

D 4057

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Third Semester

Information Technology

IT 1201 — SIGNALS AND SYSTEMS

(Regulation 2004)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

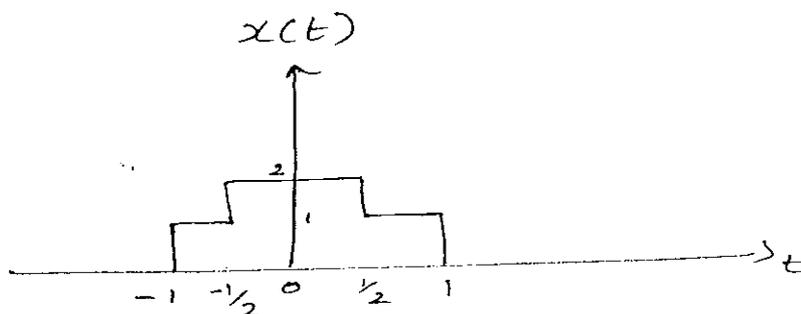
1. Find the fundamental period of the signal
$$x[n] = 2 \cos\left(\frac{\pi}{4}n\right) + \sin\left(\frac{\pi}{8}n\right) - 2 \cos\left(\frac{\pi}{2}n + \frac{\pi}{6}\right).$$
2. Given $x[n] = \{1, 2, 3, -4, 6\}$. Plot the signal $x[-n-1]$.
↑
3. Let $x(t) = t, 0 \leq t \leq 1$ be a periodic signal with fundamental period $T = 1$ and Fourier series coefficients a_k . Find the value of a_0 .
4. What is the relationship between Fourier Transform and Laplace Transform?
5. A LTI system is characterized by the following differential equation
$$\frac{d}{dt}y(t) + ay(t) = x(t).$$
 Find the frequency response of the system.
6. Given $y(t) = \int_{-\infty}^{\infty} x(\tau)h(t-\tau) d\tau$. If $x(t) = u(t-1)$ and $h(t) = u(t+3)$. The upper limit in the integral changes to _____ and lower limit changes to _____.
7. Find the Z-transform of $\delta[n-2]$.

8. Determine the Fourier Transform of the following signal $\sum_{n=-\infty}^{\infty} \delta(t - n\tau)$
9. Draw the block diagram for the system specified by the difference equation $y[n] + a y[n - 2] = b_0 x[n] + b_1 x[n - 1]$.
10. For a state space representation of the system, find the transfer function of the system.

$$A = \begin{bmatrix} 0 & 1 \\ -3 & -2 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad C = [1 \quad 2].$$

PART B — (5 × 16 = 80 marks)

11. (a) (i) Given $x(t)$. Sketch the following signals. (2 × 4 = 8)



- (1) $x(3t + 2)$
- (2) $x\left(\frac{-t}{2} - 1\right)$.

- (ii) Given $y[n] = x[n] + nx[n + 1]$. Determine whether the system is causal, linear, time invariant and memoryless. (4 × 2 = 8)

Or

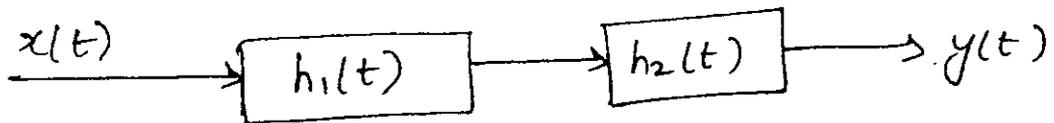
- (b) (i) Express $x[n] = (-1)^n$ $-2 \leq n \leq 2$ as a sum of scaled and shifted unit step function. (8)
- (ii) Sketch $x[n] = a^n$ where $-2 \leq n \leq 2$ for the two cases below (2 × 4 = 8)

- (1) $a = \frac{-1}{4}$
- (2) $a = -4$

12. (a) (i) Consider a continuous time LTI system described by $\frac{d}{dt} y(t) + 2y(t) = x(t)$ Using the Fourier Transform, find the output $y(t)$ when $x(t) = e^{-t} u(t)$. (8)
- (ii) Find the Laplace Transform and sketch the pole-zero plot with the ROC for $x(t) = e^{-2t} u(t) + e^{-3t} u(t)$. (8)

Or

- (b) (i) Verify the time shifting property of Laplace transform. (8)
- (ii) Given $X(j\Omega) = \frac{1}{(j\Omega)^2 + 4j\Omega + 3}$. Find $x(t)$. (8)
13. (a) The system shown below is formed by connecting two systems in cascade. The impulse responses of the systems are given by $h_1(t)$ and $h_2(t)$ respectively $h_1(t) = e^{-2t} u(t)$ $h_2(t) = 2e^{-t} u(t)$.



Find the overall impulse response of the system and determine if the overall system is BIBO stable. (16)

Or

- (b) (i) Find the state equations of a continuous-time LTI system described by $\ddot{y}(t) + 3\dot{y}(t) + 2y(t) = x(t)$. (8)
- (ii) Prove the following : (2 × 4 = 8)
- (1) $x(t) * \delta(t - t_0) = x(t - t_0)$
- (2) $x(t) * u(t) = \int_{-\infty}^t x(\tau) d\tau$

14. (a) (i) Given $x[n] = \{1, 2, 0, 2\} \rightarrow$ Input

↑

$h[n] = \{5, X, 3\} \rightarrow$ Impulse Response

↑

$y[n] = x[n] * h[n] = \{5, 12, 7, 16, 4, 6\} \rightarrow$ output

↑

Find the value of X . (8)

(ii) Find the Discrete Time Fourier Transform of $x[n] = -a^n u[-n-1]$ for $|a| > 1$.

(8)

Or

(b) (i) A finite sequence $x[n]$ is given by

$$x[n] = \{5, 3, -2, 0, 4, -3\}$$

↑

Find $X(z)$ and its ROC. (8)

(ii) Write a difference equation that characterizes a system whose frequency response is

$$H(e^{j\omega}) = \frac{1 - \frac{1}{2}e^{-j\omega} + e^{-3j\omega}}{1 + \frac{1}{2}e^{-j\omega} + \frac{3}{4}e^{-2j\omega}} \quad (8)$$

15. (a) A causal discrete-time LTI system is described by

$$y[n] - \frac{3}{4}y[n-1] + \frac{1}{8}y[n-2] = x[n]$$

Where $x[n]$ and $y[n]$ are the input and output of the system respectively

(i) Determine the system function $H(Z)$. (8)

(ii) Find the impulse response $h[n]$ of the system. (8)

Or

(b) Given
$$H(Z) = \frac{0.3 + Z^{-1} - 0.47Z^{-2}}{1 - 0.5Z^{-1} + Z^{-2} + 6Z^{-3}}$$

Draw the block diagram representation using DF I and DF II realization. (16)