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

Autonomous Institute Affiliated to VTU

May 2023 Semester End Main Examinations

Programme: B.E. **Semester: I**
Branch: All Branches Except CSE Stream **Duration: 3 hrs.**
Course Code: 22MA1BSMCV / 22MA1BSMES / 22MA1BSMME **Max Marks: 100**
Course: Mathematical foundation for Civil Engineering -1/ **Date: 12.05.2023**
Mathematical foundation for Electrical Stream-1/
Mathematical foundation for Mechanical Engineering Stream-1

Instructions: Answer any FIVE full questions, choosing one full question from each unit.

UNIT - I

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 $tan(\phi) = r\frac{d\theta}{dr}$. **6**

b) Show that the radius of curvature of the curve $r^n = a^n \sin(n\theta)$ is $\frac{a^n}{(n+1)r^{n-1}}$. **7**

c) Find the pedal equation of the curve $\frac{2a}{r} = 1 - cos\theta$. **7**

UNIT - II

2 a) Expand $e^y \log_e(1+x)$ in powers of x and y up to third degree terms. **6**

b) Find the value of n so that $v = r^n(3\cos^2\theta - 1)$ satisfies the equation $\frac{\partial}{\partial r}\left(r^2 \frac{\partial v}{\partial r}\right) + \frac{1}{\sin(\theta)}\frac{\partial}{\partial \theta}\left(\sin(\theta) \frac{\partial v}{\partial \theta}\right) = 0$. **7**

c) Find the extremum of the function $f(x,y) = x^3 + 3xy^2 - 15x^2 - 15y^2 + 72x$. **7**

OR

3 a) If $u = f\left(\frac{y-x}{xy}, \frac{z-x}{xz}\right)$, show that $x^2\frac{\partial u}{\partial x} + y^2\frac{\partial u}{\partial y} + z^2\frac{\partial u}{\partial z} = 0$. **6**

b) Expand the function $f(x,y) = \tan^{-1}\left(\frac{y}{x}\right)$ in the powers of $(x-1)$ and $(y-1)$ up to second degree terms. **7**

c) If $x = e^u\cos(v)$, $y = e^u\sin(v)$ then verify that $J.J' = 1$where $J = \frac{\partial(x,y)}{\partial(u,v)}$ and $J' = \frac{\partial(u,v)}{\partial(x,y)}$. **7**

UNIT - III

4 a) Solve: $\left[y\left(1+\frac{1}{x}\right) + \cos(y)\right]dx + [x + \log x - x\sin(y)]dy = 0$. **6**

b) Solve: $y^4dx = \left(x^{-3/4} - y^3x\right)dy$. **7**

c) For the family of curves $x - y + 1 = ae^{-y}$, where 'a' is the parameter, find the orthogonal trajectory which passes through the point (0,1). **7**

UNIT - IV

5 a) Solve: $y'' + 4y = \sin(3x) + \cos(2x)$. **6**

b) Solve: $x^2y'' - 4xy' + 6y = 4x - 6$. **7**

c) Apply the method of variation of parameters to solve $(D^2 + 3D + 2)y = e^{e^x}$. **7**

OR

6 a) Solve: $D(D+1)^2y = 12e^{-x} + 3^x$. **6**

b) Solve the initial value problem $(D^2 + 4D + 4)y = x^2 + 2x$ given $y(0) = 0$, $y'(0) = 1$. **7**

c) Solve: $(1+x)^2y'' + (1+x)y' + y = \sin[2\log(1+x)]$. **7**

UNIT - V

7 a) Investigate the values of λ and μ such that $x + 3y + 5z = 9$, $x - y + 2z = 1$ and $2x + 2y + \lambda z = \mu$ has i) Unique solution ii) infinitely many solution iii) No solution. **6**

b) Apply Gauss–Seidel iteration method to solve the system of equations $x+y+54z=110$; $27x+6y-z=85$; $6x+15y+2z=72$. Perform three iterations. **7**

c) Apply Rayleigh power method to approximate a dominant eigenvalue and corresponding eigenvector of the matrix $A = \begin{bmatrix} 2 & -12 \\ 1 & -5 \end{bmatrix}$. Perform five iterations. **7**

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