

CSE 201

B. Tech. (IIIrd SEMESTER) EXAMINATION, 2025-26

BACHELOR OF TECHNOLOGY

(CSE)

Mathematics for Machine Learning

Time : Three Hours]

[Maximum Marks : 75

Note: There are **three** sections (A, B and C) and candidate has to attempt questions from all sections. Marks are indicated against each section.

Section-A

1. Attempt all parts of the following : 5×3=15

(a) Find $\frac{d^2y}{dx^2}$, if $y = x^3 + \tan x$.

(b) Let $\vec{a} = 2\hat{i} + 3\hat{j} + \hat{k}$ and $\vec{b} = \hat{i} - 2\hat{j} + 4\hat{k}$, then find

(i) $\vec{a} + \vec{b}$ (ii) $\vec{a} \cdot \vec{b}$ (iii) $|\vec{a} \times \vec{b}|$

(c) Find the remainder when the polynomial $P(x) = x^3 - 3x^2 + 4x - 5$ is divided by $(x - 2)$.

(d) Find the value of a,b,c and d from the equation :

$$\begin{bmatrix} a - b & 2a + c \\ 2a - b & 3c + d \end{bmatrix} = \begin{bmatrix} -1 & 5 \\ 0 & 13 \end{bmatrix}$$

(e) What do you mean by dispersion ? Write the different method of computing dispersion.

Section-B

Note: Attempt all questions :

4×5=20

2. (a) A function $f(x)$ is defined as follows :

$$f(x) = \begin{cases} 1 + x, & x \leq 2 \\ 5 - x, & x > 2 \end{cases}$$

Show that $f(x)$ is not differentiable at $x = 2$.

Or

(b) Find the gradient and Hessian matrix of the function

$$f(x, y, z) = x^2 + y^2 + yz \sin(x).$$

3. (a) Prove that

$$\frac{1}{1+x^{b-a}+x^{c-a}} + \frac{1}{1+x^{a-b}+x^{c-b}} + \frac{1}{1+x^{b-c}+x^{a-c}} = 1$$

Or

(b) By using the properties of determinants show that :

$$\begin{vmatrix} x+y+2z & x & y \\ z & y+z+2x & y \\ z & x & z+x+2y \end{vmatrix} = 2(x+y+z)^3$$

4. (a) The contents of urns I, II and III are as follows :

1 white, 2 black and 3 red balls,

2 white, 1 black and 1 red balls and

4 white, 5 black and 3 red balls.

One urn is chosen at random and two balls drawn from it. They happen to be white and red. What is the probability that they come from urns I, II or III ?

Or

- (b) Let X be a continuous random variable with p.d.f.

$$f(x) = \begin{cases} ax, & 0 \leq x \leq 1 \\ a, & 1 \leq x \leq 2 \\ -ax + 3a, & 2 \leq x \leq 3 \\ 0, & \text{otherwise} \end{cases}$$

- (i) Determine the constant a
(ii) Compute $P(X \leq 1.5)$

5. (a) If X and Y are independent poisson variates such that
 $P(X = 1) = P(X = 2)$ and $P(Y = 2) = P(Y = 3)$.
Find the variance of $X - 2Y$.

Or

- (b) Calculate Arithmetic Mean and Standard Deviation from the following data :

x	2	4	6	8	10
f	1	4	6	4	1

Section-C

Note: Attempt any two questions : 2×20=40

6. (a) Find the rank of the matrix

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

- (b) Consider a linear system of equation :

$$3x_1 - 2x_2 + 3x_3 = 8$$

$$2x_1 + x_2 - x_3 = 1$$

$$4x_1 - 3x_2 + 2x_3 = 4$$

Solve by using matrix method.

7. (a) Describe Lagrangian Multipliers Method.
 (b) Optimize the function by using Lagrangian Multiplier's method :
 $f(x, y) = xy + 1$, subject to constraint $x^2 + y^2 = 1$.

8. (a) Define Distribution function with an example. Also write its properties.
 (b) Two random variable x and y have the following joint probability density function :

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

Find (i) Marginal probability density function of x and y

(ii) Covariance between x and y .

9. (a) Explain the following terms :

- (i) Simple and composite hypothesis
 (ii) Error of first and second kind
 (iii) Level of Significance
 (iv) Power function

- (b) If $x \geq 1$ is the critical region for testing $H_0 : \theta = 2$ against the alternative $H_1 : \theta = 1$, on the basis of the single observation from population,

$$f(x, \theta) = \theta e^{-\theta x}, x > 0, \theta > 0.$$

Obtain the value of type I and type II errors and power function.

