Question Paper

Exam Date & Time: 03-Dec-2019 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
END SEMESTER THEORY EXAMINATION - NOVEMBER/ DECEMBER 2019
IV SEMESTER B.Sc.(Applied Sciences) in Engg.
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) (4)

A) Determine whether the following signal is energy or power signal. Also determine the energy and power of the signal.

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

B) (10)

Find the response of the system $y(n) = x(n) * h(n)$
Where $x[n] = \{u[n+1] - u[n-10]\}$ and
$h[n] = \{-u[n] + 2u[n-3] - u[n-6]\}$

C) (6)

Given the sequence $x[n] = \left\{ -3,\ 1,\ \underset{\substack{\uparrow \\ 0}}{2},\ -1,\ 3,\ 2 \right\}$, sketch and label carefully each of the following signals (a) $x[2-n]$; (b) $x[2n+2]$; (c) $x[n+1]\delta(n+2)$

2) (8)

A)

A continuous- time signal is defined as

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

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

B) (8)

Using properties find the inverse FT of

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

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

C) (4)

Check whether the following signals are periodic. If periodic determine the fundamental period

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

3) (7)

A)

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

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 $x[n] = \delta[n] - \delta[n-1]$.

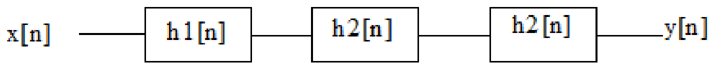

Fig.Q.3A

B) (5)

Check whether each system is (i) Linear (ii) Causal (iii) Time-invariant (iv) memory less (v) causal

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

C) (8)

Use the table of transform and properties to find the FT of the following signals:

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

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

4) (10)

A)

Use the table of transform and properties to find the inverse DTFT of the following signals:

(i) $X(e^{j\Omega}) = (\cos 4\Omega)\left[\frac{\sin\frac{3}{2}\Omega}{\sin\frac{\Omega}{2}}\right]$

(ii) $X(e^{j\Omega}) = \begin{cases} e^{-j4\Omega}, & \frac{\pi}{2} < |\Omega| < \pi \\ 0, & otherwise \end{cases} \; for\ |\Omega| < \pi$

B) (4)

Using the definition of FS to determine the time domain signals represented by the following FS coefficients :

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

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

C) (6)

Find the inverse Z-transform using partial fraction expansion

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

5) (6)

A) Find discrete-time periodic signal $x[n]$ if its DTFS co-efficient is given by

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

B) (4)

Find the complex Fourier coefficient for the signal below:

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

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) (4)

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

B) (8)

Determine Z-transform and ROC of the signals using properties

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

(ii) $x[n] = 4(2)^n u(-n)$

(ii) [illegible]

C) A analog signal $x_a(t)$ is composed of a weighted sum of 3 sinusoidal signals is given by $x_a(t) = 2\cos 90\pi t + 3\sin 150\pi t + 5\cos 450\pi t$ (i) Determine the discrete time signal $x[n]$ obtained after sampling at the rate of 300 Hz. (ii) illustrate aliasing if any (iii) What condition must be satisfied by sampling rate to ensure $y(t) = x_a(t)$? (iv) Also find the reconstructed signal y(t). (5)

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

7) A) Let $x[n]$ be the sequence $x[n] = 2\delta[n] + \delta[n-1] + 2\delta[n-3]$
Find the 5 point DFT of x[n]. (10)

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

i. $\mathrm{h(t)} = e^{-2|t|}$
ii. $\mathrm{h[n]} = \delta[\mathrm{n}] + 2\sin[\pi \mathrm{n}]$

C) 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

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

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

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

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