

IMSc DS (NEP) Sem.2 Examination
MDC- DTSC-124
Mathematical Science Concept-II

Time : 2.00 Hours]

May-2025

[Max. Marks : 50

Instructions: All questions are compulsory. Use of non-programmable scientific calculator is allowed.

Q.1 (a) Find the first and second derivative of the function $x^3 \sin x$ using Urdhva Tiryag sutra and Meru Prastara. (05)

(b) Using Vertically and Crosswise Sutra, solve 12131×20412 with proper steps. (05)

OR

(a) Using Urdhva Tiryag sutra, solve the integral of $\int x \cos x \, dx$. (05)

(b) Using Vertically and Crosswise Sutra, solve the determinant: (05)

$$D = \begin{vmatrix} 2 & 1 & 4 & 3 \\ 3 & -2 & -2 & 4 \\ -1 & -3 & 1 & -4 \\ 2 & 1 & 3 & 2 \end{vmatrix}$$

Q.2 (a) The demand function for a commodity is $p = 35 - 2x - x^2$. Find the consumer's surplus at equilibrium price $p_0 = 20$. (05)

(b) Find the area of the region bounded by $y^2 = 4x$ and the line $x = 3$. (05)

OR

(a) Define: Integration by Parts Rule. Evaluate the following integrals: (05)

i. $\int (1+x) \log x \, dx$

ii. $\int \frac{\log x}{(x+1)^2} \, dx$

(b) (Using Concept of Integration) (05)

A company determines that the marginal cost of producing x units of a particular product during a one-day operation is $MC = 16x - 1591$, where the production cost is in rupees. The selling price of commodity is fixed at Rs. 9 per unit, and the fixed cost is Rs. 1800 per day.

i. Find the Cost function, Revenue function, Profit function

ii. What is the maximum profit that can be obtained in a one-day operation.

Q.3 (a) Find the component form of sum of \overline{AB} and \overline{CD} , where the vectors are (05)

$$A = (1, -1), B = (2, 0), C = (-1, 3) \text{ and } D = (-2, 2)$$

(b) If $2X + 3Y = \begin{bmatrix} 2 & 3 \\ 4 & 0 \end{bmatrix}$ and $3X + 2Y = \begin{bmatrix} 2 & -2 \\ -1 & 5 \end{bmatrix}$ then find X and Y . (05)

OR

(a) Let $u = 3i + 2j$, $v = i + 2j$, and $w = 2i - j$. Find scalars a and b such that $u = av + bw$. (05)

(b) Find the value of x : $\begin{bmatrix} 1 & 2 & 0 \\ 2 & 0 & 1 \\ 1 & 0 & 2 \end{bmatrix} \begin{bmatrix} 0 \\ 2 \\ x \end{bmatrix} = 0$ (05)

Q.4 (a) Use the three iterations of the Newton-Raphson method to find the root of the function $f(x) = x^2 - 3$ starting from $x_0 = 2$. (05)

(b) Use Descartes's rule of sign and Budan's theorem to find maximum number of positive roots, maximum number of negative roots, and bound of number of real roots of the function $f(x)$ in $[0, 2]$. Show results in a table. (05)

$$f(x) = x^4 - 4x + 1$$

OR

(a) Use the least-square method to fit a straight line to the following data points: $(0, 1)$, $(1, 2)$, $(2, 4)$, and $(3, 5)$ (05)

(b) Use the Lagrange interpolation approach to find the polynomial that fits the data: $(0,1)$, $(1, 3)$, and $(2,5)$ (05)

Q.5 Do as directed. Attempt any **TEN** out of **TWELVE**: (Each carries 01 mark) (10)

(1) For regression line $Y = 3.76 + 0.4 X$, what is the estimated value of Y for $X = 12$?

(2) $\frac{d}{dx} (\sin x \cdot \cos x) = \underline{\hspace{2cm}}$

- A. $\cos^2 x + \sin^2 x$ C. $\sin x \cdot \cos x$
 B. $-\cos x \cdot \sin x$ D. $\cos^2 x - \sin^2 x$

(3) $\int \frac{(\log x)^2}{x} dx = \underline{\hspace{2cm}}$

- A. $\frac{(\log x)^2}{2} + c$ C. $\frac{-\log x}{2} + c$
 B. $\frac{\log x}{2} + c$ D. $\frac{(\log x)^3}{3} + c$

(4) Find adjoint of the matrix A where $A = \begin{bmatrix} -2 & 5 \\ 2 & -3 \end{bmatrix}$

(5) What is Correlation? State its types.

(6) Define: Average cost and Marginal cost

(7) Find the distance from point $(3, -4, 2)$ to the xy -plane.

(8) If $A = \begin{bmatrix} 2 & 3 & 0 \\ -2 & 2 & 1 \\ 0 & 3 & 2 \end{bmatrix}$ then find transpose of the matrix A .

- (9) Find dot product $v \cdot u$ where $v = i - 2j + \sqrt{3}k$, $u = -i + 2j - \sqrt{3}k$.
- (10) The Newton's Forward Interpolation is used for the data (0,1), (1,3), and (2,7) then $f(1.5)$ is:
A. 4
B. 4.25
C. 4.75
D. 5
- (11) The maximum number of positive real roots of the polynomial $p(x) = x^4 - 3x^3 + 2x^2 + x - 5$ are:
A. 1
B. 2
C. 3
D. 4
- (12) The true value of a measurement is 12.345 and approximate value is 12.3, then relative percentage error (rounded to 4 decimal places) is:
A. 0.3646 %
B. 0.3456 %
C. 0.3444 %
D. 0.3546 %
