis and Skewness.

Lecture plan based on Unit 2

Lecture Sl. No.	Topic
6	Introduction to various distributions.
7	Student is able to grasp concept of Normal Distribution and its applications.
8	Student becomes familiar with the concepts Poisson distribution and its applications.
9	Student is able to compare the normal and Poisson distribution.
10	Student becomes familiar with uniform and exponential distributions.
11	Student is able to grasp concept of correlation coefficient.

Lecture plan based on Unit 3

Lecture Sl. No.	Topic
12	Student is able to grasp the concept of optimization.
13	Student becomes familiar with its applications.
14	Student is able to design the mathematical programming.
15	Student is able to carry out the comparative study.

Lecture plan based on Unit 4

Lecture Sl. No.	Topic
16	Student becomes familiar with basic differential calculus.
17	Student is able to grasp the concept of single and multi-variable optimization.

Lecture plan based on Unit 5

Lecture Sl. No.	Topic
18	Student is able to understand Simplex method.
19	Student is able to grasp the concept of two phase method.
20	Student is able to grasp the concept of Duality.
21	Applications of LPP in Transportation problems.
22	Applications of LPP in Assignment problems.

TEXT/REFERENCE BOOKS

- Advanced Engineering Mathematics (RTU), Gokharoo & Saini, Navakar Publications.
- Fundamentals of Mathematical Statistics, S.C. Gupta & V.K. Kapoor, Sultan Chand & Sons.
- Optimization Techniques (RTU), Gokharoo & Saini, Navkar Publications.

Teaching and Learning resources:

Unit 1

https://www.khanacademy.org/math/statistics-probability/random-variables-stats-library/random-variables-discrete/v/random-variables

https://www.youtube.com/watch?v=5ghhMZjV65g

http://www.igntu.ac.in/eContent/IGNTU-eContent-467281593500-B.Com-4-Prof.ShailendraSinghBhadouriaDean&-BUSINESSSTATISTICS-All.pdf

Unit 2

https://www.youtube.com/watch?v=BWcQ-ZFf_TU

https://www.youtube.com/watch?v=8MpgZJHcB8w

https://www.youtube.com/watch?v=8MpgZJHcB8w

Unit 3

https://nptel.ac.in/courses/111/105/111105039/

Unit 4

https://www.youtube.com/watch?v=qzXPaWl-BzM

Unit 5

https://www.youtube.com/watch?v=a2QgdDk4Xjw

https://www.youtube.com/watch?v=5Xg-1KLnslk

https://www.youtube.com/watch?v=RcPhmPhjMbc

https://www.youtube.com/watch?v=qxls3cYg8to

Assessment Methodology:

1. Assignments one from each unit and oral questioning.
2. Midterm subjective paper. (Twice during the semester)
3. Final paper at the end of the semester subjective.

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ADVANCED ENGINEERING MATHEMATICS QUESTION BANK

Unit 1

Explain the concept of random variable with examples.

What is mathematical expectation ? Explain with examples.

State the theorems on expection.

Determine the mean and variance of the random variable X having the following probability distribution.

$X = x$	1	2	3	4	5	6	7	8	9	10
$P(x)$	0.15	0.10	0.10	0.01	0.08	0.01	0.05	0.02	0.28	0.20

Calculate the coefficient of correlation from the following data –

X	1	2	3	4	5	6	7	8	9
Y	9	8	10	12	11	13	14	16	15

Unit 2

Explain the normal distribution and its limitations.

What is spearman rank correlation? Find the rank correlation for the following data:

The scores for nine students in physics and math are as follows:

- Physics: 35, 23, 47, 17, 10, 43, 9, 6, 28
- Mathematics: 30, 33, 45, 23, 8, 49, 12, 4, 31

Compute the student's ranks in the two subjects and compute the Spearman rank correlation.

Patients arrive at a hospital accident and emergency department at random at a rate of 6 per hour.

(a) Find the probability that, during any 90 minute period, the number of patients arriving at the hospital accident and emergency department is

(i) exactly 7

(ii) at least 10

A patient arrives at 11.30 a.m.

(b) Find the probability that the next patient arrives before 11.45 a.m.

Unit 3

What is optimization ?

What are the application of optimization in engineering field ?

Unit 4

Consider the following N.L.P.P:

Minimize $Z=2x_1^2 -24x_1+2x_2^2-8x_2+2x_3^2-12x_3+200$.

Show that the function is convex. Solve the problem by solving each one-variable function by calculus.

What is the Kunh Tuker conditions ?

Unit 5

What are the various methods to solve a LPP? What do you mean by unbounded solution?

What is Duality?

Solve the following LPP :

Maximize $Z = 3x_1 + 5x_2 + 4x_3 + 0s_1 + 0s_2 + 0s_3$

subject to the constraints

(i) $2x_1 + 3x_2 + s_1 = 8$, (ii) $2x_2 + 5x_3 + s_2 = 10$, (iii) $3x_1 + 2x_2 + 4x_3 + s_3 = 15$

and $x_1, x_2, x_3, s_1, s_2, s_3 \geq 0$

3E1136

Total No of Pages: [4]

3E1136

B. Tech. III - Sem. (Main / Back) Exam., Dec. 2019
BSC Computer Science & Engineering
3CS2-01 Advanced Engineering Mathematics
CS, IT

Time: 3 Hours **Maximum Marks: 120**

Instructions to Candidates:

Attempt all ten questions from Part A, five questions out of seven questions from Part B and four questions out of five from Part C.

Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly. Units of quantities used /calculated must be stated clearly.

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. NIL 2. NIL

PART – A

(Answer should be given up to 25 words only) **[10×2=20]**

All questions are compulsory

Q.1 What is the coefficient of skewness, if the man and mode of the distribution are equal?

Q.2 What is the variance of the Poisson distribution with mean value 5?

Q.3 Define the exponential distribution.

Q.4 What is optimization?

Q.5 Match the following type of problems with their descriptions –

(a)	Geometric programming problem	(i)	Classical optimization problem
(b)	Quadratic programming problem	(ii)	Objective and constraints are posynomials with positive coefficients
(c)	Stochastic programming problem	(iii)	Objective is quadratic and constraints are linear
(d)	Calculus of variations problem	(iv)	Design variables are nondeterministic or probabilistic

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Q.6 Write four engingeering applications of optimization.

Q.7 Consider the following problem –

Minimize $z = f(X)$,

Subject to $g_j(X) \leq 0; j = 1, 2, 3, \ldots, m.$

Then write the suitable Kuhn – Tucker conditions.

Q.8 What is difference between a slack and surplus variable?

Q.9 What happens when m = n in a Linear Programming Problem (LPP)? Where m and n denotes the numbers of equation and decision variables respectively.

Q.10 For non – degenerate feasible solution of m × n transportation problem, how many independent individual positive assignments will be required?

PART – B

(Analytical/Problem solving questions) **[5×8=40]**

Attempt any five questions

Q.1 A box contains 'a' white and 'b' black balls, 'c' balls are drawn. Find the expected value of the number of white balls drawn.

Q.2 The joint probability density function of a two – dimensional random variable (X, Y) is given by –

$$f(x,y) = \begin{cases} 2, & 0 < x < 1, 0 < y < x \\ 0, & \text{elsewhere} \end{cases}$$

Find the marginal density functions of X and Y. Also find the conditional density function of Y given X = x and conditional density function of X.

Q.3 Fit a straight line to the following data –

X	1	2	3	4	6	8
Y	2.4	3	3.6	4	5	6

Q.4 A company desires to devote the excess capacity of the three machines lathe, shaping and milling to make three products A, B and C. The available time per month in these machines are tabulated below –

Machine	Lathe	Shaping	Milling
Available time per month	200 hours	110 hours	180 hours

The time (in hours) taken to produce each unit of the products A, B and C on the machines is displayed in the table below –

Machine	Lathe	Shaping	Milling
Product A	5	2	4
Product B	2	2	Nil
Product C	3	Nil	3

The profit per unit of the products A, B and C are ₹ 20, ₹ 15 and ₹ 12 respectively. Formulate the mathematical model to maximize the profit.

Q.5 Find the maximum and minimum value of the function –

$u = x^3 + y^3 - 3x - 12y + 50$

Q.6 Find the optimum of the following constrained multivariable problem –

Minimize $Z = -x_1^2 + (x_2 + 1)^2 + (x_3 - 1)^2$

Subject to $x_1 + 5x_2 - 3x_3 = 6$

$x_1, x_2, x_3 \geq 0.$

Q.7 Using two phase simplex method, solve the following linear programming problem –

Max. $z = -x_1 - x_2$

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

$-2x_1 - 3x_2 \leq -30$

$x_1 + x_2 \leq 5$

and $x_1, x_2 \geq 0$

PART – C

(Descriptive/Analytical/Problem Solving/Design Questions) **[4×15=60]**

Attempt any four questions

Q.1 (a) Find mean and variance of Poison distribution.

(b) How optimization problem are classified based on the nature of expressions?

Q.2 (a) Using Simplex method, show that the following linear programming problem has an unbounded solution –

Maximize $z = x_1 + 2x_2$

Subject to $x_1 - x_2 \leq 10$

$3x_1 - 2x_2 \leq 40$

$x_1, x_2 \geq 0$

(b) Calculate the coefficient of correlation from the following data –

X	1	2	3	4	5	6	7	8	9
Y	9	8	10	12	11	13	14	16	15

Q.3 If the skulls are classified as A, B and C according as the length – breadth index is under 75, between 75 and 80, or over 80. Using normal distribution find approximately the mean and standard deviation of a series in which A are 58%, B are 38% and C are 4%, being given that –

$$f(t) = \frac{1}{\sqrt{2\pi}} \int_0^t \exp(-x^2/2)dx,$$

then $f(0.20) = 0.08$ and $f(1.75) = 0.46$.

Q.4 Solve the following problem using Kuhn – Tucker conditions –

Minimize $f(x_1, x_2, x_3) = x_1^2 + x_2^2 + x_3^2$

$g_1 = 2x_1 + x_2 - 5 \leq 0$

$g_2 = x_1 + x_3 - 2 \leq 0$

$g_3 = 1 - x_1 \leq 0$

$g_4 = 2 - x_2 \leq 0$

$g_5 = -x_3 \leq 0.$

Q.5 (a) Write the dual of the following problem –

Minimize $z = 2x_1 + x_2$

Subject to $3x_1 + x_2 \geq 3, 4x_1 + 3x_2 \geq 6, x_1 + 2x_2 \geq 2$

and $x_1, x_2, x_3 \geq 0$

(b) Using Vogel's Approximation method, find basic feasible solution for the following unbalanced transportation problem –

	Destination				Availability
	X	Y	Z	W	
I	14	19	11	20	10
II	19	12	14	17	15
III	14	16	11	18	12
Requirement	8	12	16	14	
