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Question Paper Code : 11625

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2026.

First Semester

Civil Engineering

MA3151 — MATRICES AND CALCULUS

(Common to : All Branches (Except Marine Engineering))

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Without calculation find one eigenvalue and hence find its eigenvector of the following matrix :

$$\begin{bmatrix} 2 & 2 & 2 \\ 2 & 2 & 2 \\ 2 & 2 & 2 \end{bmatrix}$$

2. Say TRUE or FALSE :

S1 : Every square matrix satisfies its characteristic equation.

S2 : Every square matrix is diagonalizable.

3. Write the domain of the following functions :

(1 + 1)

(a) $f(x) = \sqrt{x+2}$

(b) $g(x) = \frac{1}{x^2 - x}$

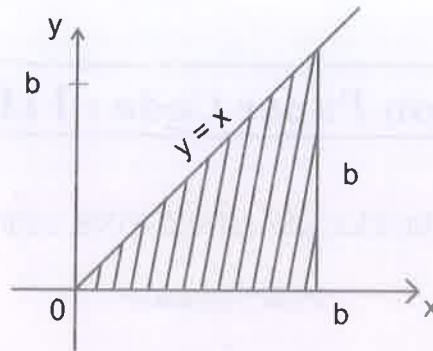
4. Find : $\lim_{x \rightarrow 1} \frac{x^2 - 1}{x - 1}$

5. If $z = x^2y + 3xy^4$, where $x = \sin 2t$ and $y = \cos t$, find $\frac{dz}{dt}$ where $t = 0$.

6. State the theorem on the second derivative test for local extreme values.

7. Comment on : $\int_a^a f(x) dx = 0$.

8. Find the area of the shaded region using integration



9. Sketch the region of integration : $\int_1^2 \int_y^{y^2} dx \, dy$.

10. Find the value(s) of c such that $\int_1^c \int_0^1 xy \, dx \, dy = 2$.

PART B — ($5 \times 16 = 80$ marks)

11. (a) Find all the eigenvalues and the corresponding eigenvectors of the matrix.

$$\begin{bmatrix} 4 & 0 & 1 \\ -2 & 1 & 0 \\ -2 & 0 & 1 \end{bmatrix}$$

Or

- (b) Reduce the quadratic form $2x_1x_2 + 2x_1x_3 - 2x_2x_3$ to a canonical form by an orthogonal reduction and discuss its nature.
12. (a) (i) Find the derivative of $g(t) = \tan(5 - \sin 2t)$.
- (ii) Find the slope of the circle $x^2 + y^2 = 25$ at the point $(3, -4)$. (8+8)

Or

- (b) Find the local maxima, local minima, and points of inflection(if any) for the function $f(x) = x^3 - 6x^2 + 9x + 1$. Also, determine the nature of each critical point using the second derivative test.
13. (a) Find and classify the critical points of the function

$$f(x, y) = 10x^2y - 5x^2 - 4y^2 - x^4 - 2y^4$$

Or

- (b) Using Taylor's formula for $f(x, y)$ at the origin find the quadratic approximation of $f(x, y) = y \sin x$ near the origin. Also estimate the error in the approximation if $|x| \leq 0.1$, $|y| \leq 0.1$.

14. (a) (i) Evaluate $\int (1 - 2 \sin^2 x) \sin 2x \, dx$.

(ii) Evaluate $\int_{-2}^2 (x^4 - 4x^2 + 6) \, dx$. (8+8)

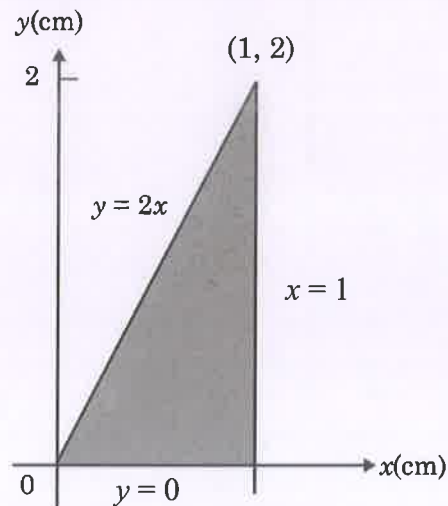
Or

(b) The triangular plate shown in the figure has a constant density of $\delta = 3 \text{ g/cm}^2$. Find

(i) The plate's moment M_y about the y -axis.

(ii) The plate's mass M .

(iii) The x -coordinate of the plate's center of mass. (4+6+6)



15. (a) Sketch the region of integration, reverse the order of integration, and evaluate the integral.

$$\int_0^2 \int_{y^2}^{2y} (4y + 2) \, dx \, dy$$

Or

(b) Find the volume of the region between the cylinder $z = y^2$ and the xy -plane that is bounded by the planes $x = 0$, $x = 1$, $y = -1$, $y = 1$, using triple integration.

10. The function $f(x) = \frac{1}{x}$ is defined on the interval $(0, \infty)$.

(a) Find the derivative of $f(x)$ using the definition of the derivative.

(b) The function $f(x) = \frac{1}{x}$ is also defined on the interval $(-\infty, 0)$.

(c) Find the derivative of $f(x)$ on the interval $(-\infty, 0)$.

(d) The function $f(x) = \frac{1}{x}$ is also defined on the interval $(0, \infty)$.

(e) Find the derivative of $f(x)$ on the interval $(0, \infty)$.



11. The function $f(x) = \frac{1}{x}$ is defined on the interval $(0, \infty)$.

$$\int_1^2 \frac{1}{x} dx = \ln 2 - \ln 1 = \ln 2$$

12. The function $f(x) = \frac{1}{x}$ is defined on the interval $(0, \infty)$.