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Question Paper Code : 40981

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2024.

Third Semester

Electronics and Communication Engineering

EC 3354 – SIGNALS AND SYSTEMS

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

(Regulations 2021)

Time : Three hours   Maximum : 100 marks

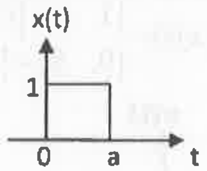
Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Determine whether the signal is periodic or not. If periodic find the fundamental period.

$$x(t)=2\sin\left(\frac{2}{3}\right)t+3\cos\left(\frac{2\pi}{5}\right)t$$

2. Sketch the even and odd parts of the signal.



3. Find the Fourier series coefficients of the signal.

$$x(t)=1+\sin 2\Omega t+2\cos 2\Omega t+\cos\left(3\Omega t+\frac{\pi}{3}\right)$$

4. Determine the Fourier transform of $x(t)$ using shifting property,

$$x(t)=e^{-3/t-t0/}+e^{-3/t+t0/}$$

5. Let $X(S)-L\{x(t)\}$. Determine the initial value $x(0)$ and the final value $x(\infty)$ for the following signal using initial value and final value theorems.

6. Find the Laplace transform of $\delta(t)$ and $u(t)$.

7. Determine whether the given causal system with transfer function $H(S) = 1 + \frac{1}{s-2}$ is stable.

8. Determine the Nyquist sampling rate for
$x(t) = \sin(200\pi t) + 3\sin^2(120\pi t)$

9. Find the Z-transform and their ROC of the discrete time signal
$x[n] = \{1, -1, 2, \underset{\uparrow}{3}, 4\}$

10. Define Sampling Theorem.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Determine the energy and power of the given signal. (5)
$x(t) = rect\,(t/T_0)$

(ii) State whether the following system is linear, causal, time variant and dynamic. (8)
$y(t) = x(t-3) + (3-t)$

Or

(b) (i) Determine the energy and power of the given signal, $x[n] = [1/4]^2 u[n]$. (5)

(ii) State whether the following system is linear, causal, time variant and dynamic $y[n] = x[n] + \frac{1}{x[n-1]}$. (8)

12. (a) (i) Determine Fourier series coefficient of periodic square wave Fig. 12(a) given by $x(t) = \begin{cases} 1, & |t| < T_1 \\ 0, & T_1 < |t| < T/2 \end{cases}$. (7)

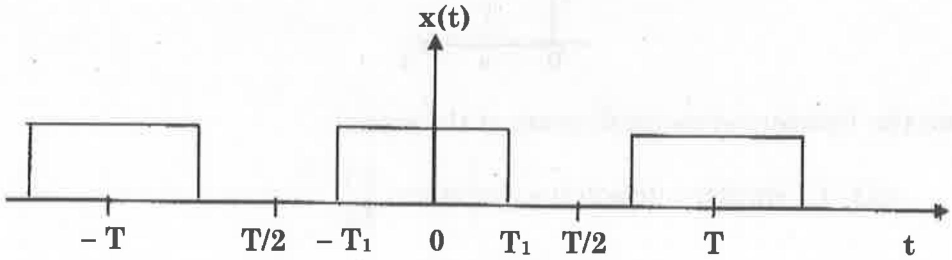


Fig. 12(a)

(ii) Derive the Shifting and Scaling properties of Fourier transform. (6)

Or

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(b) (i) Determine Fourier series coefficient of the given signal Fig.12 (b) (7)

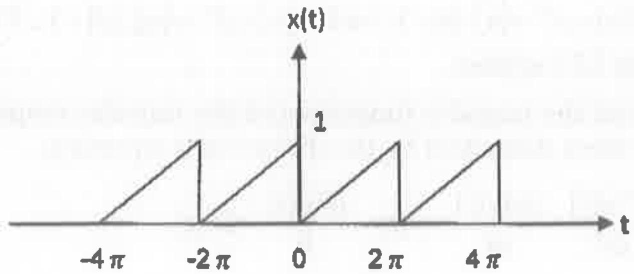

Fig. 12 (b)

(ii) State and derive the Shifting and Scaling properties of Laplace transform. (6)

13. (a) (i) Find Fourier transform of $x(t) = e^{-a|t|}$ and draw its frequency spectrum. (6)

(ii) Determine the discrete time sequence from the spectrum $X(e^{j\omega})$ where, $X(e^{j\omega}) = \frac{1}{2} \cdot \frac{e^{j\omega} + 1 + e^{-j\omega}}{1 - ae^{-j\omega}}$. (7)

Or

(b) (i) Determine the Laplace transform of the Half sine wave pulse shown in Fig. 13 (b). (6)

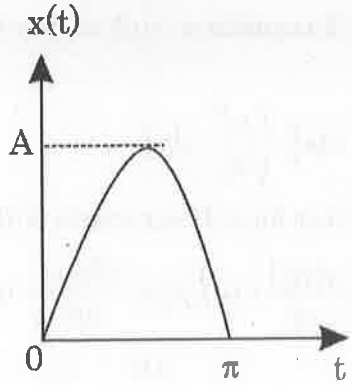

Fig. 13(b)

(ii) Perform convolution of the following signal, using Laplace transform. (7)

$x(t) = e^{2t}u(-t),\ h(t) = u(t-3)$.

14. (a) (i) Consider an LTI system with impulse response.

$h[n]=\alpha^n\, u[n];\ |\alpha|<1$ and $x[n]=\beta^n\, u[n];\ |\beta|<1$. Find the response of the LTI system. (8)

(ii) Find the transfer function and the impulse response of a causal LTI system described by the differential equation.

$$\frac{d^2y(t)}{dt^2}+\frac{2dy(t)}{dt}+y(t)=\frac{d^2x(t)}{dt}-2x(t).$$ (5)

Or

(b) (i) Find the overall impulse response of the interconnected system. Given that $h_1(t)=e^{-2t}u(t),\ h_2(t)=\delta(t)-\delta(t-1),\ h_3(t)=\delta(t)$. Also find the output of the system of the input $x(t)=u(t)$ using convolution integral (Fig. 14(b)). (8)

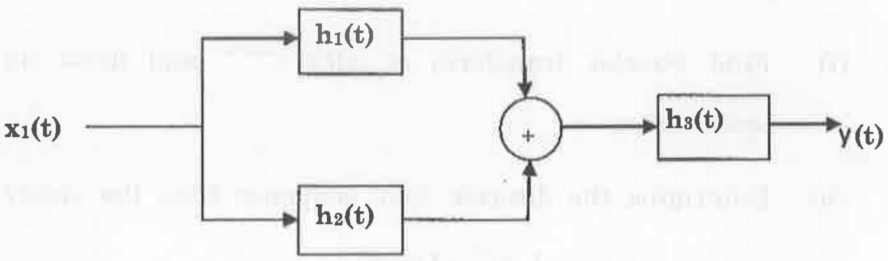

Fig. 14(b)

(ii) Check whether the LTI system is causal and stable. (5)

$$H(S)=\frac{1}{s^2-s-6}$$

15. (a) (i) Determine Z-transform and sketch the ROC along with location of poles. (7)

$$x[n]=\left[\frac{1}{2}\right]^n u[n]-\left[\frac{1}{3}\right]^n u[n]$$

(ii) Find the direct form-II structure of the continuous time system. (6)

$$\frac{d^2y(t)}{dt^2}+0.6\frac{dy(t)}{dt}+0.7\,y(t)=\frac{d^2x(t)}{dt^2}+0.5\frac{dx(t)}{dt}+0.4\,x(t)$$

Or

(b) (i) Determine the inverse Z-transform of the following function. (7)

$$X(Z)=\frac{2}{(1+z^{-1})(1-z^{-1})^2}$$

(ii) Find the direct form-I structure of the continuous time system. (6)

$$H(S)=\frac{4s+28}{s^2+6s+5}$$

(b) (i) An LTI system has an impulse response $h(t)$ for which the Laplace transform $H(s)$ is (5)

$$H(S)=\int_{-\infty}^{\infty} h(t)e^{-st}\,dt=\frac{1}{s+1},\ \mathrm{Re}\{s\}>-1$$

Determine the system output $y(t)$ for all t if the input $x(t)$ is given by $x(t)=e^{-t/2}+2e^{-t/3}$ for all t.

(ii) Determine if each of the following statements is true in general. Provide proofs for those that you think are true and counter examples for those that you think are false.

(1) $x[n]*\{h[n]g[n]\}=\{x[n]*h[n]\}g[n]$ (3)

(2) If $y(t)=x(t)*h(t)$, then $y(2t)=2x(2t)*h(2t)$ (2)

(3) If $x(t)$ and $h(t)$ are odd signals, then $y(t)=x(t)*h(t)$ is an even signal (2)

(4) If $y(t)=x(t)*h(t)$, then $Ev\{y(t)\}=x(t)*Ev\{h(t)\}+Ev\{x(t)\}*h(t)$ (3)

PART C — (1 × 15 = 15 marks)

16. (a) (i) Let $s(t)$ be a signal whose spectrum $S(j\omega)$ is given in figure 16(a)(i). Also, Consider the signal $p(t) = \cos \omega_0 t$. Find Fourier transform of the signal or spectrum of $r(t) = s(t).p(t)$. Use multiplication property.

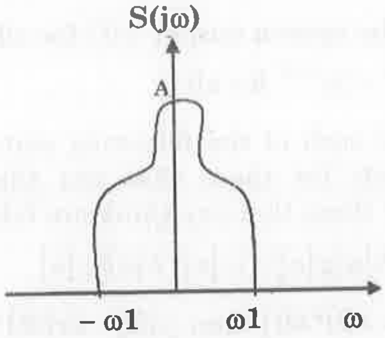

Fig. 16(a)(i)

(ii) Consider the block diagram relating the two signals $x[n]$ and $y[n]$ given in Figure 16(a)(ii).

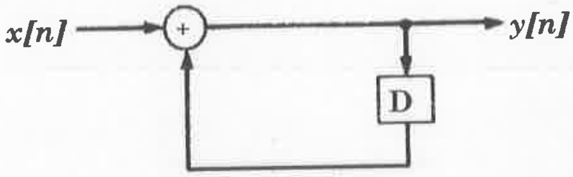

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Fig. 16(a)(ii)

Assume that the system described in Figure 16(a)(ii) is causal and is initially at rest.

(1) Determine the difference equation relating $y[n]$ and $x[n]$.

(2) Without doing any calculations, determine the value of $y[-5]$ when $x[n] = u[n]$.

(3) Assume that a solution to the difference equation in part (a) is given by $y[n] = K\alpha^n u[n]$

when $x[n] = \delta[n]$. Find the appropriate value of K and α, and verify that $y[n]$ satisfies the difference equation.

(4) Verify your answer to part (c) by directly calculating $y[0]$, $y[1]$ and $y[2]$.

Or