

Basavarajeswari Group of Institutions

2022 SCHEME

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 Summer Semester Examinations, September/October 2025

MATHEMATICS-I FOR CIVIL ENGINEERING STREAM

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
 3. Use of Mathematics Formula Handbook is permitted.

<u>Q. No</u>	<u>Question</u>	<u>Marks</u>	<u>(RBTL:CO:PI)</u>
Module-1			
1.	<p>a. Find the rank of the following matrix by row echelon form</p> $A = \begin{bmatrix} 2 & 3 & -1 & -1 \\ 1 & -1 & -2 & -4 \\ 3 & 1 & 3 & -2 \\ 6 & 3 & 0 & 7 \end{bmatrix}$	06	(1 : 1 : 1.2.1)
	<p>b. Investigate the values of λ and μ such that the system of equations $x+y+z=6$; $x+2y+3z=10$, $x+2y+\lambda z = \mu$ may have (i) Unique solution (ii) Infinite solution (iii) No solution.</p>	07	(2 : 1 : 1.2.1)
	<p>c. Solve the following system of equations by Gauss elimination method $2x+y+4z=12$, $4x+11y-z=33$, $8x-3y+2z=20$.</p>	07	(3 : 1 : 1.2.1)
(OR)			
2.	<p>a. Solve the following system of equations by Gauss-Jordon elimination method $2x+3y-z=5$; $4x+4y-3z=3$; $2x-3y+2z=2$.</p>	06	(3 : 1 : 1.2.1)
	<p>b. Solve the following system of equations using Gauss Seidel method $20x+y-2z=17$; $3x+20y-z=-18$; $2x+3y+20z=25$</p>	07	(3 : 1 : 1.2.1)
	<p>c. Find the dominant Eigen value and the corresponding Eigen vector of the matrix $A = \begin{bmatrix} 2 & 0 & 1 \\ 0 & 2 & 0 \\ 1 & 0 & 2 \end{bmatrix}$ by Rayleigh's power method taking the initial Eigen vector as $[1 \ 1 \ 1]^T$.</p>	07	(3 : 1 : 1.2.1)
Module-2			
3.	<p>a. Prove that for the curve $r = f(\theta)$ $\frac{1}{p^2} = u^2 + \left(\frac{du}{d\theta}\right)^2$ where $u = \frac{1}{r}$.</p>	06	(2 : 2 : 1.2.1)
	<p>b. Find the angle between the pairs of curves $r = a(1 + \cos \theta)$ and $r = b(1 - \cos \theta)$</p>	07	(3 : 2 : 1.2.1)
	<p>c. Find the pedal equation of the curve $r^n = a^n \cos \theta$</p>	07	(3 : 2 : 1.2.1)
(OR)			

4. a. Prove with usual notation: $\rho = \frac{(1 + y_1^2)^{3/2}}{y_2}$ 06 (2 : 2 : 1.2.1)

b. Find the radius of curvature of $a^2 y = x^3 - a^3$ where the curve cuts the x-axis. 07 (3 : 2 : 1.2.1)

c. Find the radius of curvature of the curve $r^n = a^n \cos n\theta$. 07 (3 : 2 : 1.2.1)

Module-3

5. a. Obtain the Maclaurin's series expansion of $e^{\sin x}$ upto the term containing x^4 . 06 (2 : 3 : 1.2.1)

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 (2 : 3 : 1.2.1)

c. If $u = \log(x^3 + y^3 + z^3 - 3xyz)$, then prove that $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} = \frac{3}{x + y + z}$. 07 (2 : 3 : 1.2.1)

(OR)

6. a. If $u = f(x - y, y - z, z - x)$, show that $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} = 0$ 06 (2 : 3 : 1.2.1)

b. If $u = x^2 + y^2 + z^2$, $v = xy + yz + zx$, $w = x + y + z$ then find $\frac{\partial(u, v, w)}{\partial(x, y, z)}$. 07 (3 : 3 : 1.2.1)

c. Examine the function $z(x, y) = x^4 + y^4 - 2(x - y)^2$ for extreme values. 07 (2 : 3 : 1.2.1)

Module-4

7. a. Solve: $6y^2 dx - x(x^3 + 2y)dy = 0$ 06 (3 : 4 : 1.2.1)

b. Solve: $ye^{xy} dx + (xe^{xy} + 2y)dy = 0$. 07 (3 : 4 : 1.2.1)

c. Find the orthogonal trajectories of the family $x^{2/3} + y^{2/3} = a^{2/3}$. 07 (1 : 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 06 (1 : 4 : 1.2.1)

R and L are constants and initially current $i = 0$. Find the current at any time 't'.

b. Solve: $xy \left(\frac{dy}{dx} \right)^2 - (x^2 + y^2) \frac{dy}{dx} + xy = 0$ 07 (3 : 4 : 1.2.1)

c. Modify the following equation into Clairut's form. Hence obtain the associated general and singular solutions. $xp^2 + px - py + 1 - y = 0$ 07 (2 : 4 : 1.2.1)

Module-5

9. a. Evaluate : $\int_{-1}^1 \int_0^z \int_{x-z}^{x+z} (x + y + z) dy dx dz$. 06 (3 : 5 : 1.2.1)

b. Change the order of the integration and hence evaluate $\int_0^1 \int_{\sqrt{y}}^{2-y} xy \, dx dy$. **07 (3 :5 : 1.2.1)**

c. Write a Python Program to find $\int_0^1 \int_x^{\sqrt{x}} (x^2 + y^2) \, dy \, dx$ **07 (1 :5 : 1.2.1)**

(OR)

10. a. Prove that: $\sqrt[3]{1/2} = \sqrt{\pi}$ **06 (1 :5 : 1.2.1)**

b. Prove that $\beta(m, n) = \frac{\Gamma(m) \cdot \Gamma(n)}{\Gamma(m+n)}$. **07 (1 :5 : 1.2.1)**

c. Express the following integrals in terms of beta functions and hence evaluate $\int_0^{\infty} \frac{dx}{1+x^4}$. **07 (1 :5 : 1.2.1)**

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