CBCS SCHEME

USN | | | | | | | | | | | **15EE54**

Fifth Semester B.E. Degree Examination, June/July 2018
Signals and Systems

Time: 3 hrs. Max. Marks: 80

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

Module-1

1 a. Prove that

i) $\int_{-a}^{a} x(t)dt = 2\int_{0}^{a} x(t)dt$; if x(t) is even

ii) $\int_{-a}^{a} x(t)dt = 0$; if x(t) is odd. **(06 Marks)**

b. What is the total energy of the rectangular pulse shown in Fig.Q.1(b)? **(05 Marks)**

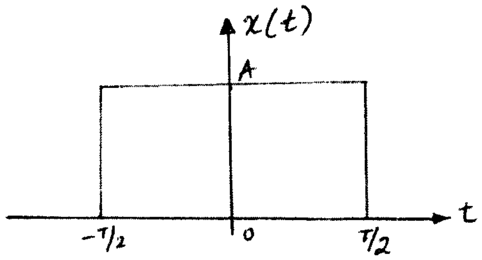


Fig.Q.1(b)

c. Determine whether the system $y(t) = x^{(t/2)}$ is i) Linear ii) Time-invariant iii) Memory iv) Causal v) Stable. **(05 Marks)**

OR

2 a. Check whether the following signals are periodic or not. If periodic, find the fundamental period: i) $x_1[n] = \cos 2\pi n$ ii) $x_2[n] = \cos 2n$. **(06 Marks)**

b. For the continuous-time signal x(t) shown in Fig.Q.2(b), sketch the signal y(t) = x(3t + 2). **(05 Marks)**

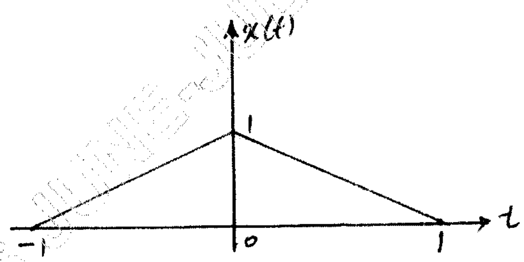


Fig.Q.2(b)

c. Sketch the signal, x(t) = -u(t + 3) + 2u(t + 1) – 2u (t – 1) + u (t – 3). **(05 Marks)**

Module-2

3 a. Consider the input signal x[n] and the impulse response h(n) given below:

$$x[n]=\begin{cases}1 & 0\le n\le 4\\ 0 & \text{elsewhere}\end{cases}\qquad h[n]=\begin{cases}\alpha^n & 0\le n\le 6\\ 0 & \text{else where}\end{cases}$$

Compute the output signal y[n]. (05 Marks)

b. Evaluate the system response of the system

$\ddot{y}(t)+5\dot{y}(t)+6y(t)=2e^{-t}u(t)$ with $y(0)=0,\ \dot{y}(0)=1$. (05 Marks)

c. Draw direct form I and direct form II implementation for the following difference equations:

i) $y(n)+\frac{1}{4}y(n-1)-\frac{1}{8}y(n-2)=2x(n)+3x(n-1)$

ii) $y(n)-\frac{1}{9}y(n-2)=x(n)+2x(n-1)$. (06 Marks)

OR

4 a. For each of the impulse response listed below,

i) $h(t)=e^{-2|t|}$ ii) $h(t)=e^{2t}\,u(t-1)$

Determine whether the corresponding system is i) Memory less ii) Causal and iii) Stable. (06 Marks)

b. Evaluate the continuous-time convolution integral given below:

$y(t)=e^{-2t}u(t)*u(t+2)$. (05 Marks)

c. For the system given below, compute the zero-input, zero-state and total response, assuming $x[n]=u[n]$ and $y[-1]=y[-2]=1$, $y(n)-\frac{3}{4}y(n-1)+\frac{1}{8}y(n-2)=x(n-1)$. (05 Marks)

Module-3

5 a. Prove the following properties of Fourier transform:

i) Frequency shifting property ii) Time-differentiation. (06 Marks)

b. For the rectangular pulse shown in Fig.Q.5(b), draw the spectrum. (05 Marks)

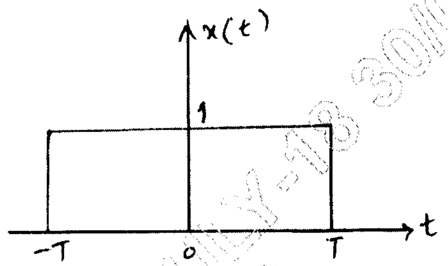
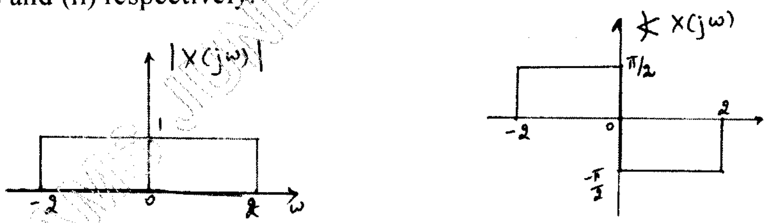


Fig.Q.5(b)

c. Determine the time-domain signal corresponding to the spectrum shown in Fig.Q.5(c) (i) and (ii) respectively. (05 Marks)



(i) (ii)

Fig.Q.5(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. **(05 Marks)**

b. Prove that, if $x(t) \xleftrightarrow{FT} x(jw)$ then, $\int_{-\infty}^{t} x(\tau)d\tau \xleftrightarrow{FT} \frac{x(jw)}{jw} + \pi x(jo)\delta(w)$. **(05 Marks)**

c. Obtain the frequency response and the impulse response of the following system described by the differential equations:

i) $\frac{dy(t)}{dt} + 8y(t) = x(t)$

ii) $\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = \frac{-dx(t)}{dt}$. **(06 Marks)**

Module-4

7 a. Compute the DTFT of the following signals:

i) $x(n) = 2^n u(-n)$

ii) $x(n) = a^{|n|}$; $|a| < 1$

iii) $x(n) = (\alpha^n \sin \Omega_0 n)u(n)$; $|\alpha| < 1$. **(06 Marks)**

b. Obtain the frequency response and the impulse response of the system having the output y(n) for the input x(n) as given below.

$x(n) = \left(\frac{1}{2}\right)^n u(n)$; $y(n) = \frac{1}{4}\left(\frac{1}{2}\right)^n u(n) + \left(\frac{1}{4}\right)^n u(n)$. **(05 Marks)**

c. A discrete-time LTI system described by $y(n) - \frac{1}{2}y(n-1) = x(n) + \frac{1}{2}x(n-1)$

i) Determine the frequency response $H(\Omega)$.

ii) Find the impulse response h(n) of the spectrum. **(05 Marks)**

OR

8 a. Find the inverse DTFT of

i) $x(\Omega) = e^{-j4\Omega}$, $\frac{\pi}{2} < |\Omega| < \pi$

ii) $x(\Omega) = \dfrac{3 - \frac{5}{4}e^{-j\Omega}}{\frac{1}{8}e^{-j2\Omega} - \frac{3}{4}e^{-j\Omega} + 1}$. **(08 Marks)**

b. State and explain Parseval's theorem of discrete time Fourier transform. **(04 Marks)**

c. Obtain the difference equation for the system with frequency response. **(04 Marks)**

$H(e^{j\Omega}) = 1 + \dfrac{e^{-j\Omega}}{\left(1 - \frac{1}{2}e^{-j\Omega}\right)\left(1 + \frac{1}{4}e^{j\Omega}\right)}$.

Module-5

9 a. Find the Z-transform of the following:

i) $x(n) = n\sin\left(\frac{\pi}{2}n\right)u(-n)$

ii) $x(n) = \left(\frac{1}{2}\right)^n u(n) * \left(\frac{1}{3}\right)^n u(n)$. (07 Marks)

b. List the properties of ROC. (04 Marks)

c. Find the inverse Z-transform of the following using partial fraction expansion:

$$X(Z) = \frac{1 - \frac{1}{2}z^{-1}}{1 + \frac{3}{4}z^{-1} + \frac{1}{8}z^{-2}}; \ |z| > \frac{1}{2}.$$ (05 Marks)

OR

10 a. A causal LTI system is described by the difference equation $y(n) = y(n-1) + y(n-2) + x(n-1)$.

i) Find the system function.
ii) Plot the poles and zeros.
iii) Indicate the ROC.
iv) Find the unit sample response of this system.
v) Find the stable (non causal) unit sample that satisfies the difference equation. (06 Marks)

b. Solve the following equation using unilateral Z-transform $y(n) - \frac{3}{2}y(n-1) + \frac{1}{2}y(n-2) = x(n)$ for $n \geq 0$ with initial conditions y(-1) = 4, y(-2) = 10 and $x(n) = \left(\frac{1}{4}\right)^n u(n)$. (05 Marks)

c. Determine the step response of the system $y(n) = \alpha y(n-1) + x(n)$; $-1 < \alpha < 1$ with initial conditions y(-1) = 1. (05 Marks)

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