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Question Paper Code : 30515

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

First Semester

Civil Engineering

MA 3151 – 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. Two eigen values of the matrix $A = \begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$ are 3 and 0. Find the third eigen value and also find the product of eigen values of A.
2. Write the quadratic form corresponding to the matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & -2 & -4 \\ 3 & -4 & -3 \end{bmatrix}$.
3. Find the domain of the function $f(x) = \frac{1}{x^2 - x}$.
4. Prove that $\lim_{x \rightarrow 0} \frac{|x|}{x}$ does not exist.
5. Find $\frac{dy}{dx}$, if $x^3 + y^3 = 3axy$.
6. If $u = \frac{y^2}{x}$ and $v = \frac{x^2}{y}$, then find the Jacobian $\frac{\partial(u,v)}{\partial(x,y)}$.
7. Evaluate $\int \frac{\cos \theta}{\sin^3 \theta} d\theta$ by the method of substitution.

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8. Determine the following integral is convergent or divergent. $\int_0^{\infty} e^x dx$.
9. Evaluate $\int_1^2 \int_2^5 [xy] dx dy$.
10. Find the limits of the integration $\iint_R f(x, y) dx dy$ where R is the region bounded by the lines $x = 0$, $y = 0$ and $x + y = 2$.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Find the eigen values and eigen vectors for the matrix

$$A = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{bmatrix} \quad (8)$$

- (ii) Using Cayley-Hamilton theorem, find the inverse of the matrix

$$A = \begin{bmatrix} 4 & 6 & 6 \\ 1 & 3 & 2 \\ -1 & -4 & -3 \end{bmatrix}. \quad (8)$$

Or

- (b) Reduce the quadratic form $8x_1^2 + 7x_2^2 + 3x_3^2 - 12x_1x_2 - 8x_2x_3 + 4x_3x_1$ to the canonical form through an orthogonal transformation. (16)

12. (a) (i) Find the equation of the tangent line to the curve $y = \frac{e^x}{(1+x^2)}$ at the point $(1, e/2)$. (8)

- (ii) Find the absolute maximum and minimum values of the function $f(x) = \log(x^2 + x + 1)$ in $[-1, 1]$. (8)

Or

- (b) (i) Show that the function $f(x)$ is continuous on $(-\infty, \infty)$

$$f(x) = \begin{cases} 1 - x^2; & x \leq 1 \\ \log x; & x \geq 1 \end{cases} \quad (8)$$

- (ii) Find the local maxima and minima for the function of the curve $y = x^4 - 4x^3$. (8)

13. (a) (i) If $u = \sin^{-1} \left[\frac{x^2 - y^2}{x + y} \right]$ then prove that $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} = 2 \tan u$. (8)

(ii) Find the maximum and minimum values of $f(x, y) = x^2 - xy + y^2 - 2x + y$. (8)

Or

(b) (i) Using Taylor's series, expand $f(x, y) = x^2 y + \sin y + e^x$ upto the second degree terms at the point $(1, \pi)$. (8)

(ii) A rectangular box open at the top is to have a volume of 32 cc. Find the dimensions of the box requiring the least material for its construction. (8)

14. (a) (i) Evaluate $\int x^2 e^x dx$ by using integration by parts. (8)

(ii) Evaluate $\int \frac{dx}{\sqrt{3x^2 + x - 2}}$ (8)

Or

(b) (i) Evaluate $\int \frac{x + 4}{6x - 7 - x^2} dx$. (8)

(ii) Evaluate $\int_{-\pi/4}^{\pi/4} [\tan^2 x \sec^2 x] dx$. (8)

15. (a) (i) Change the order of integration in $\int_0^{\pi/4} \int_x^{\pi/2} (x^2 + y^2) dy dx$ and hence evaluate it. (8)

(ii) Evaluate $\int_0^{\pi/2} \int_0^{\pi/2} e^{-(x^2+y^2)} dx dy$ by changing into polar coordinates. (8)

Or

(b) (i) Evaluate $\iint (x^2 y + xy^2) dx dy$ over the area between $y = x^2$ and $y = x$. (8)

(ii) Evaluate $\int_0^1 \int_0^x \int_0^{\sqrt{x+y}} [z] dz dy dx$. (8)