U.S.N.										

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: All Branches (Except IS/CS Clusters) **Duration: 3 hrs.**
Course Code: 22MA1BSMES/22MA1BSMCV/22MA1BSMME **Max Marks: 100**
Course: Mathematical Foundation for Electrical Stream-1
Mathematical Foundation for Civil Engineering -1
Mathematical Foundation for 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.

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		UNIT - 1	CO	PO	Marks
1	a)	If ϕ be the angle between the radius vector and the tangent at any point on the curve $r = f(\theta)$, then prove that $\tan\phi = r\frac{dr}{d\theta}$.	1	1	6
	b)	Find the pedal equation of the curve $\frac{2a}{r} = 1 - \cos\theta$.	1	1	7
	c)	If ρ_1 and ρ_2 are the radii of curvature at the extremities of any chord of the cardioid $r = a(1+\cos\theta)$ which passes through the pole, then show that $\rho_1^2 + \rho_2^2 = \frac{16a^2}{9}$.	1	1	7
		OR			
2	a)	Find the pedal equation of the curve $r = ae^{\theta\cot\alpha}$ where α is a parameter.	1	1	6
	b)	Prove that the curves $r^n = a^n \cos n\theta$ and $r^n = b^n \sin n\theta$ intersect orthogonally.	1	1	7
	c)	Find the radius of curvature at any point on the astroid $x^{2/3} + y^{2/3} = a^{2/3}$.	1	1	7
		UNIT - 2			
3	a)	If $u = F(x-y, y-z, z-x)$, then prove that $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} = 0$.	1	1	6
	b)	If $u = \log_e(x^3 + y^3 + z^3 - 3xyz)$, then prove that (i) $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} = \frac{3}{x+y+z}$, (ii) $\left(\frac{\partial}{\partial x} + \frac{\partial}{\partial y} + \frac{\partial}{\partial z}\right)^2 u = \frac{-9}{(x+y+z)^2}$.	1	1	7

		c)	Apply Taylor's theorem to expand $f(x,y)=\tan^{-1}\left(\frac{y}{x}\right)$ in powers of $(x-1)$ and $(y-1)$ up to 2nd degree term.	1	1	**7**
			OR			
4	a)		If $u=e^{a\theta}\cos(a\log(r))$, 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)	If $x=e^u\cos v$ and $y=e^u\sin v$, then prove that $JJ'=1$.	1	1	**7**
		c)	A rectangular box open at the top is to have a volume of 32 cubic units. Find the dimensions of the box requiring least material for its construction.	1	1	**7**
			UNIT - 3			
5	a)		Solve: $xy\left(1+xy^2\right)\frac{dy}{dx}=1$.	1	1	**6**
		b)	Find the orthogonal trajectory of the family of conics $\frac{x^2}{a^2}+\frac{y^2}{b^2+\lambda}=1$, where λ is the parameter.	1	1	**7**
		c)	Solve: $\left(x^2+y^2+x\right)dx+(xy)dy=0$.	1	1	**7**
			OR			
6	a)		Solve: $y(2xy+e^x)dx-e^x dy=0$.	1	1	**6**
		b)	Solve: $(4xy+3y^2-x)dx+x(x+2)dy=0$.	1	1	**7**
		c)	Find the orthogonal trajectories of the family $r^n\cos(n\theta)=a^n$.	1	1	**7**
			UNIT - 4			
7	a)		Solve: $\left(D^2+2\right)y=x^3+5^x$.	1	1	**6**
		b)	Solve: $\frac{d^2y}{dx^2}+2\frac{dy}{dx}+y=e^{-2x}-\cos 2x$.	1	1	**7**
		c)	Solve: $(x-1)^3\frac{d^3y}{dx^3}+2(x-1)^2\frac{d^2y}{dx^2}-4(x-1)\frac{dy}{dx}+4y=4\log(x-1)$.	1	1	**7**
			OR			
8	a)		Solve $\frac{d^2y}{dx^2}+4\frac{dy}{dx}-12y=e^{2x}-3\sin 2x$.	1	1	**6**
		b)	Solve $x^2\frac{d^2y}{dx^2}+x\frac{dy}{dx}+y=\sin(\log x)$.	1	1	**7**
		c)	Apply the method of variation of parameters to solve the differential equation $\frac{d^2y}{dx^2}+2\frac{dy}{dx}+y=e^{-x}\log x$.	1	1	**7**

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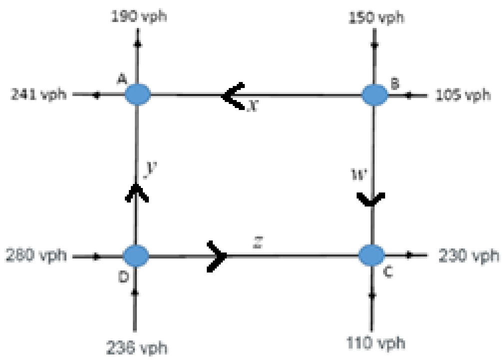
			UNIT - 5			
	9	a)	For what values of λ and μ do the system of equations $x+y+z=6,\ x+2y+3z=10$ and $x+2y+\lambda z=\mu$ have i) No solution ii) Unique solution iii) Infinitely many solutions.	*1*	*1*	**6**
		b)	Apply Gauss Seidel method to solve the system of equations $5x-y+z=12,\ x+4y+2z=15$ and $x+2y+5z=20$ taking $(1,0,3)$ as an initial approximation. Perform 3 iterations.	*1*	*1*	**7**
		c)	Find the eigenvalues and corresponding eigenvectors of the matrix $A=\begin{bmatrix}-2 & 2 & -3\\ 2 & 1 & -6\\ -1 & -2 & 0\end{bmatrix}$.	*1*	*1*	**7**
			OR			
	10	a)	Solve the system by Gauss elimination method $x+y+z=4$, $2x+y-z=1$ and $x-y+2z=2$.	*1*	*1*	**6**
		b)	Find the traffic flow in the network of one-way streets with the directions shown below. 	*1*	*1*	**7**
		c)	Apply Rayleigh Power method to find the dominant eigenvalue and the corresponding eigenvector of the matrix $A=\begin{bmatrix}8 & -6 & 2\\ -6 & 7 & -4\\ 2 & -4 & 3\end{bmatrix}$ by taking $[1\ \ 0\ \ 0]^T$ as the initial approximation. Perform four iterations.	*1*	*1*	**7**

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