CBCS SCHEME

USN

17EE54

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Signals and Systems

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

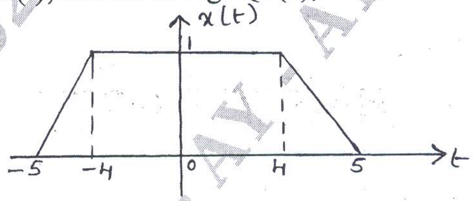
Module-1

1 a. Distinguish between : i) Continuous time signals and discrete time signals. ii) Even signal and Odd signal iii) Periodic signal and non – periodic signal. **(06 Marks)**

b. Find the even and odd components of the following signals.
i) $x(t) = 1 + t\cos t + t^2 \sin t + t^3 \sin t \cos t$ ii) $x(t) = 1 + t + 3t^2 + 5t^3 + 9t^4$. **(08 Marks)**

c. For the trapezoidal pulse x(t), shown in Fig. Q1(c), find the total energy. **(06 Marks)**

Fig. Q1(c)

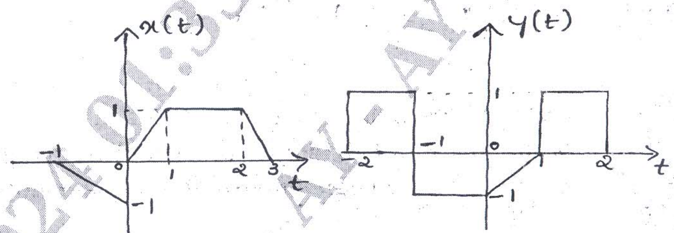


OR

2 a. A system has an input – output relation given by $y(t) = \frac{d}{dt}\{e^{-t}\ x(t)\}$. Determine whether the system is i) Memory less ii) Time invariant iii) Linear iv) Causal. **(06 Marks)**

b. Signals x(t) and y(t) are shown in Fig. Q2(b). Sketch i) $x(t)\,y(t-1)$ ii) $x(2t)\,y(2t+1)$. **(08 Marks)**

Fig. Q2(b)



c. Check whether the signals given below are periodic. If periodic find the fundamental period.
i) $x(t) = 3\cos 4t + 2\sin \pi t$ ii) $x[n] = \text{Cos}\left[\frac{n\pi}{12}\right] + \text{Sin}\left[\frac{n\pi}{18}\right]$. **(06 Marks)**

Module-2

3 a. Find the forced response for the system described by
$$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = 2x(t) + \frac{dx(t)}{dt}$$ with input $x(t) = 2e^{-t}u(t)$. **(08 Marks)**

b. Find convolution of two finite duration sequences $h[n] = a^n u[n]$ for all n and $x[n] = b^n$ [n] for all n i) When $a \neq b$ ii) When $a = b$. **(07 Marks)**

c. Draw the direct form – I and direct form – II implementation of the following system :
$$4\frac{d^3y(t)}{dt^3} - 3\frac{dy(t)}{dt} + y(t) = x(t) + \frac{dx(t)}{dt}.$$ **(05 Marks)**

OR

4 a. Find the zero input response and forced response for the system described by the difference equation $y[n] - \frac{1}{4}y[n-2] = 2x[n] + x[n-1]$. Given $x[n] = u[n]$, $y[-2] = 8$ and $y[-1] = 0$. **(10 Marks)**

b. For the following impulse response determine whether the corresponding system is
i) Memoryless ii) Causal iii) Stable
$h(t) = u(t+1) - u(t-1)$. **(05 Marks)**

c. Evaluate the step response for the LTI system represented by the impulse response $h(t) = t\,u(t)$. **(05 Marks)**

Module-3

5 a. State and prove Parsavel's theorem. **(07 Marks)**

b. Find the Fourier transform of the signal x(t) using appropriate properties
$x(t) = \frac{d}{dt}\left[t\, e^{-2t} \sin t\ u(t)\right]$. **(07 Marks)**

c. Compute the Fourier transform for the signal x(t), shown in Fig. Q5(c). **(06 Marks)**

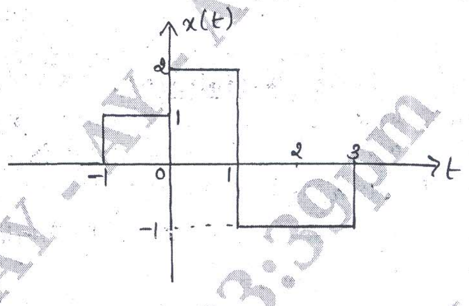


Fig. Q5(c)

OR

6 a. The impulse response of a continuous time LTI system is given by
$h(t) = \frac{1}{RC} e^{-t/RC} u(t)$. Find the frequency response and plot the magnitude and phase response. **(07 Marks)**

b. Using partial fraction expansion, determine the time domain signal corresponding to the following Fourier transform.
$x(jw) = \frac{2(jw)^2 + 5jw - 9}{(jw+4)(-w^2 + 4jw + 3)}$. **(07 Marks)**

c. The system produces the output of $y(t) = e^{-t}u(t)$ for an input of $x(t) = e^{-2t}u(t)$. Determine frequency response and impulse response of the system. **(06 Marks)**

Module-4

7 a. State and prove the following properties of discrete Fourier transform :
i) Linearity ii) Time shift. **(08 Marks)**

b. Obtain the difference equation description for the system having impulse response
$h[n] = \delta[n] + 2[\frac{1}{2}]^n u[n] + [-\frac{1}{2}]^n u[n]$. **(06 Marks)**

c. Find the DTFT of the signal $x[n] = [\frac{1}{4}]^n u[n+4]$. **(06 Marks)**

OR

8 a. Using partial fraction expansion, determine the inverse DTFT of the signal.

$$X(e^{j\Omega}) = \frac{3 - \frac{1}{4}e^{-j\Omega}}{-\frac{1}{16}e^{-j2\Omega} + 1}.$$ (06 Marks)

b. Find the DTFT of the signal $x[n] = a^{|n|}$; $|a| < 1$. (07 Marks)

c. A Signal x[n] has the DTFT

$X(e^{j\Omega}) = \frac{1}{1 - a\, e^{-j\Omega}}$. Determine the DTFT of the following :

i) $x_1[n] = x[2n+1]$ ii) $x_2[n] = e^{\pi/2^{n}}\ x[n+2]$. (07 Marks)

Module-5

9 a. List the properties of ROC. (06 Marks)

b. Determine the Z – transform, the ROC and the location of poles and zeros of x(z) for the following signal. Draw the ROC.

$x[n] = \left(\frac{1}{2}\right)^n u[n] + \left(\frac{1}{3}\right)^n u[n]$. (08 Marks)

c. Determine the forced response for the system described by the difference equation.

$y[n] - \frac{5}{6}\, y[n-1] + \frac{1}{6}\, y[n-2] = x[n]$, if input $x[n] = 2^n u[n]$. (06 Marks)

OR

10 a. Find the Z – transform of $x[n] = 2^n u[-n-3]$ using appropriate properties. (06 Marks)

b. Using Partial Fraction Expansion method, find the inverse Z – transform of

$$X(z) = \frac{\frac{1}{4}Z^{-1}}{\left(1 - \frac{1}{2}Z^{-1}\right)\left(1 - \frac{1}{4}Z^{-1}\right)}$$ for ROC i) $|Z| > \frac{1}{2}$ ii) $|Z| < \frac{1}{4}$

iii) $\frac{1}{4} < |Z| < \frac{1}{2}$. (08 Marks)

c. State and prove the following properties of Z – transform :

i) Time reversal ii) Differentiation in the Z – domain. (06 Marks)

* * * * *