II B. Tech I Semester Regular/Supplementary Examinations, December-2023
SIGNALS AND SYSTEMS
(Com to ECE, EIE, ECT)

Time: 3 hours   Max. Marks: 70

Answer any **FIVE** Questions each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) Define a signal? Determine even and odd components of the following signals?   [7M]
    i) $x(t) = \cos t + \sin t + \sin t \cos t$ ii) $x(t) = (1 + t^3)\cos^3 10t$

   b) How an arbitrary function $x(t)$ can be expressed using set of mutual orthogonal   [7M]
   functions? Explain.

OR

2 a) A continuous time signal $x(t)$ shown in Fig 1. Apply the following operations   [7M]
   and sketch, label carefully.

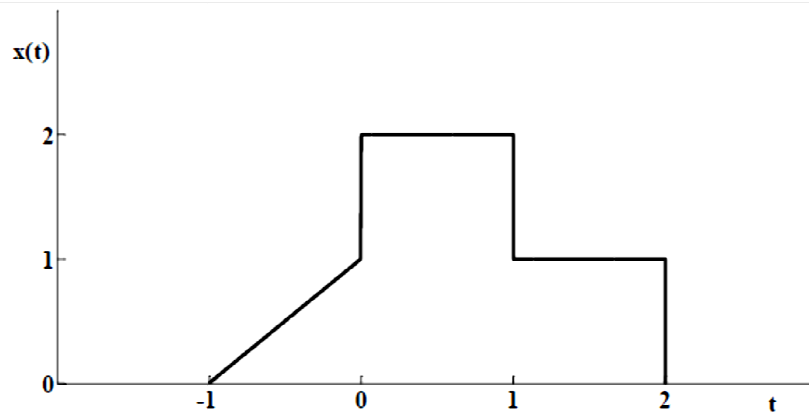   i) $x\left(\dfrac{3t}{2}\right)$ ii) $x(t-2)$ iii) $x(2t+3)$

Fig 1

   b) Explain the analogy between vectors and signals.   [7M]

UNIT-II

3 a) Show that the trigonometric Fourier series representation of even periodic   [7M]
   function contains only cosine terms.

   b) By use of suitable property of Fourier transform, find the Fourier transform of   [7M]
   the signal

$$x(t) = \frac{1}{t}$$

   Also, sketch its magnitude spectrum

OR

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4　a)　Determine the trigonometric Fourier series coefficients of the periodic waveform shown in Fig. 2?　[8M]

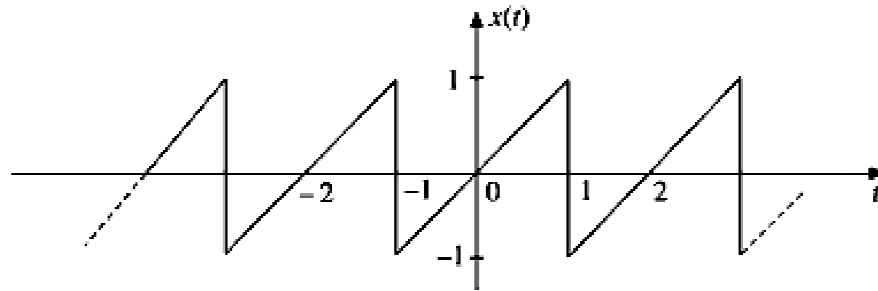Fig 2.

　b)　State the time scaling and Duality properties of Fourier transform.　[6M]

UNIT-III

5　a)　The input and impulse responses of a system are given as $x(t) = e^{-3t}u(t)$ and $h(t) = u(t + 3)$. Find the response of a system $y(t)$.　[8M]

　b)　Explain about LTI and LTV systems.　[6M]

OR

6　a)　Explain the filter characteristics of ideal LPF and BPF with neat sketches.　[7M]

　b)　Define Causality and physically realizability of a system. Also, discuss about Paley-wiener criteria.　[7M]

UNIT-IV

7　a)　Derive the relation between autocorrelation and energy spectral density of an energy signal?　[7M]

　b)　Determine the Nyquist rate and Nyquist interval of the following signals.　[7M]
　　　i) $x(t) = Sinc(500\pi t) + 5 \, sinc^2(180\pi t)$　ii) $x(t) = 10sinc^2(250\pi t)$

OR

8　a)　List out the properties power spectral density (PSD).　[7M]

　b)　With neat diagrams, explain the concept of flat-top sampling.　[7M]

UNIT-V

9　a)　Determine the inverse Laplace transform of　[7M]
$$X(s) = \frac{s + 1}{s^2 + 5s + 6}, \qquad -3 < Re\{s\} < -2$$

　b)　State and prove scaling in z-domain property of z-transform.　[7M]

OR

10　a)　State and prove the time differentiation property in Laplace transform.　[7M]

　b)　Find the z-transform of the signal, $x(n) = \left(\frac{1}{2}\right)^n u(n) + 2^n u(-n - 1)$. Also, plot its ROC.　[7M]

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SET - 2

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UNIT-I

1 a) Define and sketch the unit step function and signum function? Bring out the relation between these two functions. [7M]

   b) Consider the complex valued exponential signal [7M]
$$x(t) = A\, e^{\alpha t + j\omega t}, \qquad \alpha > 0$$
   Evaluate the real and imaginary components of $x(t)$ for the following
   i) α real, $\alpha = \alpha_1$ ii) α complex, $\alpha = \alpha_1 + j\omega_1$

OR

2 a) A triangular pulse $x(t)$ is shown in Fig 1. Sketch the following signals. [7M]
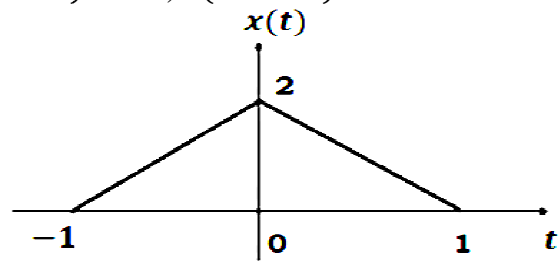   i) $x(3t)$ ii) $x(3t + 2)$ iii) $x(-2t - 1)$

Fig 1

   b) What is meant by orthogonality and derive the condition under which two signals $x_1(t)$ and $x_2(t)$ said to be orthogonal to each other. [7M]

UNIT-II

3 a) Show that the magnitude spectrum of every periodic function is symmetrical about vertical axis passing through the origin. [7M]

   b) Find the Fourier transform of the signum function [7M]
$$x(t) = sgn(t)$$
   Also, sketch its magnitude and phase spectra.

OR

4 a) What is the significance of Hilbert transform? List out any three properties of Hilbert transform. [7M]

   b) State and prove the time integration property of Fourier transform? [7M]

UNIT-III

5 a) Derive the expression for transfer function of a LTI system. [7M]

   b) A system produces an output of $y(t) = e^{-t}u(t)$ for an input of $x(t) = e^{-2t}u(t)$. Determine the impulse response and frequency response of a system. [7M]

OR

6 a) Obtain the convolution of the following two signals using graphical approach.   [9M]
        $x(t) = e^{-3t}u(t)$ and $h(t) = u(t+3)$
   b) Explain the concept of system bandwidth with neat sketch.   [5M]

UNIT-IV

7 a) State and prove any two properties of Autocorrelation for energy signals.   [7M]

   b) Explain quantitatively about reconstruction of a signal from its sampled signal   [7M]
        using interpolation.

OR

8 a) A non-periodic signal $x(t) = e^{-3t}u(t)$ is passed through an LPF with cut-off   [7M]
        frequency 1 rad/s. Determine
        i) Input energy spectral density (ESD)
        ii) Output ESD
        iii) Total energy of an output signal
   b) Differentiate between natural and flat-top sampling.   [7M]

UNIT-V

9 a) State and prove the initial value theorem in Laplace transform.   [7M]

   b) Find the inverse z-transform of   [7M]

$$X(z) = \frac{z^{-1}}{3 - 4z^{-1} + z^{-2}}; \quad ROC: |z| > 1$$

OR

10 a) Find the Laplace transform of a causal periodic signal shown in Fig. 2.   [7M]
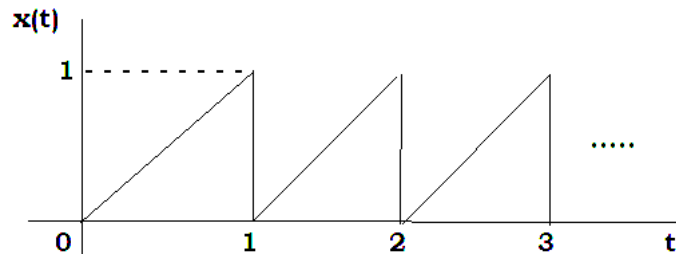

Fig. 2

   b) Define ROC? List out the properties of ROC related to z- transform.   [7M]

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UNIT-I

1. a) Define periodic signal? Verify the following signals are periodic or not.   [7M]

   i) $x(t) = \cos\frac{\pi}{3}t + 5\sin\frac{\pi}{4}t$ ii) $x(t) = e^{j\left(\frac{\pi}{2}t-1\right)}$

   b) What is meant by orthogonality? Derive the condition for the orthogonality   [7M]
   between two complex signals $x_1(t)$ and $x_2(t)$ for a real variable t.

OR

2. a) A continuous time signal x(t) shown in Fig. 1. Apply the following operations   [7M]
   and sketch, label carefully.

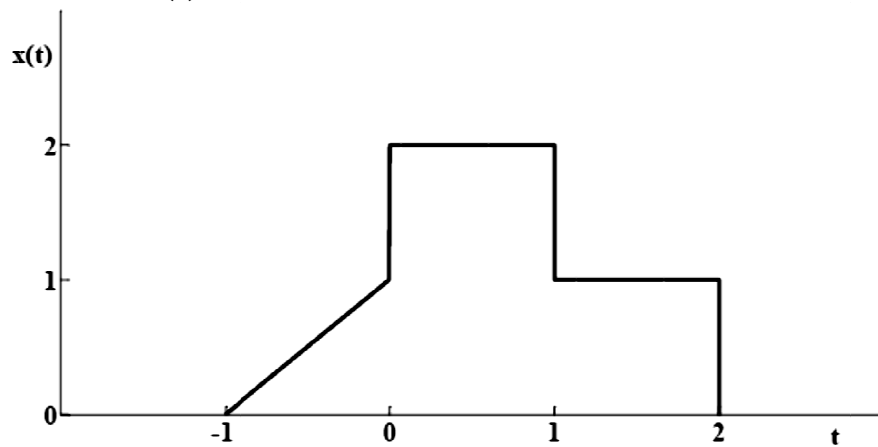   i) $x(t-4)$ ii) $x\left(\frac{t}{2}\right)$ iii) $x(4t+1)$

Fig. 1

   b) Define and list the properties of unit impulse function? Also, evaluate the   [7M]
   following integrals.

   a) $\int_{-\infty}^{+\infty} e^{-t^2}\delta(t-1)dt$ b) $x(t) = \int_{-\infty}^{+\infty}\sin 2t\,\delta(t)dt$

UNIT-II

3. a) Explain about Dirichlet's conditions to obtain Fourier series representation of   [7M]
   any signal.

   b) Determine the Fourier transform of the signal shown in Fig 2 by using time   [7M]
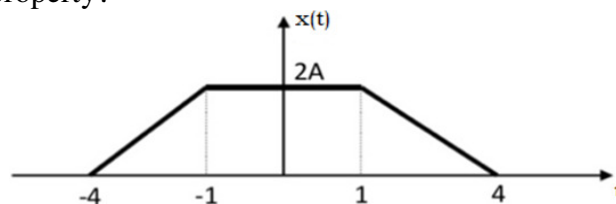   differentiation property?

Fig. 2

OR

4　a)　Obtain the trigonometric Fourier coefficients in terms of exponential Fourier coefficients?　[7M]

　　b)　Find the Fourier transform of the signal　[7M]
$$x(t) = e^{-3t}[u(t + 2) - u(t - 3)]$$

UNIT-III

5　a)　Define and explain the following:　[7M]
　　　　i) Linear and non-linear systems　　ii) Causal and non-causal systems

　　b)　Explain the characteristics of an ideal LPF? Explain why it can't be realized.　[7M]

OR

6　a)　Obtain the convolution of the following two signals using graphical approach.　[14M]
$$x(t) = \begin{cases} 1 & \text{for } -3 \le t \le 3 \\ 0 & \text{elsewhere} \end{cases} ; h(t) = \begin{cases} 2 & \text{for } 0 \le t \le 3 \\ 0 & \text{elsewhere} \end{cases}$$

UNIT-IV

7　a)　Explain about the detection of periodic signal in the presence of noise by correlation?　[7M]

　　b)　Write the statement of Sampling theorem for band limited signals? Determine the Nyquist rate and Nyquist interval of the following signal　[7M]
$$x(t) = 5\sin(250\pi t) + 6\cos(200\pi t)$$

OR

8　a)　Write any twoproperties of cross correlation function for power signals.　[4M]

　　b)　A signalx$(t) = 2\cos 400\pi t + 6\cos 640\pi t$ is ideally sampled at $f_s = 500$ Hz. If the sampled signal is passed through an ideal low pass filter with a cutoff frequency of 400 Hz, what frequency components will appear in the output? Sketch the output spectrum. Also find the output signal.　[10M]

UNIT-V

9　a)　Determine the initial and final values of　[7M]
$$X(s) = \frac{2s + 3}{s^2 + 5s + 6}$$

　　b)　Find the z-transform of the discrete time signal and also plot its ROC.　[7M]
$$x[n] = n\alpha^n u[n]; \ |\alpha| < 1$$

OR

10　a)　State and prove the time shifting property in Laplace transform.　[7M]

　　b)　Determine the inverse z-transform of the given by use of power series expansion (PSE) method　[7M]
$$X(z) = \frac{2 + z^{-1}}{1 - \frac{1}{2}z^{-1}}; \ \text{ROC:}|z| < \frac{1}{2}$$

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UNIT-I

1 a) Define and sketch the following signals   [7M]
        i) Unit step signal   ii) Unit impulse signal   iii) Signum function
   b) A rectangular function x(t) defined as   [7M]
$$x(t) = \begin{cases} 1 & \text{for } 0 < t < \pi \\ -1 & \text{for } \pi < t < 2\pi \end{cases}$$
        Approximate this function by a waveform **sin t** over the interval $(0, 2\pi)$ such that
        the mean square error (MSE) is minimum. Also, calculate MSE.

                                        OR

2 a) Determine whether the given signal is power or energy signal?   [7M]
$$x(t) = A[u(t + a) - u(t - a)], \qquad a > 0$$

   b) What is meant by Orthogonality of signals? Show that the following signals are   [7M]
        mutually orthogonal to each other over an interval $(0, 1)$.
$$x_1(t) = 2 \text{ and } x_2(t) = \sqrt{3}(1 - 2t)$$

UNIT-II

3 a) Show that the trigonometric Fourier series representation of odd periodic   [7M]
        function contains no cosine terms.
   b) Find the Fourier transform of the signal   [7M]
$$x(t) = \frac{1}{1 + t^2}$$
        Also sketch its magnitude spectrum.

                                        OR

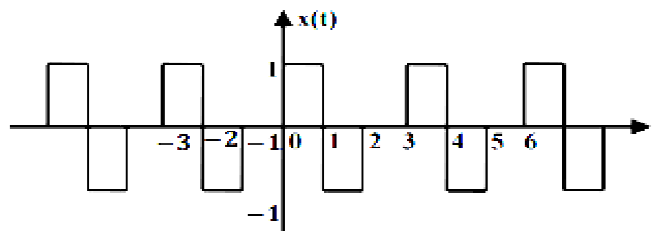4 a) Obtain the trigonometric Fourier series for the waveform shown in Fig 1.   [7M]

Fig 1

   b) What is Hilbert transform? Also, obtain its magnitude and phase spectra.   [7M]

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UNIT-III

5 a) What are the requirements to be satisfied by an LTI system to provide distortionless transmission of a signal? [7M]

　b) State and explain about Paley-wiener criteria. [7M]

OR

6 a) Obtain the relation between rise time and bandwidth of a LPF when unit step signal is applied. [7M]

　b) Write a note on signal bandwidth and system band width. [7M]

UNIT-IV

7 a) Determine the autocorrelation function and energy spectral density of the signal [7M]
$$x(t) = e^{-3t}u(t)$$

　b) What is meant by aliasing effect? Suggest the methods to avoid the aliasing. [7M]

OR

8 a) Obtain the relation between correlation and convolution. [7M]

　b) State the sampling theorem for band limited signals?Determine the minimum sampling rate and Nyquist interval of the signal [7M]
$$x(t) = Cos\ 200\pi t + 10\ Sin\ 10000\pi t + 20\ Cos\ 5000\pi t$$

UNIT-V

9 a) Write the properties of ROC for Laplace transform. [7M]

　b) Determine the inverse z-transform of the [7M]
$$X(z) = \frac{1}{1 - 1.5z^{-1} + 0.5z^{-2}};\ \ ROC: 0.5 < |z| < 1$$

OR

10 a) Find the Laplace transform of the signal, $x(t) = e^{-2t}u(t) - e^{-3t}u(t)$. Also sketch its ROC. [7M]

　b) State and prove the final value theorem in z-transform. [7M]

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