



Roll No:

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**BTECH**  
**(SEM I) THEORY EXAMINATION 2024-25**  
**ENGINEERING MATHEMATICS-I**

TIME: 3 HRS

M.MARKS: 70

**Note:** Attempt all Sections. In case of any missing data; choose suitably.

## SECTION A

1. Attempt all questions in brief.

2 x 07 = 14

Q no.	Question	CO	Level
a.	Find the eigen values of the matrix $\begin{bmatrix} \cos\theta & -\sin\theta \\ -\sin\theta & -\cos\theta \end{bmatrix}$ .	1	K2
b.	If $u = \frac{x^2+y^2}{x+y}$ , find the value of $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y}$ .	2	K3
c.	What is the difference between total derivatives and partial derivatives?	2	K1
d.	What are the applications of Jacobians	3	K4
e.	Write the statement of Liouville's Theorem.	4	K2
f.	Evaluate $\int_1^2 \int_1^3 x^2 y^2 dx dy$ .	4	K3
g.	Prove that $\text{curl } \vec{r} = 0$ .	5	K2

## SECTION B

2. Attempt any three of the following:

07 x 3 = 07

Q no.	Question	CO	Level
a.	Find two non-singular matrices P and Q such that PAQ is in normal form, Where $A = \begin{bmatrix} 1 & 3 & 6 & -1 \\ 1 & 4 & 5 & 1 \\ 1 & 5 & 4 & 3 \end{bmatrix}$	1	K2
b.	Find the $n^{\text{th}}$ derivative of $\tan^{-1} \left( \frac{x}{a} \right)$	2	K3
c.	Find the volume of the largest rectangular parallelepiped that can be inscribed in the ellipsoid $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$ .	3	K4
d.	Apply Dirichlet's theorem to evaluate $\iiint xyz dx dy dz$ taken throughout the ellipsoid $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} \leq 1$	4	K3
e.	Show that the vector $f(r)\vec{r}$ is irrotational. Where $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$	5	K5

## SECTION C

3. Attempt any one part of the following:

07 x 1 = 07

Q no.	Question	CO	Level
a.	Find the eigen values and eigen vectors of the following matrices: $A = \begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$ .	1	K4
b.	Discuss for all values of K for the system of equations	1	K2



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	$x + y + 4z = 6, x + 2y - 2z = 6, Kx + y + z = 6$ as regards existence and nature of solution.		
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4. Attempt any *one* part of the following:

Q no.	Question	CO	Level
a.	Trace the curve $y^2(a + x) = x^2(3a - x)$ .	2	K1
b.	If $u = f(r)$ , where $r^2 = x^2 + y^2$ , prove that $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = f''(r) + \frac{1}{r} f'(r)$ .	2	K1

5. Attempt any *one* part of the following:

07 x 1 = 07

Q no.	Question	CO	Level
a.	If $u = xyz, v = x^2 + y^2 + z^2$ and $w = x + y + z$ . Find the jacobian $\frac{\partial(x, y, z)}{\partial(u, v, w)}$	3	K3
b.	Find the maxima and minima of the function $\sin x + \sin y + \sin(x + y)$ .	3	K3

6. Attempt any *one* part of the following:

07 x 1 = 07

Q no.	Question	CO	Level
a.	Find the area inside the circle $r = 2a \cos \theta$ and outside the circle $r = a$	4	K4
b.	Change the order of integration and then evaluate $\int_0^{2a} \int_{\frac{x^2}{4a}}^{3a-x} (x^2 + y^2) dy dx$	4	K2

7. Attempt any *one* part of the following:

07 x 1 = 07

Q no.	Question	CO	Level
a.	Show that $\text{div}(\text{grad} r^n) = n(n + 1)r^{n-2}$ . Where $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$	5	K4
b.	Verify Stokes theorem for $\vec{F} = (x^2 + y^2)\hat{i} - 2xy\hat{j}$ taken round the rectangle bounded by the lines $x = 0, x = a, y = 0, y = b$ .	5	K5