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17MAT11

First Semester B.E. Degree Examination, Jan./Feb. 2021 Engineering Mathematics – I

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

- 1 a. Find the n^{th} derivative of $\frac{x}{(x-1)(2x+3)}$ (06 Marks)
- b. Find the angle of intersection of the curves $r = \frac{a}{1+\cos\theta}$ and $r = \frac{b}{1-\cos\theta}$. (07 Marks)
- c. Find the radius of curvature of the curve $x^4 + y^4 = 2$ at the point (1, 1). (07 Marks)

OR

- 2 a. If $y = e^{a \sin^{-1} x}$ prove that $(1-x^2)y_{n+2} - (2n+1)xy_{n+1} - (n^2+a^2)y_n = 0$. (06 Marks)
- b. Find the pedal equation of $r^2 = a^2 \sec 2\theta$. (07 Marks)
- c. Find the radius of curvature of the curve $r^n = a^n \sin n\theta$. (07 Marks)

Module-2

- 3 a. Obtain the Taylor's expansion of $\tan x$ about $x = \frac{\pi}{4}$ upto third degree terms. (06 Marks)
- b. Evaluate $\lim_{x \rightarrow 0} \left(\frac{2^x + 3^x + 4^x}{3} \right)^{1/x}$ (07 Marks)
- c. If $u = f\left(\frac{x}{y}, \frac{y}{z}, \frac{z}{x}\right)$ show that $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} + z \frac{\partial u}{\partial z} = 0$ (07 Marks)

OR

- 4 a. If $u = \sin^{-1}\left(\frac{x^2 y^2}{x+y}\right)$ then show that $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} = 3 \tan u$. (06 Marks)
- b. Obtain the Maclaurin's expansion of $\log(\sec x)$ upto fourth degree terms. (07 Marks)
- c. If $x + y + z = u$, $y + z = v$, $z = uvw$ find the Jacobian $J\left(\frac{x, y, z}{u, v, w}\right)$ (07 Marks)

Module-3

- 5 a. If $\phi = x^2 + y^2 + z^2$, $\vec{F} = x^2 \hat{i} + y^2 \hat{j} + z^2 \hat{k}$ then find $\text{grad } \phi$, $\text{div } \vec{F}$ and $\text{curl } \vec{F}$. (06 Marks)
- b. A particle moves on the curve $x = 2t^2$, $y = t^2 - 4t$, $z = 3t - 5$ where t is the time. Find the components of velocity and acceleration at $t = 1$ in the direction of the vector $\hat{i} - 3\hat{j} + 2\hat{k}$. (07 Marks)
- c. Prove that $\text{curl}(\phi \vec{A}) = \phi \text{curl } \vec{A} + (\text{grad } \phi \times \vec{A})$ (07 Marks)



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OR

- 6 a. Find the angle between the surfaces $x^2 + y^2 + z^2 = 9$ and $x^2 + y^2 - z = 3$ at $(2, -1, 2)$ (06 Marks)
- b. Show that the vector field $\vec{F} = (x^2 - yz)\hat{i} + (y^2 - zx)\hat{j} + (z^2 - xy)\hat{k}$ is irrotational and find ϕ such that $\vec{F} = \nabla\phi$. (07 Marks)
- c. Prove that $\text{div}(\phi\vec{A}) = \phi \text{div}\vec{A} + (\text{grad}\phi \cdot \vec{A})$ (07 Marks)

Module-4

- 7 a. Obtain the reduction formula for $\int_0^{\pi/2} \cos^n x \, dx$ (06 Marks)
- b. Solve $\frac{dy}{dx} = xy^3 - xy$ (07 Marks)
- c. A body originally at 80°C cools down to 60°C in 20 minutes, the temperature of the air being 40°C . What will be the temperature of the body after 40 minutes from the original? (07 Marks)

OR

- 8 a. Evaluate $\int_0^{2a} \frac{x^2}{\sqrt{2ax - x^2}} \, dx$ (06 Marks)
- b. Solve $(x^2 + y^2 + x)dx + xy \, dy = 0$ (07 Marks)
- c. Obtain the orthogonal trajectories of the family of curves $r^n = a \sin n\theta$. (07 Marks)

Module-5

- 9 a. Find the rank of the matrix $A = \begin{bmatrix} 2 & 1 & 3 & 5 \\ 4 & 2 & 1 & 3 \\ 8 & 4 & 7 & 13 \\ 8 & 4 & -3 & -1 \end{bmatrix}$ (06 Marks)
- b. Diagonalize the matrix $\begin{bmatrix} -19 & 7 \\ -42 & 16 \end{bmatrix}$ (07 Marks)
- c. Using Rayleigh's power method find the largest eigen value and the corresponding eigen vector of the matrix $A = \begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$ taking $(1 \ 1 \ 1)^T$ as the initial eigen vector. (07 Marks)

OR

- 10 a. Using Gauss-Siedel method, solve $20x + y - 2z = 17$
 $3x + 20y - z = -18$
 $2x - 3y + 20z = 25$
using $(0, 0, 0)$ as the initial approximation to the solution. (06 Marks)
- b. Show that the linear transformation $y_1 = 2x_1 + x_2 + x_3$, $y_2 = x_1 + x_2 + 2x_3$, $y_3 = x_1 - 2x_3$ is regular and find the inverse transformation. (07 Marks)
- c. Reduce the quadratic form $8x^2 + 7y^2 + 3z^2 - 12xy + 4xz - 8yz$ into the canonical form. (07 Marks)

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