Question Paper

Exam Date & Time: 26-Apr-2019 (02:00 PM - 05:00 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 - S2]

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) An analog signal $x_a(t)$ is composed of a weighted sum of 3 sinusoidal signals is given by (6)

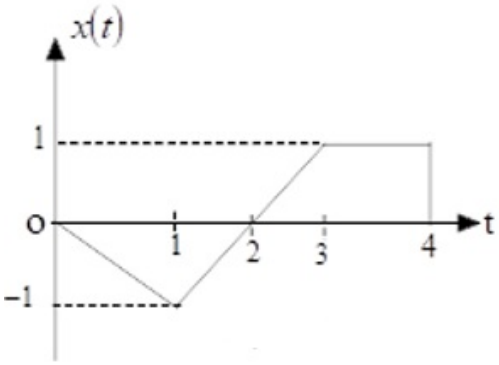
A) $$x_a(t) = 2\cos 90\pi t + 3\sin 150\pi t + 5\cos 450\pi t$$

(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).

B) Determine whether the following signals are energy signals or power signals. Also determine the energy and power of the signals. (6)
(i) x(t) shown in figure below



(ii) $y(t) = \frac{d}{dt}x(t)$

(iii) $x(n) = e^{j\left(\frac{\pi}{2}n + \frac{\pi}{8}\right)}$

C) Using properties find the inverse FT of (8)

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

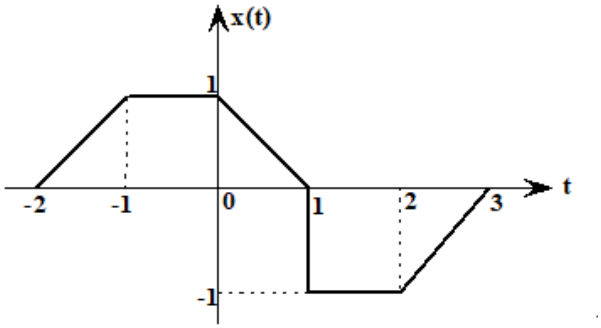
(ii) $$X(j\omega) = e^{-2|\omega|}$$

2) Find the inverse DFT of (4)

A) $X(k) = \{6, -4j, 0, +4j\}$

$x(n) = \{0, -4j, 0, +4j\}$

B) A continuous time signal is shown below. (6)



Sketch and label each of the following signals.

(i) x(2t)

(ii) x(1 − t)

(iii) $x(-1-\frac{1}{2}t)$

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

3) Given the sequence (8)

A) $x(n) = |n| \quad for \quad -3 \le n \le 3$

sketch and label the following

(i) $x(n)$; (ii) $x(2n)$; (iii) $x(2-2n)$; (iv) $x(3n-1)\delta(n-1)$

B) Check whether the following signals are periodic, if periodic determine the fundamental period. (4)

(i) $x(t) = \sin\left(\frac{2\pi}{3}t\right) + \sin 3t$ (ii) $x[n] = e^{j\left(\frac{3\pi}{7}n + \frac{\pi}{4}\right)}$

C) Find the DTFS coefficients of the signal (8)

$$x[n] = 1 + 3\sin\left(\frac{2\pi n}{3}\right) - \cos\left(\frac{5\pi n}{16}\right)$$

Also, plot the phase and magnitude spectra

4) For given impulse responses of an LTI system, (4)

A) (i) $h[n] = \delta[n] - \delta[n-1]$ and (ii) $h(t) = t[u(t+1) - u(t-1)]$

check whether each system is (i) causal and (ii) memory less

B) Find the inverse z-transform using partial fraction expansion (6)

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

C) Using properties , find the DTFT of (10)

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

(ii) $$x[n]=\left[\frac{\sin\left(\frac{\pi}{4}n\right)}{\pi n}\right]*\left[\frac{\sin\left(\frac{\pi}{2}(n-5)\right)}{\pi(n-5)}\right]$$

5) Consider the following CT signals with a fundamental period T=0.5. (10)

A)

$$x(t)=\cos(4\pi t)$$
$$y(t)=\sin(4\pi t)$$

(i) Determine the FS coefficients of x(t) and y(t)
(ii) Use the results of (i) along with the multiplication property of CTFS to determine the FS coefficients of z(t) where z(t) = x(y)y(t)

(iii) Determine the FS coefficients of z(t) through direct expansion of z(t) in trigonometric form and compare the results with (ii)

B) Find discrete-time periodic signal x[n] if its DTFS co-efficient is given by (5)

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

C) Determine whether the system represented by the following input-output relations are linear, time invariant, memory less, causal and stable (5)

(i) $y[n]=x[2n]$
(ii) $y(t)=tx(t)$

6) Using properties, find the inverse fourier transform of (6)

A)

$$X(j\omega)=\frac{4\sin(2\omega-4)}{2\omega-4}-\frac{4\sin(2\omega+4)}{2\omega+4}$$

B) Determine Z-transform of the signals x[n] using properties (8)

(i) $$x[n]=\sin\left(\frac{\pi}{6}n-\frac{\pi}{2}\right)u[n-3]$$

(ii) $x[n]=n((0.5)^n u[n]*(0.25)^n u[n-2])$

(iii) $x[n] = n((0.5)^n u[n] * (0.25)^n u[n-2])$;

C) Using the defining equation for DTFS coefficients, evaluate the DTFS representation for the following signal: (4)

$$x[n] = \sum_{m=-\infty}^{\infty} \delta[n-2m] + \delta[n+3m]$$

D) Explain the differences between FIR and IIR filters (2)

7) A causal LTI system described by difference equation (7)

A) $$y[n] = x[n] - x[n-4]$$

(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) Use the properties to find the FT of the following signals: (10)

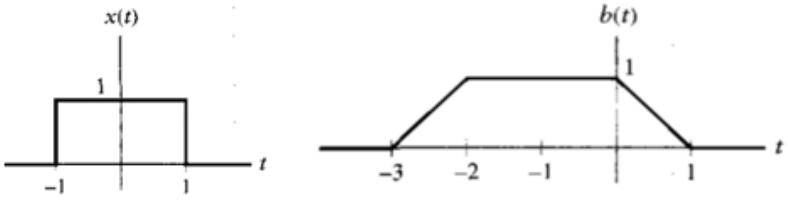
$$\text{(i)} \quad x(t) = \frac{d}{dt}\left(te^{-3t+3}u(t-4)\right)$$

$$\text{(ii)} \quad x(t) = \left(\frac{\sin(t)}{\pi t}\right) * \frac{d}{dt}\left(\frac{\sin(2t)}{\pi t}\right)$$

C) Explain the following terms: (3)
(i)Sampling
(ii)Nyquist rate
(iii)Aliasing

8) Evaluate the convolution integral x(t)*b(t) (10)

A)



B) Let x[n] be the sequence (5)

$$x[n] = 2\delta[n] + \delta[n-1] + \delta[n-3]$$

Find the 5 point DFT of x[n]

C) (5)

If $X(e^{j\Omega})$ is DTFT of signal $x[n] = \{-2, 0, -\underset{\uparrow}{\underset{0}{1}}, 2, 0, 2-1, 0, -2\}$,

(i) Find $X(1) = X(e^{j0})$ (ii) Evaluate $\int_{-\pi}^{\pi} X(e^{j\Omega})d\Omega$ (iii) Find $X(e^{j\pi})$

(i) Find $H(z)$ $H\left(e^{\quad}\right)$ (ii) Evaluate $\int_{-\pi}^{}H(e^{\quad})d$ 22; (iii) Find $H(e^{\quad})$

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