

CBCS SCHEME

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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.

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

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

(08 Marks)

- c. A signal $x(t)$ is defined by

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

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 $x(n) = \{1, 2, -1, 1\}$ and $h(n) = \{1, 0, 1\}$ 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
 $h_1(n) = u[n]$, $h_2[n] = u[n+2] - u[n]$, $h_3[n] = \delta[n-2]$, $h_4[n] = \alpha^n u[n]$. (08 Marks)

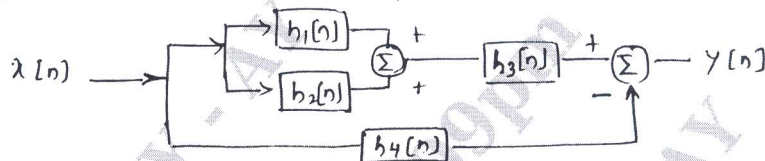


Fig.Q6(a)

- 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 $x(n) = (\frac{\pi n}{8} + \phi)$. 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 $X(j\omega) = \frac{j\omega+1}{(j\omega+2)^2}$. (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 :

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

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

(08 Marks)

- c. Find the inverse Z transformation of $X(z) = \frac{1 - z^{-1} + z^{-2}}{\left(1 - \frac{1}{2}z^{-1}\right)\left(1 - 2z^{-1}\right)\left(1 - z^{-1}\right)}$ with the following

$$\text{ROCs } i) 1 < |z| < 2 \quad ii) \frac{1}{2} < |z| < 1.$$

(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

$$\text{system is } x(n) = \left(\frac{1}{3}\right)^n u(n) \quad x(n) = \left(\frac{-1}{3}\right)^n \text{ and the output is } y(n) = 3(-1)^n u(n) + \left(\frac{1}{3}\right)^n u(n).$$

(08 Marks)

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

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

$$ii) X(z) = \frac{1}{1 - \frac{1}{4}z^{-2}} \quad |z| > \frac{1}{4}.$$

(08 Marks)
