

Applied Mathematics III

Mechanical/Automobile

QP Code : 30542

(3 Hours)

[Total Marks : 80

- N.B. : (1) Question No.1 is compulsory
 (2) Answer any three from remaining
 (3) Figures to the right indicate marks.

1. (a) Find laplace transform of $\frac{\sin^2 2t}{t}$ 5
 (b) Find the orthogonal trajectory of the family of curves $e^x \cos y + xy = \alpha$ where α is a real constant in the xy plane. 5
 (c) Find complex form of fourier series $f(x) = e^{3x}$ in $0 < x < 3$ 5
 (d) Show that the function is analytic and find their derivative $f(z) = ze^z$ 5
2. (a) Using laplace transform solve: $\frac{d^2 y}{dt^2} + y = t$ $y(0) = i$ $y'(0) = 0$ 6
 (b) Using Crank Nicholson method 6
 Solve : $\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0$
 $u(0, t) = 0$ $u(4, t) = 0$
 $u(x, 0) = \frac{x}{3}(16 - x^2)$ find u_{ij}
 for $i = 0, 1, 2, 3, 4$ and $j = 0, 1, 2$
- (c) Show that the set of functions $1, \sin \frac{\pi x}{L}, \cos \frac{\pi x}{L}, \sin \frac{2\pi x}{L}, \cos \frac{2\pi x}{L}, \dots$ 8
 form an orthogonal set in $(-L, L)$ and construct an orthonormal set.

3. (a) Find the bilinear transformation that maps points 0, 1, ∞ of the z plane into -5, -1, 3 of w plane. 6
- (b) By using Convolution theorem find inverse laplace transform of 6
- $$\frac{1}{(s-2)^4(s+3)}$$
- (c) Find the Fourier series of f(x) 8
- $$f(x) = \begin{cases} \cos x & -\pi < x < 0 \\ \sin x & 0 < x < \pi \end{cases}$$
4. (a) Find half range sine series for x sin x in (0, π) and hence deduce 6
- $$\frac{\pi^2}{8\sqrt{2}} = \frac{1}{1^2} - \frac{1}{3^2} + \frac{1}{5^2} - \frac{1}{7^2} \dots$$
- (b) Evaluate and prove that 6
- $$\int_0^{\infty} e^{-\sqrt{2}t} \frac{\sin t \sinh t}{t} dt = \frac{\pi}{8}$$
- (c) Obtain Laurent's series for the function f(z) = 8
- $$\frac{-7z-2}{z(z-2)(z+1)} \text{ about } z = -1$$
5. (a) Solve : $\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0$ subject to the conditions $u(0, t) = 0, u(5, t) = 0$ 6
- $u(x, 0) = x^2(25 - x^2)$ taking $h = 1$ upto 3 seconds only by Bender schmidt formula.
- (b) Construct an analytic function whose real part is $\frac{\sin 2x}{\cosh 2y + \cos 2x}$ 6
- (c) Evaluate $\int_0^{\pi} \frac{d\theta}{3+2\cos\theta}$ 8

6. (a) An elastic string is stretched between two points at a distance l apart. In its equilibrium position a point at a distance a ($a < l$) from one end is displaced through a distance b transversely and then released from this position. Obtain $y(x, t)$ the vertical displacement if y satisfies the equation. 6

$$\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$$

- (b) Evaluate : $\int_0^{1+i} z^2 dz$ along 6

- (i) The line $y = x$
 (ii) The parabola $x = y^2$

Is the line integral independent of path? Explain.

- (c) Find fourier expansion of 8

$$f(x) = \left(\frac{\pi - x}{2} \right)^2$$

in the interval $0 \leq x \leq 2\pi$ and $f(x+2\pi) = f(x)$
 and also deduce

(i) $\frac{\pi^2}{12} = \frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} \dots$

(ii) $\frac{\pi^4}{90} = \frac{1}{1^4} + \frac{1}{2^4} + \frac{1}{3^4} + \frac{1}{4^4} \dots$