CBCS SCHEME

USN

17EC42

Fourth Semester B.E. Degree Examination, Feb./Mar. 2022
Signals and System

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Define signals. Explain briefly the classification of signals with expressions and waveforms. **(06 Marks)**

b. Determine whether the following signals are energy or power signal and also find the energy or power of the signal.

i) $x(n) = \begin{cases} n & 0 \le n \le 5 \\ 10-n & 5 \le n \le 10 \\ 0 & \text{otherwise} \end{cases}$

ii) $x(t) = 5\cos(\pi t) \quad -\infty < t < \infty$. **(08 Marks)**

c. A signal x(t) is defined by

$$x(t) = \begin{cases} 5-t & 4 \le t \le 5 \\ 1 & -4 \le t \le 4 \\ t+5 & -5 \le t \le -4 \\ 0 & \text{otherwise} \end{cases}.$$

Determine signal $y(t) = \frac{dx(t)}{dt}$. Also find the energy of signal $y(t) = \frac{dx(t)}{dt}$. **(06 Marks)**

OR

2 a. Explain the important elementary signals with suitable expressions and waveforms. **(05 Marks)**

b. The systems given below have input x(t) or x(n) and output y(t) or y(n) respectively. Determine whether each of them is stable, causal, linear.

i) $y(n) = \log_{10}(|x(n)|)$

ii) $y(t) = \cos(x(t))$

iii) $y(t) = x\left(\frac{t}{2}\right)$. **(09 Marks)**

c. Determine whether the following signals are periodic. If so find their fundamental period.

i) $x(t) = \cos(2t) + \sin(3t)$

ii) $x(n) = \cos\left(\frac{7}{15}\pi n\right)$. **(06 Marks)**

Module-2

3 a. For an LTI system characterized by impulse response $h[n] = \beta^n u[n]$, $0 < \beta < 1$, find the output of the system for input x[n] given by $x[n] = a^n[u[n] - u[n-10]]$. **(08 Marks)**

b. State and prove the associative property and distributive properties of convolution integral. **(08 Marks)**

c. Let the impulse response of a LTI system be $h(t) = \sigma(t - a)$. Determine the output of this system in response to any input x(t). **(04 Marks)**

OR

4 a. Convolute $x(t) = u(t) - u(t-2)$ with signal $h(t) = u(t-1) - u(t-3)$. **(10 Marks)**

b. Convolve $x(n) = \left\{1,\ 2, \underset{\uparrow}{-1}, 1\right\}$ and $h(n) = \left\{1,\ \underset{\uparrow}{0}, 1\right\}$ using graphical method. **(05 Marks)**

c. Derive the equation of convolution sum. **(05 Marks)**

Module-3

5 a. Determine whether the systems described by the following impulse responses are stable, causal and memoryless i) $h(n) = (\frac{1}{2})^n u(n)$ ii) $h(t) = e^t u(-1-t)$. **(08 Marks)**

b. State linearity, time shift and convolution properties of Discrete Time Fourier Series. **(03 Marks)**

c. Evaluate the Fourier series representation of the signal $x(t) = \sin(2\pi t) + \cos(3\pi t)$. Also sketch the magnitude and phase spectra. **(09 Marks)**

OR

6 a. Consider the interconnection of LTI system depicted in Fig.Q6(a). The impulse response of each system is given by **(08 Marks)**

$h_1(n) = u[n], h_2[n] = u[n+2] - u[n],\ h_3[n] = \delta[n-2], h_4[n] = \alpha^n u[n]$.

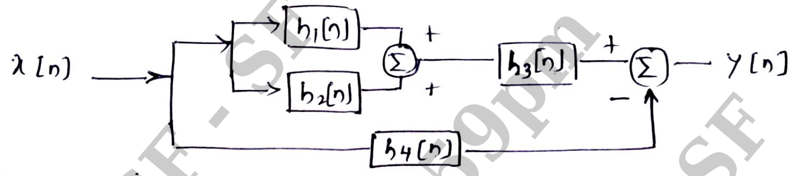

Fig.Q6(a)

Find the impulse response of the overall system, h[n]. **(04 Marks)**

b. Find the unit step response for the LTI system represented by the following responses
i) $h(n) = (\frac{1}{2})^n u(n-2)$ ii) $h(t) = e^{-|t|}$.

c. Find the DTFS representation for $x(n) = \left(\frac{\pi n}{8} + \phi\right)$. Draw magnitude and phase. **(08 Marks)**

Module-4

7 a. State and prove the following properties of Discrete Time Fourier transform.
i) Time shift property
ii) Parseval's theorem. **(08 Marks)**

b. Determine the time domain signal x(t) corresponding to $X(j\omega) = \dfrac{j\omega + 1}{(j\omega + 2)^2}$. **(06 Marks)**

c. Evaluate the DTFT of the signal $x(n) = (\frac{1}{2})^n u(n-4)$. Sketch its magnitude and phase response. **(06 Marks)**

OR

8 a. Using the appropriate properties, find the DTFT of the signal $x(n) = \sin\left(\frac{\pi}{4}n\right).\left(\frac{1}{4}\right)^n u(n-1)$. **(08 Marks)**

b. State sampling theorem. Determine the Nyquist sampling rate and Nyquist sampling interval for i) $x(t) = 1 + \cos(2000\pi t) + \sin(4000\pi t)$ ii) $x(t) = 25e^{j500\pi t}$. **(06 Marks)**

c. Evaluate the Fourier transform of the following signals
i) $x(t) = e^{-at}.u(t)$; $a > 0$ ii) $x(t) = \delta(t)$. Draw the spectrum. **(06 Marks)**

Module-5

9 a. List the properties of Region Of Convergence (ROC). **(04 Marks)**

b. Determine the Z-transform, the ROC, and the locations of poles and zeros of x(z) for the following signals :

i) $x(n) = -\left(\frac{3}{4}\right)^n u(-n-1) + \left(\frac{-1}{3}\right)^n u(n)$

ii) $x(n) = n.\sin\left(\frac{\pi}{2}n\right)u(-n)$. **(08 Marks)**

c. Find the inverse Z transformation of $X(z) = \dfrac{1-z^{-1}+z^{-2}}{\left(1-\frac{1}{2}z^{-1}\right)\left(1-2z^{-1}\right)\left(1-z^{-1}\right)}$ with the following ROCs i) $1 < |z| < 2$ ii) $\frac{1}{2} < |z| < 1$. **(08 Marks)**

OR

10 a. State and prove the 'differentiation in z-domain' property of z-transform. **(04 Marks)**

b. Find the transfer function and impulse response of a causal LTI system if the input to the system is $x(n) = \left(\frac{1}{3}\right)^n u(n)$ $x(n) = \left(\frac{-1}{3}\right)^n$ and the output is $y(n) = 3(-1)^n u(n) + \left(\frac{1}{3}\right)^n u(n)$. **(08 Marks)**

c. Using power series expansion method, determine inverse z-transform of

i) $X(z) = \cos(z^{-2})$ ROC $|z| > 0$

ii) $X(z) = \dfrac{1}{1-\frac{1}{4}z^{-2}}$ $|z| > \frac{1}{4}$. **(08 Marks)**

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