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

Autonomous Institute Affiliated to VTU

August 2023 Semester End Make-Up Examinations

Programme: B.E.
Branch: All Branches Except CSE Stream
Course Code: 22MA1BSMCV / 22MA1BSMES / 22MA1BSMME
Course: Mathematical foundation for Civil Engineering -1/
      Mathematical foundation for Electrical Stream-1/
      Mathematical foundation for Mechanical Engineering Stream-1

Semester: I
Duration: 3 hrs.
Max Marks: 100
Date: 10.08.2023

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

b) Find the pedal equation of the curve $r(1-\cos\theta) = 2a$.   7

c) Find the radius of curvature for the curve $y^2 = \dfrac{a^2(a-x)}{x}$ at the point $(a,0)$.   7

UNIT - II

2 a) If $u = x^2 \tan^{-1}\left(\dfrac{y}{x}\right) - y^2 \tan^{-1}\left(\dfrac{x}{y}\right)$, then show that $\dfrac{\partial^2 u}{\partial x\,\partial y} = \dfrac{x^2 - y^2}{x^2 + y^2}$.   6

b) Expand the function $f(x,y) = x^y$ in powers of $(x-1)$ and $(y-1)$ up to second degree terms and hence find $(1.1)^{1.1}$.   7

c) Find the shortest distance from origin to the surface $xyz^2 = 2$.   7

OR

3 a) If the kinetic energy K is given by $K = \dfrac{1}{2}mv^2$, find approximately the change in K as the mass m changes from 49 to 49.5 and the velocity v changes from 1600 to 1590.   6

b) If z is a function of x and y and $x = e^u \sin v$, $y = e^u \cos v$, then prove that $\left(\dfrac{\partial z}{\partial u}\right)^2 + \left(\dfrac{\partial z}{\partial v}\right)^2 = e^{2u}\left[\left(\dfrac{\partial z}{\partial x}\right)^2 + \left(\dfrac{\partial z}{\partial y}\right)^2\right]$.   7

c) If $u = x\sqrt{1-y^2} + y\sqrt{1-x^2}$, $v = \sin^{-1}x + \sin^{-1}y$, then show that u and v are functionally dependent and find the functional relationship.   7

UNIT - III

4

a) Solve: $\dfrac{dy}{dx} = \dfrac{x^2 + y^2 + 1}{2xy}$.   6

b) Solve: $\left(xy^2 - e^{1/x^3}\right)dx - x^2 y\, dy = 0$.   7

c) Find the value of constant d such that the parabolas $y = c_1 x^2 + d$ are the orthogonal trajectories of the family of ellipses $x^2 + 2y^2 - y = c_2$.   7
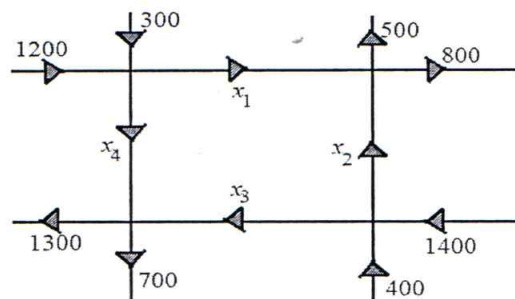
UNIT - IV

5

a) Solve: $x\dfrac{d^2 y}{dx^2} - \dfrac{2y}{x} = x + \dfrac{1}{x^2}$.   6

b) Solve: $\dfrac{d^3 y}{dx^3} + 2\dfrac{d^2 y}{dx^2} + \dfrac{dy}{dx} = e^{-x} + \sin 2x$.   7

c) Apply the method of variation of parameters to solve the differential equation $\dfrac{d^2 y}{dx^2} - 6\dfrac{dy}{dx} + 9y = \dfrac{e^{3x}}{x^2}$.   7

OR

6

a) Solve: $\dfrac{d^2 x}{dt^2} + n^2 x = k\cos(nt + \alpha)$.   6

b) Solve: $(D^2 + 4D + 4)y = x^2 + 2x,\ y(0) = 0,\ y'(0) = 0$.   7

c) Solve: $(2x + 3)^2 y'' - (2x + 3)y' - 12y = 6x$.   7

UNIT - V

7 a) 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.   6

b) Find all the eigen values and the corresponding eigen vectors for the matrix   7

$$A = \begin{bmatrix} -2 & 2 & -3 \\ 2 & 1 & -6 \\ -1 & -2 & 0 \end{bmatrix}.$$

c) Find the traffic flow in the net of one-way street directions as shown in the figure: 7

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