Time: 2 Hours **Marks: 60**

Note: 1. Question No. 1 is Compulsory.
2. Attempt any 3 Questions from the remaining questions.
3. Scientific Calculator is allowed to use

Q.1 Attempt **any Five** questions of the following.

a. Find Laplace transform of $e^{-2t}t.sin3t$ **3**

b. Find inverse Laplace transform of $\frac{s-2}{s^2+2s+17}$ **3**

c. Find ' a_n ' in Fourier series for $f(x) = 1 - x^2$ in $(-1,\ 1)$ **3**

d. Show that v= $x^2 - y^2 - 2xy - 2x + 3y$ is a harmonic function. **3**

e. Find eigen values of A^3 -3A^2 +4I, if $A = \begin{bmatrix} 2 & 3 & 2 \\ 0 & -1 & 3 \\ 0 & 0 & -3 \end{bmatrix}$ **3**

f. State one dimensional and two dimensional heat flow equation along with steady state flow **3**

Q.2 a. Find analytic function whose imaginary part is $e^{-x}(ycos\ y - xsin\ y)$ **4**

b. Find half range cosine series for $f(x) = x(\pi - x)$ in $(0,\ \pi)$ **5**

c. By Laplace transform, prove that $\int_0^\infty e^{-t}\frac{cos3t-cos2t}{t}dt = \frac{1}{2}\log\frac{1}{2}$ **6**

Q.3 a. Find inverse Laplace transform of $\log\left(\frac{s^2+a^2}{s^2+b^2}\right)$ **4**

b. Find ρ, if $f(z) = r^2cos2\theta + ir^2sin\rho\theta$ is an analytic function **5**

c. Solve $\frac{\partial^2 u}{\partial x^2} - 32\frac{\partial u}{\partial x} = 0$ by Bender-Schmidt method, subject to conditions $u(0,\ t) = 0,\quad u(x,\ 0) = 0,\ u(1,\ t) = t$ taking h=0.25, $0 < x < 1$ **6**

Q.4 a. Expand Fourier series for $f(x) = x|x|$ in $(-\pi,\ \pi)$ **4**

b. Find eigen values and eigen vectors of $A = \begin{bmatrix} 2 & -3 & 0 \\ 2 & -5 & 0 \\ 0 & 0 & 3 \end{bmatrix}$ **5**

c. By Crank- Nicholson method, solve $\frac{\partial^2 u}{\partial x^2} - 16\frac{\partial u}{\partial x} = 0$ subject to conditions $u(0,\ t) = 0,\quad u(x,\ 0) = 0,\ u(1,\ t) = 200t$ Compute u(x, t) for one step in t division taking h=0.25, $0 < x < 1$. **6**

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Q.5 a. Verify Cayley-Hamilton theorem for $A = \begin{bmatrix} 2 & 1 & 2 \\ 1 & 2 & 1 \\ 2 & 1 & 2 \end{bmatrix}$ **4**

b. Find inverse Laplace transform of $\frac{s+4}{(s-1)(s-2)(s-3)}$ **5**

c. Expand Fourier series for $f(x) = \frac{1}{2}(\pi - x)$ in $(0,2\pi)$ **6**

Q.6 a Find Laplace transform of $\int_0^t \int_0^t \int_0^t \sqrt{1 + sin2u}\,(du)^3$ **4**

b. By using convolution theorem, find inverse Laplace transform of $\frac{s^2}{(s^2+4)(s^2+9)}$ where a and b are constants. **5**

c. Show that the matrix $A = \begin{bmatrix} -9 & 4 & 4 \\ -8 & 3 & 4 \\ -16 & 8 & 7 \end{bmatrix}$ is diagonalisable **6**

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