[Total No. of Questions - 9] [Total No. of Printed Pages - 4]
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B. Tech 4th Semester Examination

Signals & Systems (N.S.)

EE-223

Time : 3 Hours **Max. Marks : 100**

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt five questions in all, selecting one question from each of the Sections A, B, C & D. Section E is compulsory.

SECTION - A

1. (a) If x(n) is an arbitrary signal with its even and odd parts denoted by $x_e(n) = E\{x(n)\}$ and $x_0(n) = O\{x(n)\}$, respectively, then prove

$$\sum_{n=-\infty}^{\infty} x^2(n) = \sum_{n=-\infty}^{\infty} x_e^2(n) + \sum_{n=-\infty}^{\infty} x_0^2(n) \qquad (10)$$

(b) A linear time-invariant discrete systems consists of two sub-systems S_1 and S_2 in cascade as shown in Figure 1.

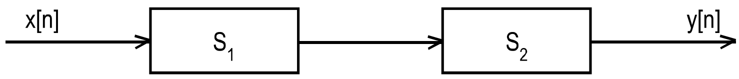

Figure 1

Find the impulse response of the composite system, when the systems S_1 and S_2 are characterized as $y[n] = x[n] - 0.5x[n-1]$ and $h[n] = (0.5)^n u[n]$ respectively. (10)

2. (a) Show that a relaxed linear time invariant system is causal if and only if h[n]=0, for n<0. (10)

(b) Find the fundamental period of the discrete time signal $x[n] = (-1)^{n^2}$ (10)

SECTION - B

3. (a) Determine and sketch the convolution of the following two signals:

$$x(t) = \begin{cases} 1, & -1 < t < 1 \\ 0, & \text{elsewhere} \end{cases} \quad \text{and} \quad h(t) = \delta(t+1) + 2\delta(t+2)$$ (10)

(b) Determine the Fourier series coefficients of the signal x(n) and plot its magnitude and phase spectrum $x(n) = 1 + \sin\left(\frac{2\pi}{N}n\right) + 3\cos\left(\frac{2\pi}{N}n\right) + \cos\left(\frac{4\pi}{N}n + \frac{\pi}{2}\right)$ (10)

4. (a) State and prove the Parseval's relation for continuous-time periodic signal. (10)

(b) Determine the Fourier series coefficients of the continuous-time periodic signal of period 'T' given as

$$x(t) = \begin{cases} 1, & |t| < T_1 \\ 0, & T_1 < |t| < \frac{T}{2} \end{cases}$$ (10)

SECTION - C

5. (a) Let the second derivative of the signal x(t) is given as:

$\frac{d^2x(t)}{dt^2} = \delta(t+10) - 2\delta(t+8) + \delta(t+6) + \delta(t-6) - 2\delta(t-8) + \delta(t-10)$. Find $X(j\Omega)$ (10)

(b) Find the Fourier transform of the noncausal sequence $x(n) = a^{|n|}, \ |a| < 1$ (10)

6. Consider a discrete-time LTI system with unit sample response.

$h(n) = \left(\frac{1}{2}\right)^n u(n) + \frac{1}{2}\left(\frac{1}{4}\right)^n u(n)$. Determine a linear constant coefficient difference equation relating the input x(n) and output y(n) of the system (20)

SECTION - D

7 (a) Show that when a continuous-time signal

$x(t) = 6\cos(60\pi t)+3\sin(300\pi t)+2\cos(340\pi t)+4\cos(500\pi t)+10\sin(660\pi t)$ is uniformly sampled at a sampling rate of 200 Hz, the resulting discrete-time signal is $x[n] = 8\cos(0.3\pi n)+5\cos(0.5\pi n + 0.6435)-10\sin(0.7\pi n)$. (10)

(b) State sampling theorem. It is known that sampling theorem is applicable for strictly band limited signals. In practice, however an information bearing signal is not strictly band limited and has effect of aliasing when sampled. What are the corrective measures to reduce such effects? (10)

8. (a) The continuous-time LTI system is described by the differential equation $\frac{d^2y(t)}{dt^2} + 3\frac{dy(t)}{dt} + 2y(t) = \frac{dx(t)}{dt} + x(t)$. Find the output response of the system for the input signal $x(t) = e^{-3t}u(t)$. (10)

(b) Determine the impulse response h[n] of the causal discrete-time system characterized by the difference equation: $y[n] + y[n-1] - 6y[n-2] = x[n]$ (10)

SECTION - E

9. (a) Evaluate the unit step response for the LTI system represented by the impulse response $h(n) = \delta(n)-\delta(n-2)$.

(b) Find the energy of the sequence $x(n) = \text{sinc}\left(\frac{w_c n}{\pi}\right)$ assuming $w_c < \pi$.

(c) The signal $x_1(t) = 10\cos(100\pi t)$ and $x_2(t) = 10\cos(50\pi t)$ are both sampled with sampling frequency $f_s = 75$ Hz. Show that the two sequences of samples so obtained are identical.

(d) Show that the continuous-time system described by y{t) = x(sin t) is a linear system.

(e) Let x(n) = {–1, 2, 3, 2}, $T_s = 1$ What is the value of the reconstructed signal x(t) at 2.5 second that results from linear interpolation function?

(f) Prove whether the following discrete time signal is energy signal or power signal:

$$x[n] = \begin{cases} \frac{1}{n}, & n \geq 1 \\ 0 & n \leq 0 \end{cases}$$

(g) Test whether the following discrete time system are stable or not

$h[n] = 3^n u(-n)$

(h) Compute the convolution of x[n] = {1, –2, 3, –4} and h[n] = {4, –3, 2, –1}.

(i) A discrete-time filter transfer function is given by $H(e^{j\omega}) = \frac{1 - 1.6e^{-j\omega} + e^{-j2\omega}}{1 - 1.5e^{-j\omega} + 0.8e^{-j2\omega}}$. What is the amplitude response at dc?

(j) Find the fundamental period of the signal $x(t) = 10\sin(12\pi t) + 4\cos(18\pi t)$. (2×10=20)