CBCS SCHEME

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1BMATM101

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 $\tan\varphi = r\frac{d\theta}{dr}$.	**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 $\sqrt{1+\sin 2x} = 1 + x - \frac{x^2}{2} - \frac{x^3}{6} + \ldots$	**6**	**L3**	**CO1**
	b.	Evaluate $\lim_{x\to 0}\left(\frac{\tan x}{x}\right)^{1/x}$.	**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 $\frac{dy}{dx}+\frac{y}{x}=y^2x$.	**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 $\left(x^2+y^2+x\right)dx+xydy=0$	**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 $[1 \quad 1 \quad 1]'$	**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**

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