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

Autonomous Institute Affiliated to VTU

February / March 2025 Semester End Main 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

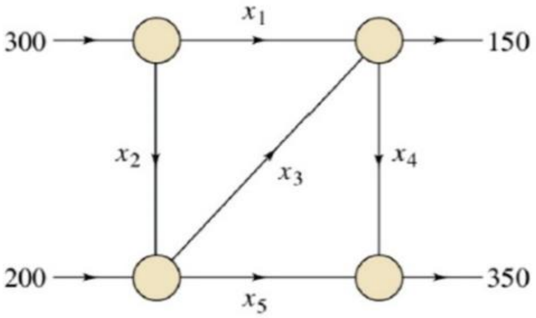
Instructions:

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 of the curve $r = f(\theta)$ then prove that $tan(\phi) = r\frac{d\theta}{dr}$.	1	1	6
	b)	Find the pedal equation of the curve $r^n = a^n \cos(n\theta)$.	1	1	7
	c)	Show that the radius of curvature of the curve $y = 4\sin x - \sin(2x)$ at $x = \pi/2$ is $\frac{5\sqrt{5}}{4}$.	1	1	7
		OR			
2	a)	Find the angle between the radius vector and the tangent for the curve $r = a(1 - cos\theta)$.	1	1	6
	b)	Estimate the angle between the curves $r^n = a^n \cos(n\theta)$ and $r^n = b^n \sin(n\theta)$.	1	1	7
	c)	Show that the radius of curvature for the curve $r^2 sec2\theta = a^2$ is $\rho = \frac{a^2}{3r}$.	1	1	7
		UNIT - 2			
3	a)	If $u = f(2x-3y, 3y-4z, 4z-2x)$, prove that $6u_x + 4u_y + 3u_z = 0$.	1	1	6
	b)	If $u = x + y + z,\ uv = y + z,\ uvw = z,$ show that $\frac{\partial(x,y,z)}{\partial(u,v,w)} = u^2 v$.	1	1	7
	c)	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
		OR			

	4	a)	If $u = e^{ax+by} f(ax-by)$ prove that $b\frac{\partial u}{\partial x} + a\frac{\partial u}{\partial y} = 2abu$.	1	1	**6**
		b)	Expand $f(x,y) = e^{xy}$ in powers of $(x-1)$ and $(y-1)$ up to second degree term.	1	1	**7**
		c)	Find the extreme values for the function $f(x_1,x_2) = x_1^3 + x_2^3 + 2x_1^2 + 4x_2^2 + 6$.	1	1	**7**
			UNIT - 3			
	5	a)	Solve: $\frac{dy}{dx} + \frac{y}{x} = y^2$.	1	1	**6**
		b)	Solve: $(2xy - y^2 + y)dx + (3x^2 - 4xy + 3x)dy = 0$.	1	1	**7**
		c)	Show that the family of parabolas $y^2 = 4a(x+a)$ is self-orthogonal.	1	1	**7**
			OR			
	6	a)	Solve $(2x + y + 1)dx + (x + 2y + 1)dy = 0$.	1	1	**6**
		b)	A tank contains 1000 gallons of brine in which 500lb of salt are 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**
		c)	Find the orthogonal trajectory of the family of curves $r^2 = a^2 \cos^2\theta$.	1	1	**7**
			UNIT - 4			
	7	a)	Solve: $(D^2 - 4D + 13)y = e^{3x} \cosh 2x$.	1	1	**6**
		b)	Solve: $(2x+1)^2 \frac{d^2y}{dx^2} - 6(2x+1)\frac{dy}{dx} + 16y = 8(2x+1)^2$.	1	1	**7**
		c)	The differential equation for a circuit in which self-inductance and capacitance neutralize each other is $L\frac{d^2q}{dt^2} + \frac{q}{C} = 0$. Estimate the charge q as a function of t given that $q = 0$ and $i = 0$ when $t = 0$.	2	1	**7**
			OR			
	8	a)	Solve: $(D^2 - 2D + 4)y = e^x + \cos x$.	1	1	**6**
		b)	Apply the method of variation of parameters to solve the differential equation $\frac{d^2y}{dx^2} + y = cosec x$.	1	1	**7**
		c)	Solve: $x^2\frac{d^2y}{dx^2} + 4x\frac{dy}{dx} + 2y = x$.	1	1	**7**
			UNIT - 5			
	9	a)	Find the rank of a matrix A= $\begin{bmatrix} 0 & 1 & -3 & -1 \\ 1 & 0 & 1 & 1 \\ 3 & 1 & 0 & 2 \\ 1 & 1 & -2 & 0 \end{bmatrix}$.	1	1	**6**

		b)	Apply Gauss-Seidel method to approximate the solution for the system of equations $20x+y-2z=17$, $3x+20y-z=-18$ and $2x-3y+20z=25$ with an initial approximation as $(0,0,0)$. Perform three iterations.	*1*	*1*	**7**
		c)	Balance the chemical equation $C_2H_6 + O_2 \rightarrow CO_2 + H_2O$ by constructing the homogeneous system of equations.	*2*	*1*	**7**
			OR			
	10	a)	Find the values of β and μ for which the system $x+y+z=6$, $x+2y+3z=10$ and $x+2y+\beta z=\mu$ has (i) a unique solution, (ii) infinitely many solutions and (iii) no solution.	*1*	*1*	**6**
		b)	Apply matrix method to find the traffic flow in the net of one-way street directions shown in the figure: 	*2*	*1*	**7**
		c)	Apply Rayleigh Power method to find the dominant eigenvalue and the corresponding eigenvector of the matrix $A=\begin{pmatrix} 4 & 1 & -1 \\ 2 & 3 & -1 \\ -2 & 1 & 5 \end{pmatrix}$ by taking the initial vector as $\begin{bmatrix}1 & 0.8 & -0.8\end{bmatrix}^T$. Perform four iterations.	*1*	*1*	**7**

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