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Question Paper Code : 11239

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2026.

Third Semester

Electronics and Communication Engineering

EC3354 — SIGNALS AND SYSTEMS

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

(Regulations 2021)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Find the energy of the signal $x[n] = (1/2)^n u[n]$.
2. Find the odd and even components of the signal : $\cos t + \sin t + \cos t \sin t$.
3. Find the Fourier series coefficients for the following signal.
$$x(t) = \sin\left(10\pi t + \frac{\pi}{6}\right).$$
4. Find the Fourier transform $\delta(t - 5)$ and sketch the magnitude and phase as a function of frequency.
5. Determine the Laplace transform, for following time function.
$$x(t) = 3e^{2t}u(t) + 4e^{3t}u(t).$$
6. A system is described by the differential equation

$$\frac{d^2y(t)}{d(t)^2} + \frac{6dy(t)}{dt} + 8y(t) = \frac{dx(t)}{dt} + x(t).$$

Find the transfer function.

7. Give the relation between Discrete Time Fourier Transform (DTFT) and Z-transform.
8. Determine the Nyquist sampling rate for $x(t) = \sin(200\pi t) + 3 \sin^2(120\pi t)$.

9. Find $x(\infty)$ if $X(z)$ is given by $\frac{z+1}{3(z-1)(z+0.9)}$.

10. State Parseval's relation in z-transform.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Determine if the following systems are time-invariant, linear, causal, and/or memoryless? $\frac{dy}{dt} + \sin(t)y(t) = 4x(t)$. (8)

(ii) Find out whether the following signals are energy or power signal or neither power nor energy as the case may be for the signal. (5)

$$x(t) = u(t) + 5u(t-1) - 2u(t-2).$$

Or

(b) (i) Determine if the following systems are time-invariant, linear, causal, and/or memoryless? $y[n+1] + 4y[n] = 3x[n+1] - x[n]$. (8)

(ii) Determine whether the discrete time sequence is periodic or not. (5)

$$x[n] = \sin[(3\pi/7)n + \pi/4] + \cos(\pi/3)n.$$

12. (a) Find the Laplace transform of half wave rectifier with amplitude A overtime period 0 to π .

Or

(b) Formulate the trigonometric Fourier series over the interval $(-1, 1)$ for the signal $x(t) = t^2$.

13. (a) (i) Find the convolution between $x(t)$ and $h(t)$

$$x(t) = \begin{cases} 1, & \text{for } 0 \leq t < 1 \\ -1, & \text{for } 1 \leq t < 3 \\ 0, & \text{otherwise} \end{cases} \quad h(t) = \begin{cases} 1, & \text{for } 0 \leq t \leq 2 \\ 0, & \text{otherwise} \end{cases} \quad (8)$$

(ii) Find the inverse Laplace transform of

$$X(s).X(s) = \frac{2s^2 + 9s - 47}{(s+1)(s^2 + 6s + 25)}. \quad (5)$$

Or

(b) (i) Evaluate the response $y(t)$ of a continuous time system using Laplace transform with transfer function $H(s) = 1/(s+2)(s+3)$ for an input $x(t) = e^{-t}u(t)$. (8)

(ii) The system produces the output $y(t) = e^{-t}u(t)$ for an input $x(t) = e^{-2t}u(t)$. Estimate its frequency response and impulse response. (5)

14. (a) (i) Examine the Nyquist rate and Nyquist interval for the signal

$$x(t) = \frac{1}{4\pi} \cos(5000\pi t) \cos(2000\pi t). \quad (8)$$

- (ii) Describe the effects of under sampling and the steps to eliminate aliasing. (5)

Or

- (b) (i) Determine the z-transform of the sequence

$$x[n] = \left[\frac{1}{3}\right]^n u(n) - 6\left[\frac{1}{2}\right]^n u(n) \text{ and sketch the pole-zero pattern for the sequence.} \quad (8)$$

- (ii) Consider the analog signal $x(t) = 2 \cos 2000\pi t + \sin 4000\pi t + 12 \cos 2000\pi t$. Obtain the Nyquist sampling rate. (5)

15. (a) (i) Estimate the system function and output response $y(n)$ of a linear time invariant discrete time system specified by the equation (8)

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

- (ii) Determine the inverse Z-transform of the following function

$$X(Z) = \frac{2}{(1+z^{-1})(1-z^{-1})^2}. \quad (5)$$

Or

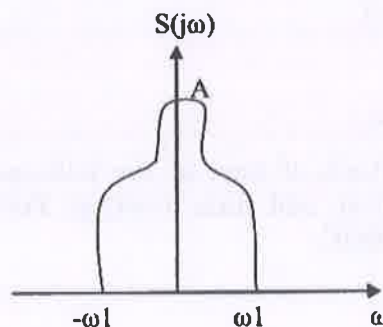
- (b) (i) Obtain the direct form I and direct form II realizations of the LTI system

$$y(n) = -\frac{3}{8} y(n-1) + \frac{3}{32} y(n-1) + \frac{1}{64} y(n-3) + x(n) + 3x(n-1) + 2x(n-2) \quad (8)$$

- (ii) For two discrete-time systems with impulse response $h_1[n] = (0.5)^n u[n]$, $h_2[n] = u[n]$. Determine the overall system response to the input $x[n] = \delta[n] + 2\delta[n-1]$. (5)

PART C — (1 × 15 = 15 marks)

16. (a) (i) Let $s(t)$ be a signal whose spectrum $S(j\omega)$ is given in figure below. Also, consider the signal $p(t) = \cos \omega_0 t$. Find Fourier transform of the signal or spectrum of $r(t) = s(t) \cdot p(t)$. Use multiplication property. (8)



- (ii) A system is described by the following differential equation

$$\frac{d^2 y(t)}{dt^2} + \frac{7dy(t)}{dt} + 12y(t) = x(t). \text{ Determine the response of the system to a unit step applied at } t = 0. \text{ The initial conditions are } y(0^-) = -2; \frac{dy(t)}{dt}(0^-) = 0. \quad (7)$$

Or

- (b) (i) If $x(t)$ is an even time function such that $x(t) = x(-t)$, show that this requires that $X(s) = X(-s)$.
- (ii) If $x(t)$ is an odd time function such that $x(t) = -x(-t)$, show that $X(s) = -X(-s)$.
- (iii) Determine which, if any, of the pole-zero plots in Figures (a, b, c, d) could correspond to an even time function. For those that could, indicate the required ROC.

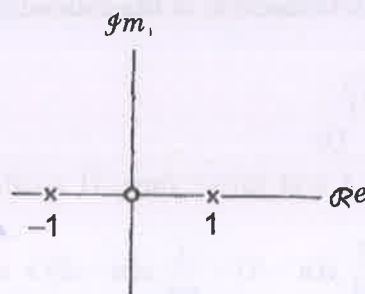


Fig. a

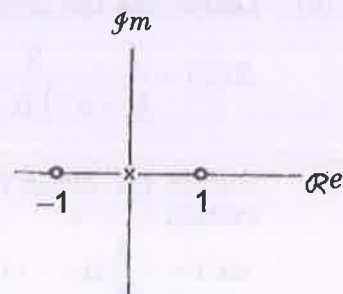


Fig. b

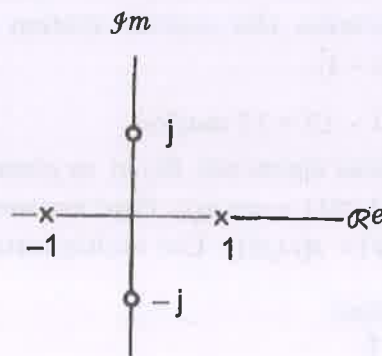


Fig. c

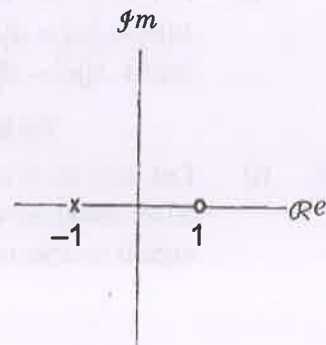


Fig. d

- (iv) Determine which, if any, of the pole-zero plots in part (iii) could correspond to an odd time function. For those that could, indicate the required ROC.