U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

April 2025 Semester End Make-Up Examinations

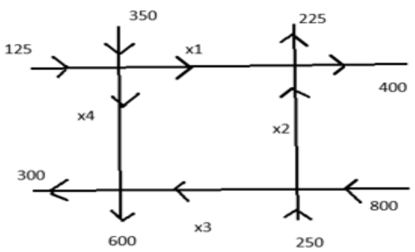
Programme: B.E. **Semester: I**
Branch: CV, EEE, ECE, ME, IEM, AS, CH, ETE, EIE, MD **Duration: 3 hrs.**
Course Code: 23MA1BSCEM **Max Marks: 100**
Course: Mathematical Foundation for Civil, Electrical and Mechanical Engineering stream– 1

Instructions:
1. All units have internal choice, answer one complete question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - 1	*CO*	*PO*	Marks
1	a)	If ϕ be the angle between radius vector and the tangent at any point on the curve $r = f(\theta)$, then prove that $tan(\phi) = r\frac{d\theta}{dr}$.	1	1	**6**
	b)	Find the radius of curvature for the curve $y^2 = \frac{a^2(a-x)}{x}$ at the point $(a,0)$.	1	1	**7**
	c)	Find the pedal equation of the curve $r(1-\cos\theta) = 2a$.	1	1	**7**
		OR			
2	a)	Find the angle ϕ for the polar curve $r = a(1+\sin\theta)$. Hence determine the slope of the curve at $\theta = \pi/2$.	1	1	**6**
	b)	If ρ_1 and ρ_2 are the radii of curvature at the extremities of a chord through the pole for the polar curve $r = a(1+\cos\theta)$, prove that $\rho_1^2 + \rho_2^2 = \frac{16a^2}{9}$.	1	1	**7**
	c)	Find the angle of intersection between the curves $r = \frac{a\theta}{1+\theta}$ and $r = \frac{a}{1+\theta^2}$.	1	1	**7**
		UNIT - 2			
3	a)	If $u = e^{a\theta}\cos(a\log_e r)$, then show that $\frac{\partial^2 u}{\partial r^2} + \frac{1}{r}\frac{\partial u}{\partial r} + \frac{1}{r^2}\frac{\partial^2 u}{\partial \theta^2} = 0$.	1	1	**6**
	b)	The diameter and altitude of a can in the shape of a right circular cylinder are measured as 4 cm and 6 cm respectively. The possible error in each measurement is 0.1 cm. Find approximately the maximum possible error in the values computed for the volume and the lateral surface area.	2	1	**7**

		c)	If $x = r\sin\theta\cos\phi,\ y = r\sin\theta\sin\phi,\ z = r\cos\theta$ then show that $\frac{\partial(x,y,z)}{\partial(r,\theta,\phi)} = r^2\sin\theta.$	1	1	**7**
			OR			
	4	a)	The altitude of a right circular cone is $15cm$ and is increasing at $0.2cm/\sec$. The radius of the base is $10cm$ and is decreasing at $0.3cm/\sec$. How fast is the volume changing?	2	1	**6**
		b)	Find the shortest distance from the origin to the surface $xyz^2 = 2$.	2	1	**7**
		c)	Expand the function $f(x,y) = x^y$ in powers of $(x-1)$ and $(y-1)$ up to the second-degree term.	1	1	**7**
			UNIT - 3			
	5	a)	Solve: $xy(1+xy^2)\frac{dy}{dx} = 1.$	1	1	**6**
		b)	Solve: $\left(xy^2 - e^{1/x^3}\right)dx - x^2y\,dy = 0.$	1	1	**7**
		c)	Find the orthogonal trajectory of the family of curves $r^n\cos(n\theta) = a^n$.	1	1	**7**
			OR			
	6	a)	Solve: $\left(y^2e^{xy^2} + 4x^3\right)dx + \left(2xy\,e^{xy^2} - 3y^2\right)dy = 0$.	1	1	**6**
		b)	Find the orthogonal trajectory of the family of conics $\frac{x^2}{a^2} + \frac{y^2}{b^2+\lambda} = 1$, λ being the parameter.	1	1	**7**
		c)	A tank contains 1000 gallons of brine in which $500lb$ of salt is dissolved. Fresh water runs into the tank at the rate of 10 gallons per minute and the mixture is kept uniform by stirring, runs out at the same rate. How long will it be before only $50lb$ of salt is left in the tank?	2	1	**7**
			UNIT - 4			
	7	a)	Solve: $\frac{d^3y}{dx^3} + 2\frac{d^2y}{dx^2} + \frac{dy}{dx} = e^{-x} + \sin 2x.$	1	1	**6**
		b)	Apply the method of variation of parameters to solve the differential equation $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 9y = \frac{e^{3x}}{x^2}.$	1	1	**7**
		c)	Solve: $x\frac{d^2y}{dx^2} - \frac{2y}{x} = x + \frac{1}{x^2}.$	1	1	**7**
			OR			
	8	a)	Solve: $(D^2 + 4D + 4)y = x^2 + 2x.$	1	1	**6**
		b)	Determine the charge Q in the LRC-circuit whose governing equation is $L\frac{d^2Q}{dt^2} + R\frac{dQ}{dt} + \frac{Q}{C} = E(t)$ with $L = 0.5H, R = 6\Omega, C = 0.02F,$ $E(t) = 24\sin(10t)$ and the initial conditions $Q = i = 0$ at $t = 0$.	2	1	**7**
		c)	Solve: $(2x+3)^2y'' - (2x+3)y' - 12y = 6x.$	1	1	**7**

			UNIT – 5			
	9	a)	Determine the values of λ and μ for which the system of equations $x+y+z=6$; $x+2y+3z=10$; $x+2y+\lambda z=\mu$ may have (i) unique solution (ii) infinite number of solutions (iii) no solution.	1	1	**6**
		b)	Apply Gauss –Seidel iteration method to approximate the solution for the system of equations $x+y+54z=110$; $27x+6y-z=85$ and $6x+15y+2z=72$ with an initial approximation as $(0,0,0)$. Perform three iterations.	1	1	**7**
		c)	Apply Rayleigh Power method to find the dominant eigenvalue and the corresponding eigenvector of the matrix $A=\begin{bmatrix}2&-1&0\\-1&2&-1\\0&-1&2\end{bmatrix}$ by taking the initial vector as $[1\quad 0\quad 0]^T$. Perform three iterations.	1	1	**7**
			OR			
	10	a)	Balance the chemical equation $C_5H_8+O_2\rightarrow CO_2+H_2O$ by constructing the homogeneous system of equations.	2	1	**6**
		b)	Find the eigenvalues and the corresponding eigenvectors for the matrix $A=\begin{bmatrix}-2&2&-3\\2&1&-6\\-1&-2&0\end{bmatrix}$.	1	1	**7**
		c)	Find the traffic flow in the net of one-way street directions shown in the figure given below. 	2	1	**7**

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