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Question Paper Code : 90465

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

Third Semester

Electronics and Communication Engineering

EC 8352 – SIGNALS AND SYSTEMS

(Common to: Biomedical Engineering/ Computer and Communication Engineering/ Electronics and Telecommunication Engineering/ Medical Electronics)

(Regulations 2017)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

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1. Consider a discrete time signal $x(n) = \cos\left(\frac{\pi}{2}n\right)\cos\left(\frac{\pi}{4}n\right)$. If signal is periodic, calculate the fundamental time period.

2. Sketch the even and odd part of the given signal $x(t)$

   $x(t) = \frac{t}{4}; \quad 0 \le t \le 4$

3. Use the duality property to find the Fourier transform of the given signal

   $x(t) = \frac{1}{1+(3t)^2}$

4. Determine the inverse Laplace transform of $x(s) = \log\left(\frac{S+5}{S+6}\right)$.

5. Consider an LTI system with impulse response $h(t) = e^{-5t}u(t)$. If the output of the system is $y(t) = e^{-3t}u(t) - e^{-5t}u(t)$, then calculate the input of the system.

6. The differential equation $\frac{d^2y(t)}{dt^2} + \frac{dy(t)}{dt} - 2y(t) = x(t)$ describe a system with an input $x(t)$ and output $y(t)$. The system, which is initially relaxed, is excited by a unit step input. Find the impulse response of the system.

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7. Determine the region of convergence (ROC) of the given discrete time signal $x[n]=\left(\frac{1}{3}\right)^{|n|}-\left(\frac{1}{2}\right)^{n}u[n]$.

8. State the sampling theorem. A band-limited signal with a maximum frequency 5KHz is to be sampled. According to the sampling theorem calculate the minimum sampling frequency.

9. The system function of causal LTI system is $H(z)=\frac{z-1}{(z-3)(z+1)}$. Find the difference equation representation of system.

10. Let $y[n]$ denotes the convolution of $h[n]$ and $g[n]$, where $h[n]=(0.5)^2u[n]$ and $g[n]$ is a causal sequence. If $y[0]=1$ and $y[1]=0.5$, then find the value of $g[1]$?

PART B — (5 × 13 = 65 marks)

11. (a) (i) A discrete time signal shown in Fig 11 (a), sketch and label each of the following signals: (8)

(1) $x[n]u[3-n]$

(2) $x[3n+1]$

(3) $x[n-2]\delta[n-2]$

(4) $\frac{1}{2}x[n]+\frac{1}{2}(-1)^n x[n]$

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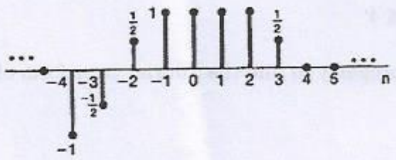

Fig. 11 (a)

(ii) Determine the energy and power signals of the signals $x(t)=e^{j\left(2t+\frac{\pi}{4}\right)}$. (5)

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(b) (i) For the signal $x(t)$ shown in Fig 11 (b), sketch an label each of the following signals: (8)

(1) $x(t)\,u(1-t)$

(2) $x(t)\,\{u(t)-u(t-1)\}$

(3) $x(-2t+2)$

(4) $x(t)\,\delta\left(t-\frac{3}{2}\right)$

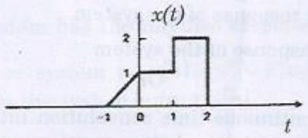

Fig. 11 (b)

(ii) Determine the energy and power signals of the signals $x(n)=2e^{j4n}$ (3)

(iii) Check whether the given system is causal or not $y[n]=Even\{x[n-2]\}$ (2)

12. (a) (i) If a continuous time signal $x(t)$ is defined as (8)

$$x(t)=rect\left(t\frac{1}{2}\right);\quad \left(rect(t)=1;\ \left(-\frac{1}{2}\le t\le\frac{1}{2}\right)\right.$$

Calculate the Fourier transform of $y(t)$. If $y(t)$ = Even part of $x(t)$.

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(ii) Determine the Laplace transform of the continuous time signals $x(t)=|t|\,e^{-2|t|}$ and sketch its region of convergence. (5)

Or

(b) (i) Determine the Laplace transform of the continuous time signals $x(t)=e^{-2t}u(t)+e^{5t}u(-t)$ and sketch its region of convergence. (5)

(ii) A triangular pulse $x(t)$ in the Fig. 12 (b) as the convolution of two rectangular pulses, determine the Fourier transform of $x(t)$. Also evaluate the Fourier transform of individual rectangular pulses. (8)

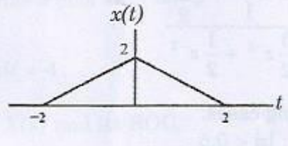

Fig. 12 (b)

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13\. (a) Consider a Continuous-time LTI system for which input $x(t)$ and output $y(t)$ is related by differential equation: $\frac{d^2y(t)}{dt^2}+3\frac{dy(t)}{dt}+2y(t)=x(t)$ with having the initial conditions $y(0)=0, \left.\frac{dy(t)}{dt}\right|_{t=0^-}=4$. If $x(t)=4e^{-2t}u(t)$,

Determine the following

(i) Zero input response of the system

(ii) Zero state response of the system

(iii) Overall Response of the system

Or

(b) Evaluate the continuous-time convolution integrals between the signals $x(t)$ and $h(t)$ given below $x(t)=\cos(2\pi t)[u(t+1)-u(t-1)]$ and $h(t)=e^{-t}u(t)$

14\. (a) (i) Find the Z-transform of the given sequence. Plot the pole-zero constellation diagram and also indicate the region of convergence (6)

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

(ii) Use the Fourier transform Synthesis equation to determine the inverse Fourier transform $X(e^{j\omega})$: (7)

$$\left|X(e^{j\omega})\right|=\begin{cases}1, & 0\le|\omega|\le\frac{\pi}{4}\\ 0, & \frac{\pi}{4}\le|\omega|\le\pi\end{cases} \text{ and } \measuredangle X(e^{j\omega})=-\frac{3\omega}{2}.$$

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Or

(b) (i) Let $X(e^{j\omega})$ denotes the Fourier transform of given signal $x[n]$. (7)

$$X(e^{j\omega})=\frac{1}{1-e^{-j\omega}}\left(\frac{\sin\frac{3}{2}\omega}{\sin\frac{\omega}{2}}\right)+5\delta(\omega),\ -\pi\le\omega\le\pi$$

Determine $x[n]$.

(ii) Determine the inverse Z-transform of $X(z)$. (6)

$$x[z]=\frac{1}{1-\frac{3}{2}z^{-1}+\frac{1}{2}z^{-2}}.$$

For following cases:

(1) ROC : $|z|<0.5$

(2) ROC : $0.5<|z|<1$.

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15. (a) (i) Consider a system consisting of the cascade of two LTI system with frequency responses. (5)

$$H_1(e^{j\omega}) = \frac{2 - e^{-j\omega}}{1 + \frac{1}{2}e^{-j\omega}} \text{ and } H_2(e^{j\omega}) = \frac{1}{1 - \frac{1}{2}e^{-j\omega} + \frac{1}{4}e^{-j2\omega}}$$

Find the difference equation describing the overall system.

(ii) An LTI system has the impulse response $h[n] = \left(\frac{1}{2}\right)^n u[n+2]$. The input to the system is $x[n] = \gamma^{|n|}$. Find the general closed form equation for the system output $y[n]$. (8)

Or

(b) (i) An LTI system is described by the equation $y[n] = x[n] + 0.8x(n-1) + 0.8x(n-2) - 0.49y[n-2]$. Determine the Impulse response of the system. (5)

(ii) An LTI system has the impulse response $h[n] = \beta^n u[n]$; for $|\beta| < 1$. The input to the system is $x[n] = \langle u[n+10] - 2u[n] + u[n-4] \rangle$ with no restriction on the value of β. Find the general closed form equation for the system output $y[n]$. (8)

PART C — (1 × 15 = 15 marks)

16. (a) (i) Suppose $g(t) = x(t)\cos t$ and the Fourier transform of $g(t)$ is (8)

$$G(j\omega) = \begin{cases} 1, & |\omega| \le 2 \\ 0, & otherwise \end{cases}$$

(1) Determine $x(t)$

(2) Specify the Fourier transform $X_1(j\omega)$ of a signal $x_1(t)$ such that $x(2t) = x_t(t)\cos\left(\frac{2}{3}t\right)$.

(ii) Suppose the following facts are given about the signal $x(t)$ with Laplace transform $X(s)$: (7)

(1) $x(t)$ is real and even.

(2) $X(s)$ has four poles and no zeros in the finite s-plane.

(3) $X(s)$ has a pole at $S = \frac{1}{2}e^{j\frac{\pi}{4}}$.

(4) $\int_{-\infty}^{\infty} x(t)dt = 4$

Determine $X(s)$ and its ROC.

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(b) (i) Consider a discrete time signal $x(n)$ with Z-transform $X(Z)$. Following facts are given,

(1) $x(n)$ is real and right sided

(2) $X(z)$ has exactly two poles

(3) $X(x)$ has two zeros at origin

(4) $X(z)$ has one pole at $z = \frac{1}{2} e^{j\frac{\pi}{3}}$

(5) $x(1) = \frac{8}{3}$

Determine $X(z)$ and region of convergence. (8)

(ii) Find the impulse response of a LTI system having frequency response.

$$H(j\omega) = \frac{(\sin^2(3\omega))\cos\omega}{\omega^2}.$$ (7)

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