

## First Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026 Differential Calculus and Linear Algebra : EEE Stream

Time: 3 hrs.

Max. Marks: 100

- Note:** 1. Answer any FIVE full questions, choosing ONE full question from each module.  
 2. M : Marks , L: Bloom's level , C: Course outcomes.  
 3. VTU Handbook is permitted.

| Module – 1 |    |                                                                                                                                                                                       | M | L  | C   |
|------------|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|----|-----|
| Q.1        | a. | With usual notations, prove that $\tan\theta = r \frac{d\theta}{dr}$ .                                                                                                                | 6 | L2 | CO1 |
|            | b. | Find angle between the following curves $r = a \log \theta$ & $r = \frac{a}{\log \theta}$ .                                                                                           | 7 | L2 | CO1 |
|            | c. | Show that the radius of curvature of the curve $r^n = a^n \cos n\theta$ varies inversely as $r^{n-1}$ .                                                                               | 7 | L2 | CO1 |
| OR         |    |                                                                                                                                                                                       |   |    |     |
| Q.2        | a. | Find the radius of curvature of the curve $x^3 + y^3 = 3axy$ at the point $(3a/2, 3a/2)$ .                                                                                            | 6 | L2 | CO1 |
|            | b. | Show that the following pair of curves cut orthogonally:<br>$r = a(1 + \sin \theta)$ & $r = a(1 - \sin \theta)$                                                                       | 7 | L2 | CO1 |
|            | c. | Find the pedal equation $r^2 = a^2 \sec 2\theta$ .                                                                                                                                    | 7 | L2 | CO1 |
| Module – 2 |    |                                                                                                                                                                                       |   |    |     |
| Q.3        | a. | Expand $\log(\sec x)$ in powers of $x$ up to the term containing $x^4$ .                                                                                                              | 6 | L2 | CO1 |
|            | b. | Evaluate i) $\lim_{x \rightarrow 0} \left( \frac{a^x + b^x + c^x}{3} \right)^{1/x}$ ii) $\lim_{x \rightarrow \pi/2} (\sec x)^{\cot x}$ .                                              | 7 | L2 | CO1 |
|            | c. | Discuss the maxima and minima of the function<br>$f(x, y) = x^3 + y^3 - 3x - 27y + 24$ .                                                                                              | 7 | L3 | CO1 |
| OR         |    |                                                                                                                                                                                       |   |    |     |
| Q.4        | a. | If $u = f\left(\frac{x}{y}, \frac{y}{z}, \frac{z}{x}\right)$ , prove that $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} + z \frac{\partial u}{\partial z} = 0$ . | 6 | L2 | CO1 |
|            | b. | If $u = x^2 + y^2 + z^2, v = xy + yz + zx, w = x + y + z$ evaluate Jacobian of $u, v, w$ with respect to $x, y, z$ .                                                                  | 7 | L3 | CO1 |
|            | c. | If $u = x^2 + y^2 + z^2, x = e^{2t}, y = \cos 3t, z = \sin 3t$ . Find $\frac{du}{dt}$ .                                                                                               | 7 | L2 | CO1 |
| Module – 3 |    |                                                                                                                                                                                       |   |    |     |
| Q.5        | a. | Solve $(y \cos x + \sin y + y)dx + (\sin x + x \cos y + x)dy = 0$ .                                                                                                                   | 6 | L2 | CO1 |
|            | b. | Find a solution for the non-linear differential equation<br>$xyp^2 - (x^2 + y^2)p + xy = 0$ .                                                                                         | 7 | L2 | CO1 |
|            | c. | Solve $(px - y)(py + x) = 2p$ by reducing into Clairaut's form, taking the substitutions $x^2 = X, y^2 = Y$ .                                                                         | 7 | L2 | CO1 |
| OR         |    |                                                                                                                                                                                       |   |    |     |
| Q.6        | a. | Solve $\frac{dy}{dx} + y \tan x = y^3 \sec x$ .                                                                                                                                       | 6 | L2 | CO1 |

|                   |    |                                                                                                                                                                                                                                                |   |    |     |
|-------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|----|-----|
|                   | b. | Solve $(xy + y^2 + y)dx + (x^2 + 3xy + 2x)dy = 0$ .                                                                                                                                                                                            | 7 | L2 | CO1 |
|                   | c. | Find the orthogonal trajectories of curve $r^n = a^n \sin n\theta$ .                                                                                                                                                                           | 7 | L3 | CO1 |
| <b>Module – 4</b> |    |                                                                                                                                                                                                                                                |   |    |     |
| <b>Q.7</b>        | a. | Solve $\frac{d^3y}{dx^3} - \frac{d^2y}{dx^2} + 4\frac{dy}{dx} - 4y = 0$ .                                                                                                                                                                      | 6 | L2 | CO1 |
|                   | b. | Solve $x^2 \frac{d^2y}{dx^2} - 2y = x^2 + \frac{1}{x}$ .                                                                                                                                                                                       | 7 | L2 | CO1 |
|                   | c. | Solve by the method of variation of parameters $\frac{d^2y}{dx^2} + y = \tan x$ .                                                                                                                                                              | 7 | L2 | CO1 |
| <b>OR</b>         |    |                                                                                                                                                                                                                                                |   |    |     |
| <b>Q.8</b>        | a. | Solve $\frac{d^2y}{dx^2} + 3\frac{dy}{dx} + 2y = 12x^2$ .                                                                                                                                                                                      | 6 | L2 | CO1 |
|                   | b. | Solve $y'' - 6y' + 9y = 5e^{3x} - \sin 2x$ .                                                                                                                                                                                                   | 7 | L2 | CO1 |
|                   | c. | Solve $(3x + 2)^2 y'' + 3(3x + 2)y' - 36y = 8x$ .                                                                                                                                                                                              | 7 | L2 | CO1 |
| <b>Module – 5</b> |    |                                                                                                                                                                                                                                                |   |    |     |
| <b>Q.9</b>        | a. | Determine the rank of the matrix $\begin{bmatrix} 1 & 2 & 3 & 2 \\ 2 & 3 & 5 & 1 \\ 1 & 3 & 4 & 5 \end{bmatrix}$                                                                                                                               | 6 | L2 | CO2 |
|                   | b. | Solve the following system of equations by Gauss seidal<br>$10x + y + z = 12$ , $x + 10y + z = 12$ , $x + y + 10z = 12$ , Carry out three iteration.                                                                                           | 7 | L2 | CO2 |
|                   | 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 power method. With initial Eigen vector $[1 \ 0 \ 0]^T$ . Carry out four iterations. | 7 | L3 | CO2 |
| <b>OR</b>         |    |                                                                                                                                                                                                                                                |   |    |     |
| <b>Q.10</b>       | a. | Solve by Gauss elimination method<br>$x + y + z = 9$ , $x - 2y + 3z = 8$ , $2x + y - z = 3$ .                                                                                                                                                  | 6 | L2 | CO2 |
|                   | b. | Investigate the values of $\lambda$ and $\mu$ , such that the system of equations<br>$x + y + z = 6$ , $x + 2y + 3z = 10$ , $x + 2y + \lambda z = \mu$ have<br>i) Unique solution ii) No solution iii) Infinitely many solution.               | 7 | L3 | CO2 |
|                   | c. | Find the Eigen values and Eigen vectors of the matrix $\begin{bmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{bmatrix}$ .                                                                                                                    | 7 | L2 | CO2 |

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