Question Paper

Exam Date & Time: 08-Jun-2019 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
IV SEMESTER B.Sc(Applied Sciences) IN ENGINEERING
END SEMESTER THEORY APRIL / MAY 2019

SIGNALS AND SIGNAL PROCESSING [IEE 241]

Marks: 100 **Duration: 180 mins.**

Answer 5 out of 8 questions.

Missing data, if any, may be suitably assumed

Table of transforms may be supplied

1) (6)

A) Given the sequence $x[n]=\left\{-3,\ 1,\ \underset{\uparrow\atop 0}{2},\ -1,\ 3,\ 2\right\}$, sketch and label carefully each of the following signals

(a) $x[2-n]$; (b) $x[2n+2]$; (c) $x[n+1]\delta(n+2)$

B) Determine whether the following signal is energy or power signal. Also determine the energy and power of the signal. (6)

$$x(t)=\begin{cases}-t, & 0\le t\le 1\\ t-2, & 1\le t\le 3\\ 1, & 3\le t\le 4\end{cases}$$

C) Find the response of the system $y(n)=x(n)*h(n)$ (8)

Where $x[n]=\{u[n+1]-u[n-10]\}$ and

$h[n]=\{-u[n]+2u[n-3]-u[n-6]\}$

2) Check whether the following signals are periodic. If periodic determine the fundamental period (4)

A) (i) $x(t)=\cos\left(\frac{\pi}{4}t\right)+\sin\left(\frac{\pi}{8}t+\frac{\pi}{6}\right)-\cos\left(\frac{\pi}{2}t\right)$

(ii) $x(n)=\sin\frac{\pi}{3}n$

B) (6)

A continuous- time signal is defined as

$$\begin{cases}0 & ;t<-1\\ (-2t-2) & ;-1\le t<0\\ -1 & ;0\le t<1\end{cases}$$

$$x(t) = \begin{cases} (t-1) & ; 1 \le t \le 2 \\ 1 & ; 2 \le t < 3 \\ (4-t) & ; 3 \le t \le 4 \\ 0 & ; t > 4 \end{cases}$$

Plot the followings: (i) $x(t)$; (ii)$x(-2t+1)$; (iii) $x\left(\frac{t}{3}-1\right)$

C) Using properties find the inverse FT of (10)

(i) $$X(j\omega) = j\frac{d}{d\omega}\left\{\frac{e^{j2\omega}}{1+j\left(\frac{\omega}{3}\right)}\right\}$$

(ii) $$X(j\omega) = e^{-2|\omega|}$$

3) Check whether each system is (i) Linear (ii) Causal (iii) Time-invariant (6)

A) (i) $y[n] = 2\,x[n]u[n]$ and (ii) $y(t) = x(2-t)$

B) (6)

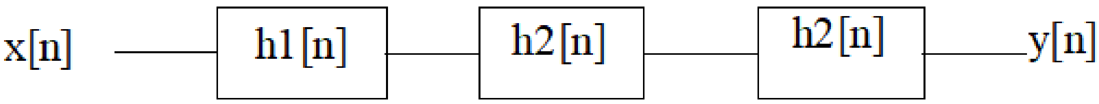
A cascade of three LTI systems is shown in Fig.Q.3B.

Given : $h_2[n] = u[n] - u[n-2]$

Overall impulse response, $h[n] = h_1[n] * h_2[n] * h_2[n] = \{1\ 5\ 10\ 11\ 8\ 4\ 1\}$ starting at n=0.

(i) Find $h_1[n]$.

(ii) Also find the response of the overall system to the input $x[n] = \delta[n] - \delta[n-1]$.



C) Use the table of transform and properties to find the FT of the following signals: (8)

(i) $x(t) = \frac{4t}{(1+t^2)^2}$

(ii) $x(t) = e^{-2t+1}u\left(\frac{t-4}{2}\right)$

4) A) Using the definition of FS to determine the time domain signals represented by the following FS coefficients : (4)

(i) $X(k) = j\delta(k-1) - j\delta(k-1) + j\delta(k+3) + j\delta(k-3)$; $\omega_0 = 3\pi$

(ii) $X(k) = \left(\frac{1}{2}\right)^{|k|}$; $\omega_0 = 1$

B) Use the table of transform and properties to find the inverse DTFT of the following signals: (10)

(i) $X(e^{j\Omega}) = (\cos 4\Omega)\left[\dfrac{\sin\frac{\text{[illegible]}}{2}\Omega}{\sin\frac{\Omega}{2}}\right]$

(ii) $X(e^{j\Omega}) = \begin{cases} e^{-j4\Omega}, & \frac{\pi}{4} < |\Omega| < \frac{3\pi}{4} \\ 0, & otherwise \end{cases}\ for\ |\Omega| < \pi$

C) Find the inverse Z-transform using partial fraction expansion (6)

$$X(z) = \frac{z^3 + z^2 + \frac{3}{2}z + \frac{1}{2}}{z^3 + \frac{3}{2}z^2 + \frac{1}{2}z}\ ;\ |z| < \frac{1}{2}$$

5) Find the complex Fourier coefficient for the signal below: (4)

A)

$$x(t) = \sum_{m=-\infty}^{\infty}\left[\delta\left(t - \frac{1}{2}m\right) + \delta\left(t - \frac{3}{2}m\right)\right]$$

B) Find discrete-time periodic signal x [n] if its DTFS co-efficient is given by (6)

$$X[k] = \cos\left(\frac{8\pi}{21}k\right) + j\sin\left(\frac{4\pi}{21}k\right)$$

C) (10)

Find the continuous convolution integral for the signals $y(t) = x(t) * h(t)$ where $x(t) = u(t+2) - u(t-2)$ and $h(t) = u(t) - u(t-2)$

6) Consider the analog signal $x(t) = 4\cos(100\pi t)$ (5)

A)
(i) What is the Nyquist rate of this signal?
(ii) Suppose the signal is sampled at Fs = 75Hz, What is the discrete time signal obtained after sampling?
(iii) What is the frequency of a sinusoid that yields samples identical to those obtained in part (ii)?

B) Determine Z-transform and ROC of the signals using properties (8)

(i)

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

(ii)

$$x[n] = \left((3)^{n-2}u[n]\right) * \left(\cos\left(\frac{\pi}{6}n + \frac{\pi}{3}\right)u[n]\right)$$

C) Find the inverse DFT of X (k) = { 6 , -4 j , 0 , + 4j } (4)

D) Explain the differences between FIR and IIR filters. (3)

7) A) A causal LTI system is described by the difference equation (6)

y [n] = x [n] - x [n - 4]

i) Find the impulse response h[n]

ii) Find the output of the system to the input

$$x[n] = 4 + 3\sin\left[\frac{\pi}{2}n\right]$$

B) For each of the following impulse responses, determine whether the corresponding system is causal and stable. Justify the answers. (4)

i. $h(t) = e^{-2|t|}$

ii. $h[n] = \delta[n] + 2\sin[\pi n]$

C) Let $x[n]$ be the sequence $x[n] = 2\delta[n] + \delta[n-1] + 2\delta[n-3]$ (10)

Find the 5 point DFT of x[n].

8) A) Find the Z-transform of the following signals and determine ROC. (10)

(a) $x[n] = \left(\frac{1}{4}\right)^n u[n] + \left(\frac{1}{2}\right)^n u[-n-1]$

(b) $x[n] = \left(\frac{2}{3}\right)^{|n|}$

B) Use table of transforms and properties to find the DTFT of the following signals: (10)

(a) $x[n] = (n-2)(u[n+4] - u[n-5])$

(b) $x[n] = \cos\left(\frac{\pi}{4}n\right)\left(\frac{1}{2}\right)^n u[n-2]$

-----End-----