

Code : 031510

(2)

B.Tech 5th Semester Exam., 2018

SIGNALS AND SYSTEMS

Time : 3 hours

Full Marks : 70

Instructions :

- (i) The marks are indicated in the right-hand margin.
 (ii) There are **EIGHT** questions in this paper.
 (iii) Attempt **FIVE** questions in all.
 (iv) Question No. 1 is compulsory.

1. Answer any seven questions of the following :
 2×7=14

(a) Show

$$\delta(at) = \frac{1}{|a|} \delta(t)$$

where $\delta(t)$ is an impulse function.

(b) Prove that

$$u(n) = \sum_{k=-\infty}^n \delta(k)$$

(c) Draw the time waveform of the signal

$$x(t) = u(t-3) - u(t-6)$$

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(Turn Over)

(a) Determine the fundamental period of the signal $x(t) = je^{j10t}$.

(e) If E_x is the energy of the signal $x(t)$, determine the energy of the signal $x(at-b)$ in terms of E_x .

(f) If $x_1(t)$ and $x_2(t)$ are odd and even signals respectively, determine whether the signal $x_1(t)x_2(t)$ would even or odd signal.

(g) Determine whether the system described by $y(t) = x(2t)$ is causal.

(h) A system is described by the input-output relationship $y(n) = \text{Re}[x(n)]$. Determine whether the corresponding system is linear, where $\text{Re}[x(n)]$ represents the real part of $x(n)$.

(i) Determine whether the system described by $y(t) = \frac{d}{dt}u(t)$ is stable or not.

(j) Sketch the time waveform of the signal $x(t) = \frac{d}{dt}[u(t-4) - u(t-7)]$

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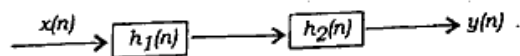
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2. (a) Determine convolution of a rectangular signal $x(t)$ with itself. $x(t)$ is described as
- $$x(t) = \begin{cases} A & -T < t < T \\ 0 & \text{otherwise} \end{cases}$$
- Draw the sketch of the convolved signal. 8

- (b) Prove that
- $$x(t) * u(t) = \int_{-\infty}^t x(t) dt$$
- 3

- (c) Prove that $u(t) * u(t) = r(t)$. 3

3. (a) Determine the overall impulse response of the system shown in the figure below : 5



where $h_1(n) = \delta(n) - a\delta(n-1)$ and $h_2(n) = \left(\frac{1}{2}\right)^n u(n)$

- (b) Evaluate the unit step response of the LTI system represented by
- $$h(n) = \delta(n) - \delta(n-2)$$
- 5

- (c) The impulse response of a system is given by

$$h(n) = \left(\frac{1}{2}\right)^n u(n+2)$$

Determine whether this system is causal. 4

4. (a) From the given Fourier series

$$x(t) = \sum_{k=-\infty}^{\infty} a_k e^{ik\omega_0 t}$$

derive the relation to determine the Fourier series coefficients a_k . Given $x(t)$ is periodic with period T . 4

- (b) Determine the Fourier series coefficients of the following : 4

$$x(t) = 1 + \sin \omega_0 t + 2 \cos \omega_0 t + \cos \left(2 \omega_0 t + \frac{\pi}{4} \right)$$

- (c) Prove the following properties of the Fourier series : 2×3=6

- (i) Time shifting
- (ii) Time reversal
- (iii) Multiplication

5. (a) Determine the Fourier transform of the following signals : 3×2=6

(i) $x(t) = e^{-2|t-1|}$

(ii) $x(t) = (e^{-\alpha t} \cos \omega_0 t) u(t), \alpha > 0$

- (b) Determine the inverse Fourier transform of

$$X(j\omega) = 2\pi \delta(\omega) + \pi \delta(\omega - 4\pi) + \pi \delta(\omega + 4\pi)$$
 4

- (c) Prove that the Fourier transform of a real and even signal is real and even. 4

6. (a) Given that $x(n]$ has Fourier transform $X(e^{j\omega})$. Using Fourier transform properties or otherwise, determine the Fourier transform of the following signals : <http://www.akubihar.com> $3 \times 3 = 9$

(i) $x_1(n) = x(1-n) + x(-1-n)$

(ii) $x_2(n) = \frac{x^*(-n) + x(n)}{2}$

(iii) $x_3(n) = (n-1)^2 x(n)$

(b) Prove the following properties of discrete-time Fourier transform : $1+2+2=5$

(i) Conjugation

(ii) Differentiation in frequency

(iii) Convolution

7. (a) If the input to an LTI system is

$$x(t) = e^{-3t} u(t)$$

then the output is

$$y(t) = [e^{-t} - e^{-2t}] u(t)$$

Determine the system function of this system. Comment on the stability of the system.

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(Turn Over)

(b) Given

$$X(s) = \frac{s+2}{s^2+7s+12}$$

determine the signal $x(t)$ when

(i) ROC $\text{Re}(s) > -4$

(ii) ROC $\text{Re}(s) < -3$

(iii) ROC $-4 < \text{Re}(s) < -3$

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8. (a) Determine the z-transform of the following signals. Sketch their pole-zero plot and indicate the region of convergence : $3 \times 2 = 6$

(i) $x_1(n) = \left(\frac{1}{2}\right)^{n+1} u(n+3)$

(ii) $x_2(n) = 2^n u(-n) + \left(\frac{1}{4}\right)^n u(n-1)$

(b) Consider an even sequence $x(n]$ with rational z-transform $X(z)$. From the definition of z-transform, show that

$$X(z) = X\left(\frac{1}{z}\right)$$

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(Continued)

(7) .

- (c) Determine the system function for the causal LTI system with difference equation

$$y(n) - \frac{3}{2}y(n-1) + \frac{1}{2}y(n-2) = x(n-1)$$

and also determine its impulse response.

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