CBCS SCHEME

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15EE54

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Express x(t) interms g(t)

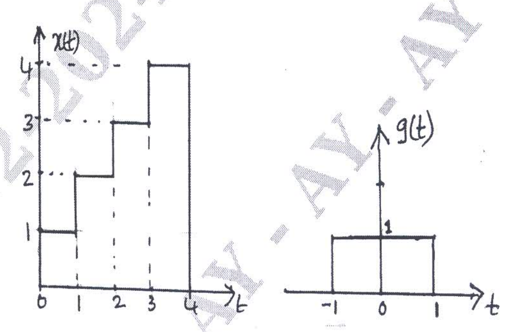

Fig Q1(a) **(05 Marks)**

b. Check whether the following signals are periodic or not. If periodic, determine their fundamental period

i) $x(t) = 2\text{Cos}t + 3\ \text{Cos}\ t/3$

ii) $x[n] = \text{Cos}\left(\frac{\pi n}{5}\right)\text{Sin}\left(\frac{\pi n}{3}\right)$ **(06 Marks)**

c. Show that if x[n] is an odd signal then

$$\sum_{n=-\infty}^{\infty} x[n] = 0$$ **(05 Marks)**

OR

2 a. Prove the following :

i) The power of the energy signal is zero over infinite time

ii) The energy of the power signal is infinite over infinite time **(06 Marks)**

b. Compute the energy of the length – N sequence $x[n] = \text{Cos}\left(\frac{2\pi Kn}{N}\right)$; $0 \le n \le N - 1$. **(05 Marks)**

c. State whether the system $y(t) = e^{x(t)}$ is

i) memory less

ii) stable

iii) linear

iv) causal

v) time invariant **(05 Marks)**

Module-2

3 a. Evaluate the continuous – time convolution integral given below

$y(t) = \{u(t + 2) - u(t - 1)\} * u(-t + 2)$ **(10 Marks)**

b. Draw the direct form I and direct form II for the system shown below

$y[n]-\frac{1}{2}[n-1]+\frac{1}{4}y[n-2]=x[n]+2x[n-1]$ (06 Marks)

OR

4 a. Determine the convolution of two given sequence
$x[n]=\{1\ \underset{\uparrow}{2}\ 3\ 4\}$ and $h(n)=\{\underset{\uparrow}{1}\ 1\ 3\ 2\}$ (06 Marks)

b. Solve the difference equation of a system defined by

$y[n]-\frac{1}{4}y[n-1]-\frac{1}{8}y[n-2]=x[n]+x[n-1]$

Given that $x[n]=2^n u[n]$, $y[-1]=2$, $y[-2]=-1$ (10 Marks)

Module-3

5 a. State and prove convolution and modulation property of Fourier Transform (CTFT) (10 Marks)

b. Use the defining equation for the Fourier Transform (FT) to evaluate the frequency domain representations for the following signals
i) $x(t)=e^{-3t}u(t-1)$
ii) $x(t)=e^{-|t|}$ (06 Marks)

OR

6 a. State and prove the following of Fourier Transform (FT)
i) Time shift property
ii) Parseval's Theorem (10 Marks)

b. Using convolution theorem, find the inverse Fourier transform of $x(w)=\frac{1}{(a+jw)^2}$. (06 Marks)

Module-4

7 a. Using the appropriate properties, find the DTFT of the following :

$x[n]=\left[\frac{1}{2}\right]^n u[n-2]$ (06 Marks)

b. Let $x[n]=\{3\ 0\ 1\ -\underset{\uparrow}{2}\ -3\ 4\ 1\ 0\ -1\}$ with DTFT $X(e^{j\Omega})$. Evaluate the following functions of $X(e^{j\Omega})$ without computing $X(e^{j\Omega})$
i) $X(e^{j0})$
ii) $X(e^{j\pi})$
iii) $\int_{-\pi}^{\pi} X(e^{j\Omega})d\Omega$
iv) $\int_{-\pi}^{\pi} |x(e^{j\Omega})|^2 d\Omega$
v) $\int_{-\pi}^{\pi} \left|\frac{dx(e^{j\Omega})}{d\Omega}\right|^2 d\Omega$. (10 Marks)

OR

8 a. Find the time-domain signal corresponding to the following DTFT.

i) $x(e^{j\Omega}) = \cos^2\Omega$

ii) $x(e^{j\Omega}) = 1 + 2\cos\Omega + 3\cos 2\Omega$ **(08 Marks)**

b. A signal x(n) has the DTFT

$$x(e^{j\Omega}) = \frac{1}{1 - ae^{-j\Omega}}.$$

Determine the following :

i) $x_1[n] = x(2n + 1)$

ii) $x_2[n] = e^{(\pi/2)n}\, x(n + 2)$ **(08 Marks)**

Module-5

9 a. List the properties of ROC. **(05 Marks)**

b. Using appropriate properties, find the Z-transform of the following :

i) $x_1[n] = n\left(\frac{1}{2}\right)^n u[n-3]$

ii) $x_2[n] = 3(2)^n u(-n)$ **(07 Marks)**

c. Find the inverse Z-transform of

$$x(z) = \ln\left(\frac{\alpha}{\alpha - z^{-1}}\right);\ |z| > \frac{1}{|\alpha|}$$ **(04 Marks)**

OR

10 a. A causal LTI system is described by the difference equation

$$y(n) = 2y(n-1) - 2y(n-2) + \frac{1}{2}x(n-1) + x[n]$$

Find the system function H(z) and it impulse response h[n]. Also find the stability of the system. **(08 Marks)**

b. Solve the following difference 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 $x[n] = \left(\frac{1}{4}\right)^n u(n)$. **(08 Marks)**

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