(Time: 3 Hours) **Total Marks: 80**

Note: 1) Question No.1 is compulsory.
2) Attempt any Three from the remaining.

Q1 A) Find L $\left\{\int_0^t u^3 e^{-2u} du\right\}$ **5**

B) Prove that $f(z) = e^{2x}(\cos 2y + i \sin 2y)$ is analytic everywhere. Hence find $f'(z)$ **5**

C) Find half range sine series of $f(x) = x$ in $(0, \pi)$ **5**

D) If $A=\begin{bmatrix}2 & 1 & 1\\ 1 & 1 & 2\\ 1 & 2 & 1\end{bmatrix}$ then Find an eigen value of **5**

i) A
ii) Adj(A)
iii) $A^2 - 2A + I$

Q2

A) If $L[f(t)] = \frac{1}{9s^2-3s+16}$ then Find $L[e^t f(3t)]$ **6**

B) Find Fourier series for $f(x) = x$, if $0 < x < 2\pi$ and $f(x + 2\pi) = f(x)$ **6**

C) Find analytic function f(z) in terms of z where $u = 3x^2 - 3y^2 + x$ **8**

Q3

A) A string is stretched and fastened to two points distance l apart. Motion is started by displacing the string in the form y=a sin(πx/ l) from which it is released at time t=0.Show that the displacement of a point at a distance x from one end at time t is given by y = a sin(πx/ l) cos (πct / l) **6**

B) Prove that $u = y^3 - 3x^2y$ is harmonic function hence find it's harmonic conjugate function **6**

C) Find the Fourier Series for $f(x) = \pi + x$ in $(-\pi, \pi)$where **8**

Q4

A) Evaluate $\int_0^\infty \left[\frac{e^{-2t}-e^{-3t}}{t}\right] dt$ **6**

B) Find Inverse Laplace transform of $\frac{s+1}{(s-1)(s+2)}$ **6**

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C) Is the matrix $A = \begin{bmatrix} 2 & 1 & 1 \\ 2 & 3 & 2 \\ 1 & 1 & 2 \end{bmatrix}$ Diagonalizable? If so find the Diagonal form of A and transforming matrix of A **8**

Q5

A) If $A=\begin{bmatrix} 2 & -1 & 1 \\ -1 & 2 & -1 \\ 1 & -1 & 2 \end{bmatrix}$ then Using Caley Hamilton theorem evaluate $A^9 - 6A^8 + 9A^7 - 4A^6$ **6**

B) Solve by Crank-Nicholson simplified formula $\frac{\partial^2 u}{\partial x^2} - 16\frac{\partial u}{\partial t} = 0$, $0 \le x \le 1$ subject to the condition $u(0,t) = 0, u(1,t) = 100t$, $u(x,0)=0$ h=0.25 for one-time step. **6**

c) Find inverse Laplace transform of (i) $\log\left[\frac{(s+16)}{(s+25)}\right]$ (ii) $\frac{s}{(s+4)^2}$ **8**

Q6

A) Find the Laplace Transform of $\int_0^t e^{-u}(\sin u + \cos u)du$ **6**

B) Find the solution of **6**

$4\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0, 0 < x < 8, \quad u(x,0) = 4x - \frac{1}{2}x^2$, u(0,t)=0, u(8,t)=0

Taking $h = 1, k = \frac{1}{8}$ for $0 \le t \le 4/8$

Where h is the step length for x axis and k is the step size in time direction using Bender –Schmidt method

C) Find inverse Laplace transform of $\frac{1}{(s^2+25)^2}$ using convolution theorem **8**

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