

17 DEC.2025 SE EXTC (SEM-III) NEP-2020 MSA QP CODE: 10099025

Time: 2 Hours

Marks: 60

Note : 1) Question no 1 is compulsory

2) Attempt any three questions from the remaining.

3) Assume suitable data, if required and state it clearly.

Q.1 Solve any FIVE questions (15 M)

a) Find $L[e^{-2t} \cdot \cos^2 t]$ (03 M)b) Find the Fourier Series of $f(x) = x$ in the interval $(-1,1)$ (03 M)c) Find the Fourier transform of signal $X(t)$ where $X(t) = e^{-at}u(t)$ where $a > 0$. (03 M)d) Find Z- transform of $f(k) = a^k, k \geq 0$ (03 M)

e) The probability mass function of a random variable X is (03 M)

$X = x$	0	1	2	3	4
$P(X = x)$	K	$2k$	k	$4k$	$3k$

Find k and $P(X \leq 2)$ f) Three of the eigen values of 5×5 matrix are 1,2 & 3. If the determinant and trace of matrix are 24 & 11 respectively, find the remaining Eigen values. (03 M)

Q.2 Solve all questions: (15 M)

a) Obtain $Z\{1\}$ and hence prove that $Z\{k\} = \frac{z}{(z-1)^2}, |z| > 1$ (04 M)

b) The local authorities in a certain city installed 10,000 electric lamps in the streets of the city these lamps have average life of 1000 burning hours with a standard deviation of 200hours. What number of lamps might be expected to fail in first 800 hours. (05 M)

c) Find the eigen values and eigen vectors of the matrix $\begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$ (06 M)

Q.3 Solve all questions: (15 M)

a) Find Laplace transform of $\frac{1-\cos t}{t}$ (04 M)b) Find the Fourier transform of $X(t) = \cos(\omega t)$ (05 M)c) Obtain the Fourier expansion of $f(x) = (x - 2\pi)^2$ in the interval $0 \leq x \leq 2\pi$ (06 M)

Q.4 Solve all questions: (15 M)

a) If $f(k) = \frac{1}{3^k}$, $k \geq 0$ and $g(k) = \frac{1}{5^k}$, $k \geq 0$ then find Z- transform of $f(k) * g(k)$ (04 M)

b) Check whether matrix $\begin{bmatrix} 2 & 1 & 0 \\ 0 & 2 & 1 \\ 0 & 0 & 3 \end{bmatrix}$ is diagonalizable or not? If so then find the diagonal form and transforming form. (05 M)

c) If the pdf of a random variable is given by (06 M)

$$f(x) = \begin{cases} kx, & 0 \leq x \leq 2 \\ 6k - kx, & 2 \leq x \leq 4 \end{cases}$$

Find (i) k , (ii) $E(X)$, (iii) $V(X)$

Q.5 Solve all questions: (15 M)

a) Find the inverse Z-transform of $F(z) = \frac{1}{(z-3)(z-2)}$ if ROC is $|z| < 2$ (04 M)

b) Find $L^{-1} \left[\frac{s}{(s-1)^2(s-2)} \right]$ using partial fraction. (05 M)

c) Let $X_1(t)$ & $X_2(t)$ be two signals defined by (06 M)

$$X_1(t) = te^{-t}u(t) \text{ \& } X_2(t) = te^{-t}u(t).$$

Find Fourier Transform of the convolution $X_1(t) * X_2(t)$.

Q.6 Solve all questions: (15 M)

a) Let $X(t)$ be a signal defined as $X(t) = \begin{cases} 1 - t^2, & |t| < 1 \\ 0, & |t| > 1 \end{cases}$. Find the Fourier transform of $X(t)$. (04 M)

b) Obtain complex form of Fourier series for $f(x) = \cosh 3x + \sinh 3x$ in $(-3,3)$ (05 M)

c) Solve using Laplace transform $L \frac{di}{dt} + Ri = Ee^{-at}$ where $i(0) = 0$. (06 M)
