04-06-2026 SE EXTC SEM-III (NEP-2020) MSA QP CODE: 20013400

Time: 2 Hrs **Marks: 60**

N.B.:- 1) Question no.1 is compulsory.
2) Attempt any 3 questions from the remaining questions.

Q.1 Attempt any five questions of the following

(a) Find the Laplace Transform of $(\sin 2t - \cos 2t)^2$. (3)

(b) Find the fourier series of $f(x) = 9 - x^2 \quad in\ the\ interval\ (-3, 3)$. (3)

(c) Obtain fourier transform of $x(t) = -e^{at}u(-t)$. (3)

(d) Find the characteristics roots of $A^2 - 2A + 2I \ \ where\ A = \begin{bmatrix} 2 & 3 \\ 0 & 1 \end{bmatrix}$. (3)

(e) Find the Z-transform of $f(k) = a^k, k \geq 0$. (3)

(f) A Hospital switch board receives an average of 4 emergency calls in a 10 minutes interval. What is the probability that there are at least 2 emergency calls. (3)

Q.2 (a) Find the Laplace Transform of $\frac{\cos 2t \,.\sin t}{e^t}$. (4)

(b) Obtain Fourier Transform of signal given below $x(t) = 3e^{-t}u(t) - 2e^{-2t}u(t)$. (5)

(c) A random variable X has the following density function,

$f(x) = \begin{cases} x/4 + k, & 0 \leq x \leq 2 \\ 0 & elsewhere \end{cases}$, then find k and $(1 \leq x \leq 2)$. (6)

Q.3 (a) Find the Z-transform of $\{\sin(ak + b)\}, k \geq 0$. (4)

(b) Show that the matrix $A = \begin{bmatrix} 2 & 3 & 4 \\ 0 & 2 & -1 \\ 0 & 0 & 1 \end{bmatrix}$ is not similar to a diagonal matrix. (5)

(c) Obtain the Fourier expansion of $f(x) = \left(\frac{\pi - x}{2}\right)^2$ in the interval $0 \leq x \leq 2\pi$. (6)

Q.4 (a) Perform convolution of these signal using Fourier transform (4)

$x(t) = e^{-2t}u(t)\ ; \quad h(t) = e^{-3t}u(t).$

(b) Find Inverse Laplace Transform of $\phi(s) = \frac{1}{(s-2)(s+2)^2}$. (5)

(c) Show that matrix $A = \begin{bmatrix} 8 & -8 & -2 \\ 4 & -3 & -2 \\ 3 & -4 & 1 \end{bmatrix}$ is diagonalisable. Find the transforming matrix and the diagonal matrix. (6)

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Q.5 (a) Find inverse Z-transform of $F(z) = \frac{1}{(z-1)(z-2)}, |z| > 2$. (4)

(b) Obtain the complex form of Fourier Series for $f(x) = e^{ax} in\ (-l, l)$. (5)

(c) If $f(x) = e^{-ax^2}, Find\ F\{f(x)\}$. (6)

Q.6 (a) Find, $Z^{-1}\left\{\frac{z}{(z-1)(z-2)}\right\}$. (4)

(b) In an intelligence test administered to 1000 students, the average was 42 and standard deviation was 24.Find the number of students (i) exceeding the score 50 and (ii) between 30 and 54. (5)

(c) Solve the following differential equation using Laplace Transforms (6)

$$L\frac{di}{dt} + Ri + \frac{1}{C}\int_0^t i\,dt = E\ .$$

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