

I B.Tech Semester Regular Examinations, June 2009

MATHEMATICS-I

(Common to Civil Engineering, Electrical & Electronic Engineering, Mechanical Engineering, Electronics & Communication Engineering, Computer Science & Engineering, Chemical Engineering, Electronics & Instrumentation Engineering, Bio-Medical Engineering, Information Technology, Electronics & Control Engineering, Mechatronics, Computer Science & Systems Engineering, Electronics & Telematics, Metallurgy & Material Technology, Electronics & Computer Engineering, Production Engineering, Aeronautical Engineering, Instrumentation & Control Engineering Bio-Technology and Automobile engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Solve $(3y + 2x + 4) dx - (4x + 6y + 5) dy = 0$.
 (b) Bacteria in a culture grows exponentially so that the initial number has doubled in three hours. How many times the initial number will be present after 9 hours. [8+8]
2. (a) Solve $(4D^2 - 4D + 1) y = 100$
 (b) Solve $(D^3 - 6D^2 + 11D - 6) y = e^{-2x} + e^{-3x}$. [8+8]
3. (a) Using Mean Value Theorem prove that $\tan x > x$ in $0 < x < \pi/2$.
 (b) Find the maximum value of $x^2 y^3 z^4$ subject to the condition $2x + 3y + 4z = a$. [8+8]
4. (a) Find the radius of curvature of $y = c \cosh \left(\frac{x}{c} \right)$.
 (b) Find the envelope of $x \operatorname{cosec} \theta - y \cot \theta = p$ where ' θ ' is a parameter. [8+8]
5. (a) Evaluate $\iint x^2 dx dy$, over the region bounded by hyperbola $xy = 4, y = 0, x = 1, x = 4$.
 (b) Evaluate $\int_0^1 \int_0^{1-z} \int_0^{1-y-z} xyz dx dy dz$. [8+8]
6. (a) Examine the convergence or divergence of $\sum \frac{1.3.5..(2n-1)}{2.4.6..2n(2n+2)}$
 (b) Examine the convergence or divergence of $\frac{x}{1.2} + \frac{x^2}{2.3} + \frac{x^3}{3.4} + \dots$ [8+8]
7. Verify Green's theorem in the plane for $\int_C (x^2 - xy^3) dx + (y^2 - 2xy) dy$ where C is a square with vertices (0,0), (2,0), (2,2), (0,2) [16]

8. (a) Find $L^{-1} \left[s / (s^2 + 1) (s^2 + 9) (s^2 + 25) \right]$.
- (b) Using Laplace transform, solve $(D^3 - D^2 + 4D - 4)y = 68 e^x \sin 2x$, $y = 1$,
 $Dy = -19$, $D^2y = -37$ at $x = 0$. [8+8]

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(b) Bacteria in a culture grows exponentially so that the initial number has doubled in three hours. How many times the initial number will be present after 9 hours. [8+8]
2. Solve $(D^2 - 2D + 1) y = x^2 e^{3x} - \sin 2x + 3$. [16]
3. (a) Using Rolle's theorem show that $g(x) = 8x^3 - 6x^2 - 2x + 1$ has a zero between 0 and 1.
(b) If $u = \frac{yz}{x}$, $v = \frac{xz}{y}$, $w = \frac{xy}{z}$ find $\frac{\partial(u, v, w)}{\partial(x, y, z)}$. [8+8]
4. (a) Find the centre of curvature
 $x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$.
(b) Trace the curve $x = a(t + \sin t)$, $y = a(1 - \cos t)$. [8+8]
5. (a) By changing the order of integration, evaluate $\int_0^1 \int_1^{2-x} xy \, dx dy$.
(b) Find the length of the curve $3x^2 = y^3$ between $y = 0$ and $y = 1$. [8+8]
6. (a) Discuss the convergence of $\sum x^{2n} / (n + 2) \sqrt{(n + 1)}$, $(x > 0)$
(b) Examine the convergence of $\frac{1}{5.9.13} - \frac{1}{9.13.17} + \frac{1}{13.17.21} - \dots$ [6+10]
7. (a) Find a unit normal vector to the surface $z = x^2 + y^2$ at $(-1, -2, 5)$
(b) Evaluate by Stoke's theorem $\iint_S \text{curl} \vec{F} \cdot \vec{n} \, ds$ where $\vec{F} = y^2 \vec{i} + x^2 \vec{j} - (x + z) \vec{k}$ and S comprising the planes $x = 0, y = 0, y = 4, z = -1$. [8+8]
8. (a) Find $L^{-1} [1 / (s^3 + 1) s^3]$.

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(b) Find $L^{-1} \left[\frac{1}{(s^2 - 1)(s^2 + 1)} \right]$. [8+8]

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Time: 3 hours

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Answer any FIVE Questions
All Questions carry equal marks

1. (a) Solve $2xy \, dy - (x^2 - y^2 + 1)dx = 0$.
 (b) A copper ball is heated to a temperature of 80°C and time $t = 0$, then it is placed in water which is maintained at 30°C . If at $t = 3$ minutes, the temperature of the ball is reduced to 50°C find the time at which the temperature of the ball is 40°C . [8+8]
2. Solve $D^2(D^2 + 4)y = 96x^2 + \sin 2x - K$. [16]
3. (a) Find the maximum and minimum values of $x + y + z$ subject to $\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = 1$.
 (b) Give an example of a function that is continuous on $[-1, 1]$ and for which mean value theorem does not hold, with explanations. [8+8]
4. (a) Find the radius of curvature of $x = a(\theta + \sin \theta)$, $y = a(1 - \cos \theta)$ at $\theta = \frac{\pi}{2}$.
 (b) Find the envelope of $x \cos^3 \theta + y \sin^3 \theta = p$ where θ is a parameter. [8+8]
5. (a) Find the volume of the solid that results when the region enclosed by the curve $y = x^3$, $x = 0$, $y = 1$ is revolved about the y-axis.
 (b) Find the volume of tetrahedron bounded by the plane $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$ and the coordinate planes by triple integrals. [8+8]
6. (a) Examine the convergence or divergence of $\sum x^{2n}/(n+2)\sqrt{(n+2)}$, ($x > 0$)
 (b) Examine the convergence of $\sum 1/(n^{3/2} + n + 1)$ [8+8]
7. Prove that if $\vec{r}$ is the position vector of any point in space, then $r^n \vec{r}$ is irrotational and is solenoidal if $n = -3$. [16]
8. (a) Find $L[f(t)]$ where $f(t)$ is given by
 $f(t) = t, \quad 0 < t < b$

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Set No. 3

- $= 2b-t, b < t < 2b,$
2b being the period of $f(t)$.
- (b) Find $L^{-1} \left[\frac{(2s+3)}{(s^3-6s^2+11s-6)} \right]$ [8+8]

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1. (a) Solve $(x^2 - y^2) dx = 2xy dy$.
 (b) If a population is increasing exponentially at the rate of 2 percent per year, what will be the percentage increase over a period of 10 years? [8+8]
2. Solve $(D^2 + 3D + 2) y = 2 \cos (2x+3) + 2 e^x + x^2$. [16]
3. (a) Using Mean Value Theorem prove that the function $f(x) = x^2 - 4x + 7$ is increasing when $x > 2$ and is decreasing when $x < 2$.
 (b) Decompose a positive number into three positive terms such that their product is a maximum. [8+8]
4. (a) Prove that the evolute of the curve $x = a (\cos \theta + \log \tan \frac{\theta}{2})$, $y = a \sin \theta$ is $y = a \cosh \frac{x}{a}$.
 (b) Show that if ρ is the radius of curvature for the curve $r = a (1 + \cos \theta)$ then $\frac{\rho^2}{r}$ is a constant. [8+8]
5. (a) Evaluate $\iiint_V (xy + yz + zx) dx dy dz$, where V is the region of space bounded by $x = 0, x = 1, y = 0, y = 2, z = 0, z = 3$.
 (b) Find the value of $\iint xy dx dy$ taken over the positive quadrant of the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$. [8+8]
6. (a) Examine the convergence of
$$\sum \left[\frac{1.4.7.....(3n-2)}{3.6.9.....3n} \right]^2$$

 (b) Examine the convergence of $1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \dots$ [8+8]
7. (a) If $\vec{r}$ is a position vector of the point P(x,y,z) then prove that $\nabla f(r) = f'(r) \frac{\vec{r}}{|\vec{r}|}$

(b) If $\vec{F} = (5xy - 6x^2) \vec{i} + (2y - 4x)\vec{j}$, evaluate $\int_C \vec{F} \cdot d\vec{r}$ along the curve C in xy-plane $y = x^3$ from (1,1) to (2,8). [8+8]

8. (a) Find L $\left[\frac{\cos 4t \sin 2t}{t} \right]$

(b) Find L $\left[\int_0^t \frac{e^{-t} \sin t}{t} dt \right]$. [8+8]
