

**BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT**

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

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Course Code 

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**First Semester B.E. Degree Examinations, February 2024**  
**MATHEMATICS FOR CIVIL ENGINEERING STREAM-I**

Duration: 3 hrs

Max. Marks: 100

*Note:* 1. Answer any FIVE full questions choosing ONE full Question from each Module.  
2. Missing data, if any, may be suitably assumed

<u>Q. No</u>	<u>Question</u>	<u>Marks</u>	<u>(RBTL:CO:PO)</u>
<b>Module-1</b>			
1. a.	Find the rank of the following matrix by row echelon form $\begin{pmatrix} 1 & 2 & 4 & 3 \\ 2 & 4 & 6 & 8 \\ 4 & 8 & 12 & 16 \\ 1 & 2 & 3 & 4 \end{pmatrix}$	06	(2 : 1 : 1.2.1)
b.	Test for consistency and solve the following system of equations. $5x + y + 3z = 20; 2x + 5y + 2z = 18; 3x + 2y + z = 14$	07	(3 : 1 : 1.2.1)
c.	Solve the following system of equations by Gauss elimination method $3x + 4y + 5z = 18; 2x - y + 8z = 13; 5x - 2y + 7z = 20$	07	(3 : 1 : 1.2.1)
<b>OR</b>			
2. a.	Solve the following system of equations by Gauss-Jordan elimination method $2x + y + 3z = 1; 4x + 4y + 7z = 1; 2x + 5y + 9z = 3$	06	(3 : 1 : 1.2.1)
b.	Solve the following system of equations using Gauss Seidel method $20x + y - 2z = 17; 3x + 20y - z = -18; 2x - 3y + 20z = 25$	07	(3 : 1 : 1.2.1)
c.	Find the numerically largest eigen value and the corresponding eigen vector of the matrix $A = \begin{bmatrix} 4 & 1 & -1 \\ 2 & 3 & -1 \\ -2 & 1 & 5 \end{bmatrix}$ by taking the initial approximation to the eigen vector as $[1, 0.8, -0.8]^T$ . Perform 5 iterations.	07	(2 : 1 : 1.2.1)
<b>Module-2</b>			
3. a.	Prove with usual notation $\frac{1}{p^2} = \frac{1}{r^2} + \frac{1}{r^4} \left( \frac{dr}{d\theta} \right)^2$	06	(3 : 2 : 1.2.1)
b.	Show that the following pairs of curves intersect each other orthogonally $r = a(1 + \cos\theta)$ and $r = b(1 - \cos\theta)$ .	07	(2 : 2 : 1.2.1)
c.	Find the pedal equation of the curve $r(1 - \cos\theta) = 2a$ .	07	(2 : 2 : 1.2.1)

**OR**

4. a. Prove with usual notation:  $\rho = \frac{(1 + y_1^2)^{3/2}}{y_2}$  06 (3 : 2 : 1.2.1)
- b. Find the radius of curvature of the curve  $r^n = a^n \cos n\theta$  07 (2 : 2 : 1.2.1)
- c. Write a program to Plot the cardioid  $r = 3(1 + \cos\theta)$  07 (1 : 2 : 1.7.1)

### Module-3

5. a. Using Maclaurin's series prove that 06 (3 : 3 : 1.2.1)
- $$\sqrt{1 + \sin 2x} = 1 + x - \frac{x^2}{2} - \frac{x^3}{6} + \frac{x^4}{24} \dots\dots$$
- b. If  $z = f(x + ct) + g(x - ct)$ , prove that  $\frac{\partial^2 z}{\partial t^2} = c^2 \frac{\partial^2 z}{\partial x^2}$  07 (3 : 3 : 1.2.1)
- c. If  $u = f\left(\frac{x}{y}, \frac{y}{z}, \frac{z}{x}\right)$ , prove that  $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} + z \frac{\partial u}{\partial z} = 0$ . 07 (3 : 3 : 1.2.1)

OR

6. a. If  $u = e^{-x}(x \cos y + y \sin y)$ , show that  $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$ . 06 (3 : 3 : 1.2.1)
- b. Find  $\frac{\partial(u, v, w)}{\partial(x, y, z)}$  at  $(1, -1, 0)$ , where  $u = x^2 + 3y^2 - z^3$ ,  $v = 4x^2 yz$ ,  $w = 2z^2 - xy$ . 07 (2 : 3 : 1.2.1)
- c. Find the extreme values of the function  $f(x, y) = x^3 + y^3 - 3x - 12y + 20$ . 07 (2 : 3 : 1.2.1)

### Module-4

7. a. Solve:  $x \frac{dy}{dx} + y = x^3 y^6$ . 06 (3 : 4 : 1.2.1)
- b. Solve:  $(x^2 + y^3 + 6x)dx + y^2 x dy = 0$ . 07 (3 : 4 : 1.2.1)
- c. Find the orthogonal trajectories of the family of parabolas  $y^2 = 4ax$  07 (2 : 4 : 1.2.1)

OR

8. a. A series circuit with resistance  $R$ , inductance  $L$  and electromotive force  $E$  is governed by the differential equation  $L \frac{di}{dt} + Ri = E$ , where  $L$  and  $R$  are constants and initially the current  $i$  is zero. Find the current at any time  $t$  06 (2 : 4 : 1.2.1)
- b. Solve:  $xyp^2 + (3x^2 - 2y^2)p - 6xy = 0$  07 (3 : 4 : 1.2.1)

- c. Show that the equation  $xp^2 + px - py + 1 - y = 0$  is Clairaut's equation. Hence obtain the general and singular solution. 07 (3 : 4 : 1.2.1)

#### Module-5

9. a. Evaluate:  $\int_0^1 \int_0^{1-x} \int_0^{1-x-y} dz dy dx$  06 (2 : 5 : 1.2.1)
- b. Change the order of the integration and hence evaluate  $\int_0^1 \int_{\sqrt{y}}^1 dx dy$ . 07 (2 : 5 : 1.2.1)
- c. Find the area of the circle  $x^2 + y^2 = a^2$  by double integration. 07 (2 : 5 : 1.2.1)

#### OR

- 10 a. Find the volume of the tetrahedron bounded by the planes  $x=0, y=0, z=0, x/a + y/b + z/c = 1$ . 06 (2 : 5 : 1.2.1)
- b. Prove that  $\beta(m, n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$  07 (3 : 5 : 1.2.1)
- c. Evaluate  $\int_0^{\pi/2} \sqrt{\tan \theta} d\theta$  by expressing in terms of gamma functions. 07 (2 : 5 : 1.2.1)

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