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First Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026 Differential Calculus and Linear Algebra : ME 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 the usual notation prove that $\tan \phi = r \frac{d\theta}{dr}$.	6	L2	CO1
	b.	Find the angle between the curves $r = a(1 + \cos\theta)$ and $r = b(1 - \cos\theta)$.	7	L2	CO1
	c.	Find the radius of curvature for the curve $r^n = a^n \cos n\theta$.	7	L2	CO1
OR					
Q.2	a.	Find the angle between the radius vector and tangent to the curve $\frac{2a}{r} = (1 - \cos\theta)$.	6	L2	CO1
	b.	Find the Pedal equation for the curve $r(1 - \cos\theta) = 2a$.	7	L2	CO1
	c.	Find the radius of curvature for the curve $x^3 + y^3 = 3axy$ at the point $(3a/2, 3a/2)$.	7	L2	CO1
Module – 2					
Q.3	a.	Apply Maclaurin's series to prove that $\sqrt{1 + \sin 2x} = 1 + x - \frac{x^2}{2} - \frac{x^3}{6} + \dots$	6	L3	CO1
	b.	Evaluate $\lim_{x \rightarrow 0} \left(\frac{\tan x}{x} \right)^{1/x}$.	7	L2	CO1
	c.	Determine the extreme value of the function $f = x^3 + y^3 - 3x - 12y + 20$.	7	L2	CO1
OR					
Q.4	a.	If $u = x^3 - 3xy^2 + x + e^x \cos y + 1$ show that $\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$	6	L2	CO1
	b.	If $u = F(x-y, y-z, z-x)$ then prove that $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} = 0$	7	L2	CO1
	c.	If $u = \frac{yz}{x}, v = \frac{zx}{y}, w = \frac{xy}{z}$ Prove that $\frac{\partial(u, v, w)}{\partial(x, y, z)} = 4$	7	L2	CO1

Module – 3					
Q.5	a.	Solve $\frac{dy}{dx} + \frac{y}{x} = y^2 x$.	6	L2	CO1
	b.	Solve the differential equation $y(2xy + 1) dx - xdy = 0$.	7	L2	CO1
	c.	The number N of bacteria in a culture grew at a rate proportional to N. The value of N was initially 100 and increased to 332 in one hour. What would be the value of N after $1\frac{1}{2}$ hours?	7	L3	CO1
OR					
Q.6	a.	Solve $r \sin \theta - \cos \theta \frac{dr}{d\theta} = r^2$.	6	L2	CO1
	b.	Apply the concept of differential equations to find the orthogonal trajectories $\frac{x^2}{a^2} + \frac{y^2}{b^2 + \lambda} = 1$.	7	L3	CO1
	c.	Solve the differential equation $(x^2 + y^2 + x)dx + xydy = 0$	7	L2	CO1
Module – 4					
Q.7	a.	Find the Rank of the matrix $A = \begin{bmatrix} 4 & 0 & 2 & 1 \\ 2 & 1 & 3 & 4 \\ 2 & 3 & 4 & 7 \\ 2 & 3 & 1 & 4 \end{bmatrix}$	6	L2	CO2
	b.	Apply Gauss - Seidel method to approximate the solution of the system $20x + y - 2z = 17$, $3x + 20y - z = -18$, $2x - 3y + 20z = 25$ by choosing initial solution (0,0,0). Perform three iterations.	7	L3	CO2
	c.	Test for consistency and solve $x + 2y + 3z = 14$, $4x + 5y + 7z = 35$, $3x + 3y + 4z = 21$	7	L2	CO2
OR					
Q.8	a.	Apply Gauss-elimination method to find the solution of system equations $x + y + z = 9$, $x - 2y + 3z = 8$, $2x + y - z = 3$.	6	L3	CO2
	b.	Apply Jordan method. To find inverse of the matrix $A = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 1 & 4 \\ 5 & 6 & 0 \end{bmatrix}$	7	L3	CO2
	c.	Apply LU decomposition method to find the solution of the system $AX = b$, where $A = \begin{bmatrix} 2 & 3 \\ 4 & 5 \end{bmatrix}$, $b = \begin{bmatrix} 8 \\ 14 \end{bmatrix}$	7	L3	CO2

Module – 5					
Q.9	a.	Apply Moore Penrose Pseudo inverse method to find the inverse of the matrix $A = \begin{bmatrix} 1 & 2 \\ 2 & 1 \\ 1 & -1 \end{bmatrix}$	6	L3	CO2
	b.	Reduce the matrix $A = \begin{bmatrix} -2 & 5 \\ -3 & 6 \end{bmatrix}$ into diagonal form.	7	L2	CO2
	c.	Apply Rayleigh power method to find the largest eigen value and the corresponding eigen vector of the matrix $\begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$ by taking the initial eigen vector as $[1 \ 1 \ 1]'$	7	L3	CO2
OR					
Q.10	a.	Apply Cayley Hamilton theorem to find the inverse of the matrix $A = \begin{bmatrix} 2 & 1 \\ 1 & 1 \end{bmatrix}$	6	L3	CO2
	b.	Determine the eigen values and the corresponding eigen vectors for the matrix $A = \begin{bmatrix} 1 & 1 & 3 \\ 1 & 5 & 1 \\ 3 & 1 & 1 \end{bmatrix}$	7	L2	CO2
	c.	Find the characteristic and minimal polynomial of the block matrix $A = \begin{bmatrix} 2 & 1 & 0 & 0 \\ 0 & 2 & 0 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & 0 & 0 & 5 \end{bmatrix}$	7	L2	CO2
