Institute of Information Technology
Jahangirnagar University
THIRD YEAR FIRST SEMESTER B.SC (HONS) FINAL EXAMINATION, 2019
[In Information Technology]

Course Code: IT 3105

Course Title: Signals & Systems

Time: 3 Hours

Full Marks: 60

Answer any **5 (five)** of the following questions. Figures in the right margin indicate marks.

1. a) Consider the given continuous signal given in fig. 1. Sketch the following forms: 6

   i. $x(t-2)$;
   ii. $x(2t)$;
   iii. $x(t/2)$;
   iv. $x(-t)$

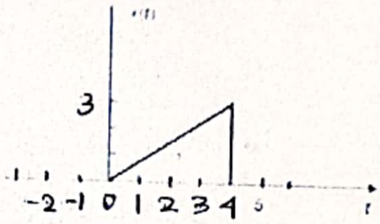


Fig. 1

b) Consider the following signals $x_1(t) = \begin{cases} 1; & -3 < t < 3 \\ 0; & otherwise \end{cases}$ and $x_2(t) = \begin{cases} 2; & -10 < t < 10 \\ 0; & otherwise \end{cases}$ 4

Find and sketch

   i. $Y_1(t) = x_1(t) - x_2(t)$
   ii. $Y_2(t) = x_1(t) \times x_2(t)$

c) Consider the continuous time signal $x(t) = \begin{cases} 0; & t < 0 \\ 1.5; & 0 \le t \le 2 \\ -1; & t > 2 \end{cases}$. Find and sketch $y(t) = 3x(t)$. 2

2. a) How impulse signal, ramp signal and parabolic signal can be expressed using unit step signal? Express the signals shown in Fig. 2 in terms of unit step functions. 4

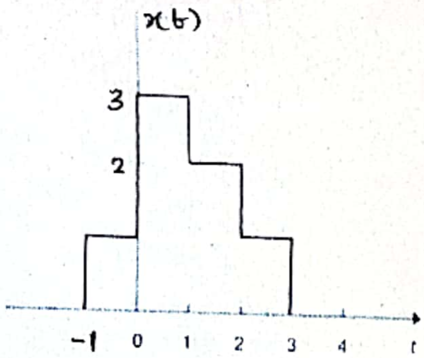
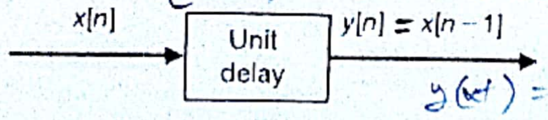


Fig. 2

b) The discrete-time system shown in Fig. 3 is known as the unit delay element. Determine whether the system is (i) memoryless, (ii) causal, (iii) linear, (iv) time-invariant, or (v) stable. 5

$y(t_1+t_2) = y(t_1) + y(t_2)$



$y(t) = T\,x(t)$

Fig. 3

c) Find the even and odd components of $x(t) = e^{jt}$. 3

3. a) Define LTI system. Write the properties of LTI system. 6

b) Derive the differential and difference equations of casual LTI systems 4

c) Prove that x[n] * h[n] = h[n] * x[n]. 2

4. a) Prove the following properties of Fourier Transform for continuous time signals: 6

i. Shifting in time and frequency

ii. Time and frequency differentiation

b) Determine C_n of periodic impulses shown fig. 2 3

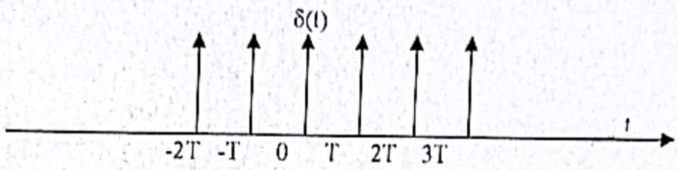


Fig. 2

c) Find Fourier Transform of signal, $sgn\,(t) = \begin{cases} 1; & t > 0 \\ -1; & t < 0 \end{cases}$ 3

5. a) Mention the properties of Laplace Transform. 3

b) Find Laplace transform of the following signals: 6

i. $f(t) = sin\omega_0 t.u(t)$

ii. $f(t) = e^{-3t}u(t) + e^{2t}u(t)$

c) Find the inverse Laplace transform of $X(s) = \frac{2s+4}{s^2+4s+3}$; $Re(s) > -1$ 3

6. a) Prove the differentiation property in time and in Z-domain. 3

b) Find $X(z)$ and its ROC for the following sequences: 9

i. $x[n] = \{5,3,\underset{\uparrow}{-2},0,4-3\}$

ii. $x[n] = a^n u[n]$ $\frac{z}{z-a}$

iii. $x[n] = na^{n-1}u[n]$ $\frac{z}{(z-a)^2}$

7. a) Explain the reconstruction of sampled signal. Why message reconstruction is not possible with practical low pass filter? 6

b) A message signal m(t)=cos$10\pi t$ + cos $30\pi t$ be sampled at 20 Hz and reconstruction using an ideal low-pass filter with cut off frequency 20Hz. Find the frequency or frequencies present in the reconstructed signal. 3

c) Find the Nyquist rate for a sampled signal $sa^2(4\pi t).sa^4(3\pi t)$. A band pass signal extends from 4-6kz. What is the smallest sampling frequency to retain the signal completed 3

cos = $\frac{s}{s^2+a^2}$

Institute of Information Technology
Jahangirnagar University
THIRD YEAR FIRST SEMESTER B.SC (HONS) FINAL EXAMINATION, 2018
[In Information Technology]

Course Code: IT 3105 | **Time: 3 Hours**

Course Title: Signals & Systems | **Full Marks: 60**

Answer any <u>5 (five)</u> of the following questions. Figures in the right margin indicate marks.

1. a) Show the representation of a system. Mention different types of system 4

   b) Write properties of Linear Time-Invariant systems. 3

   c) A system has the input-output relation given by $y[n] = T\{x[n]\} = nx[n]$. Determine whether the system is (a) memoryless, (b) causal, (c) linear, (d) time-invariant, or (e) stable. 5

2. a) Show that the complex exponential signal $x(t) = e^{j\omega_0 t}$ is periodic and that its fundamental period is $2\pi/\omega_0$. 4

   b) i. Find the even and odd components of signal $x(t)= \cos(t)+ \sin(t)+ \sin(t)\cos(t)$. 4

   ii. Consider a discrete-time signal, $x[n] = \begin{cases} 1, & -2 \le n \le 2 \\ 0, & |n| > 2 \end{cases}$, Find $y[n]= x[3n-2]$.

   c) *Sketch the waveform of the following signals:* 4

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

   ii. b) $x(t) = r(t + 1) - r(t) + r(t - 2)$

3. a) Find the Fourier coefficient C_n for signal $x(t)$ shown in fig. 1. 3

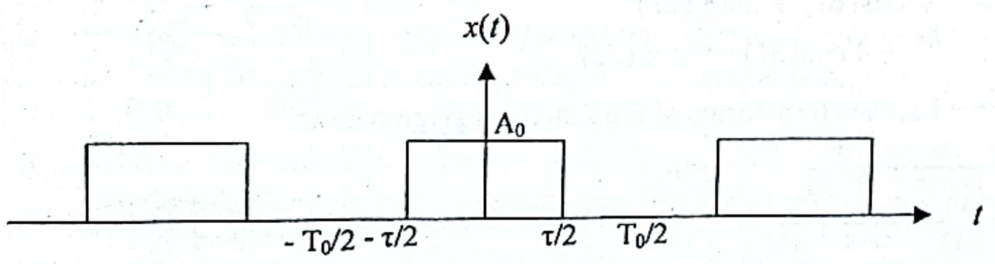


Fig. 1

   b) How Fourier series of any periodic signal can be derive using trigonometric representation? 6

   c) Derive the Parseval's power theorem. 3

4. a) Express the Fourier transform of a rectangular pulse. If $y(t)= x(t)\cos(t)$ and Fourier transfo[rm] of $y(t)$ is given as $Y(\omega)=\begin{cases}2; & |\omega|\le 2\\ 0; & \text{otherwise}\end{cases}$; Then find $x(t)$.

b) Write and derive the shifting properties of Fourier transform for both time and frequency domain. 4

c) Find the Fourier transform of the signal $x(2t-3)$. 2

5. a) Write the properties of Z-transform. 3

b) The Z-transform of a signal is given by $C[Z]=\dfrac{1z^{1}(1-z^{4})}{4(1-z^{-1})^{2}}$, Find its final value. 3

c) A finite sequence $x[n]$ is defined as $x[n]=\{5,3,\underset{\uparrow}{-2},0,4,-3\}$, Find X(z) and its ROC. 3

d) Determine the Z-transform and ROC of $x[n]=-u[-n+1]+\left(\frac{1}{2}\right)^{n}u[n]$. 3

6. a) What are the various representations of signal? Why is a signal converted from one representation to another? 3

b) *If x(t) is an integrable continuous-time signal, then write the equation of Fourier transform X(ω) of this signal. How x(t) can be constructed from X(ω) ?* 3

c) Briefly explain the following properties of Fourier transform: 4

- i) Time Scaling
- ii) Time Reversal

d) What is the significant of impulse response (IR) for LTI system? 2

7. a) Determine the Laplace transform of the following functions: 4

- i) $h(t) = e^{2t} + \cos(6t) + 3\sin(2t)$
- ii) $x(t) = 5e^{-4t} + 4\cos(3t) + 9\sin(3t)$

$9\cdot\frac{3}{s^2+3^2}$

b) Determine the inverse Laplace transforms of the functions given below: 4

$= \frac{27}{s^2+9}$

- i) $F(s) = \frac{6s}{s^2+25} + \frac{3}{s^2+25}$
- ii) $H(s) = \frac{19}{s+2} - \frac{1}{3s-5} + \frac{7}{s^5}$

$4\cdot\frac{s}{s^2+9}$

c) Show that the z-transform of $x[n] = \cos(an)$) is $X(z) = \frac{z(z-\cos(a))}{(z^2-2\cos(a)z+1)}$ (where a is a real number) 4

$= \frac{5}{s+4} + 4\frac{s}{s^2+9} + 9\cdot\frac{3}{s^2+3^2}$

$\frac{7\cdot 4!}{4!\, s^5}$

44

INSTITUTE OF INFORMATION TECHNOLOGY
JAHANGIRNAGAR UNIVERSITY
3rd Year 1st Semester B.Sc. (Hons.) Final Examination-**2017** (Session: 2014-15)
Subject: Information Technology
Course IT-3105 (Signal and System)
Time: 3 Hours Marks: 60

Answer any FIVE of the following questions. Numerals at the right margin indicate marks.

1. a) What is signal? Explain the classification of signals with examples. 5

   b) Find out whether the signal given by $x(n) = 5\cos(6\pi n)$ is periodic. 2

   1, 2, 3 ... $\pi =$

   c) Let $x_1(t)$ and $x_2(t)$ be periodic signals with fundamental periods T_1 and T_2 respectively. Under what conditions is the sum $x(t)=x_1(t)+x_2(t)$ periodic? 2

   d) For the systems represented by the function $T[x(n)] = ax(n)+6$, determine whether the system is (i) stable (ii) causal (iii) linear (iv) shift invariant. 3

2. a) Define causal system. What is the condition for (i) causality and (ii) stability for a given system? 4

   b) A system is given by $H(z)= (z3 + z)/(z+1)$. Check whether the system is causal or not. 2

   c) Suppose $r(t)$ is a ramp function, when will $r(t)=0$ and $r(t)=t$? For which condition, the unit step function produce a i) zero output ii) unit output? 2

   d) Define system with examples. Draw a block diagram that describes the interaction between a system and its associated signal. 4

   coefficient, trigonometric, Harmonic

3. a) What are the types of Fourier series? Write down the trigonometric form of the Fourier series representation of non-periodic signal. What are the various representations of signal? Why is a signal converted from one representation to another? 3

   b) If $x(t)$ is an integrable continuous-time signal, then write the equation of Fourier transform $X(\omega)$ of this signal. How $x(t)$ can be constructed from $X(\omega)$? 4

   c) Briefly explain the following properties of Fourier transform: 3

      i) Time Scaling

      ii) Time Reversal

   d) Determine whether the system $y(t) = x(t+10) + x^2(t)$ is static or dynamic, linear or non-linear, shift variant or invariant, causal or non-causal, stable or unstable. 2

4. a) Define Laplace transform and inverse Laplace transform. 2

   b) Find the trigonometric fourier series representation of a periodic signal x(t)=t, for the interval of t=-1 to t=1? 3

   c) Determine the inverse Laplace of the following function: $\dfrac{s^2+8s+6}{(s+2)(s^2+2s+1)}$ 4

   d) What do you mean by 'region of convergence' of Laplace transform? 3

ROC

$(s+2)(s+1)^2$

$$s^2+2s+1 = \frac{-b\pm\sqrt{b^2-4ac}}{2a} = \frac{-2\pm\sqrt{4-4}}{2\cdot 1} = \frac{-2}{2} = -1$$

3

5. a) Define z-transform. State the importance of z-transform on signals and systems? 4

b) Differentiate between-

   i) z-transform and Laplace transform

   ii) differential equation and difference equation

c) Using the power series expansion technique, find out the unilateral z-transform of the discrete-time signal $x[n]=a^n$ where a is a real number. 2

d) State some properties of a z-transform and Laplace transform. 3

6. a) What do you meant by aiasing? What are the effects of aliasing? How the aliasing process is eliminated? 3

b) Determine the z-transform of the signal $x(n) = (-1)^n 2^{-n} u(n)$ and plot the ROC for the sequence. 3

7. a) What do you mean by 'multiplexing' and 'de-multiplexing' techniques? Why are they used in communication system? 4

b) List various categories of multiplexing techniques. Give the conceptual illustrattion of frequency-division multiplexing and demultiplexing technique. 5

c) What are the merits and demerits of FDM over TDM? 3

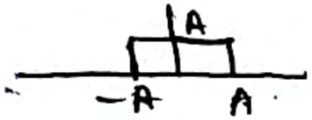
Scanned with CamScanner

IT 3105: Signals and Systems **CT02** **Time: 1 hour** **Full Marks: 20**

1. Draw the following signals: [4×3=12]

ram a. $x(t) = \begin{cases} t & t \geq 0 \\ 0 & t < 0 \end{cases}$

R b. $x(t) = A\, ract\left[\frac{r}{T}\right]$



c. $x(t) = e^{\alpha t};\ \alpha > 0$

d. $x[n] = \{0, \underset{\uparrow}{0}, 1, 2, 3, 4, \ldots\ldots\}$

2. How impulse signal, ramp signal and parabolic signal can be expressed using unit step signal? [3]
3. Express the signals shown in Fig. 1 in terms of unit step functions. [2]
4. The impulse response $h[n]$ and input signal $x[n]$ of a discrete-time LTI system given in fig. 2 . Find $y[n] = x[n]*\ h[n]$. [3]

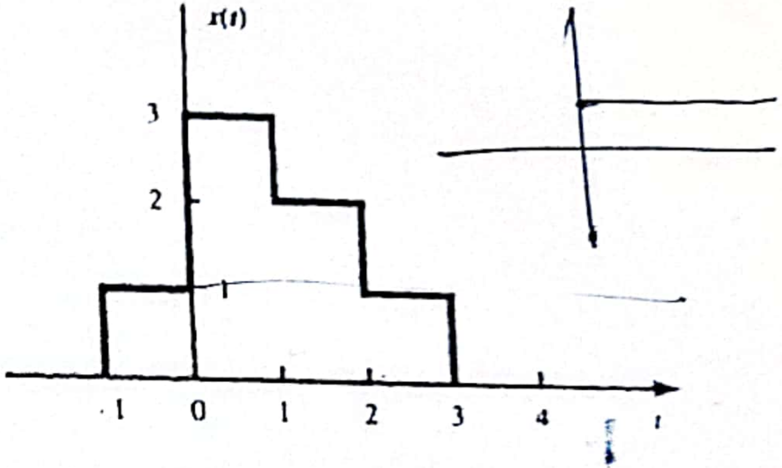


Fig. 1

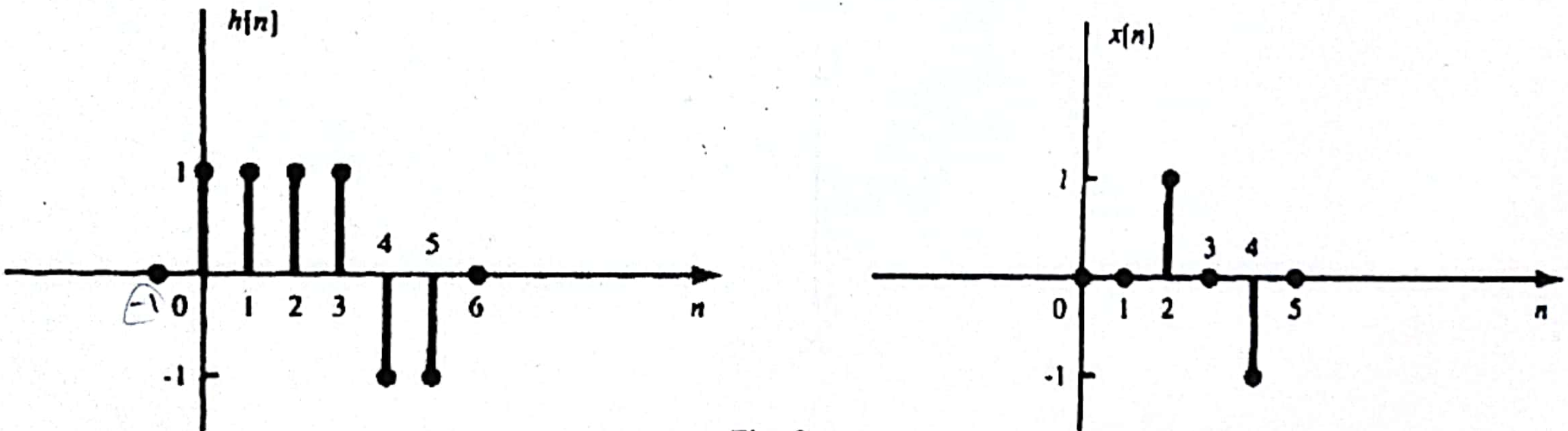


Fig. 2

IT 3105: Signals and Systems CT01(SET A) Time: 1 Hour Full Marks: 20

1. Consider the given continuous signal given in fig. 1. Sketch the following forms:
(a) $x(t-2)$; (b) $x(2t)$; (c) $x(t/2)$; (d) $x(-t)$

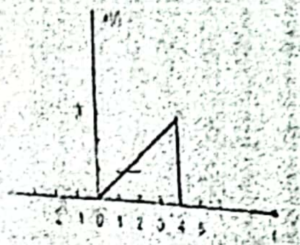


Fig. 1

2. Plot the discrete signal given as $x[n]=\{0,\ldots,0,-1,3,2,2,\underline{1},1,3,4,-2,-1,0,\ldots,0\}$.
Then also draw the mentioned form as (a) $x[n-2]$; (b) $x[2n]$; (c) $x[-n]$; (d) $x[-n+2]$

3. Using the discrete-time signals $x_1[n]$ and $x_2[n]$ shown in Fig. 2, represent each of the following signals by a graph and by a sequence of numbers
(a) $y_1[n] = x_1[n] + x_2[n]$; (b) $y_2[n] = 2x_1[n]$; (c) $y_3[n] = x_1[n] \times x_2[n]$

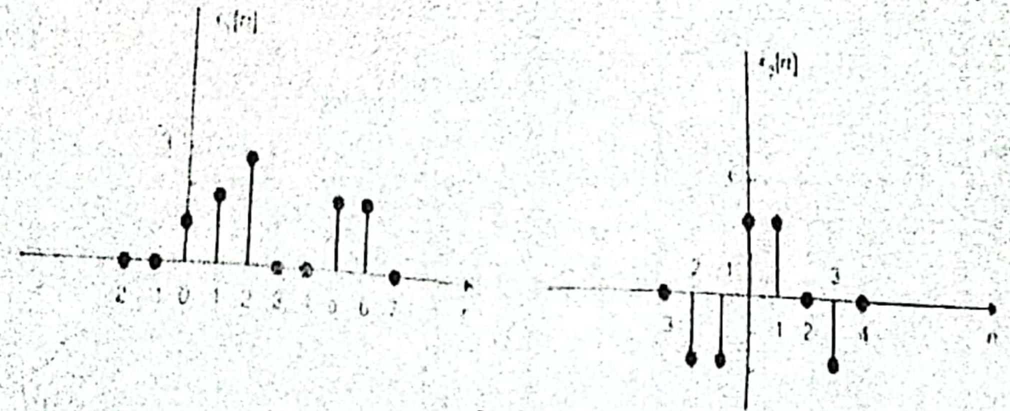


Fig. 2

4. Consider the continuous time signal $x(t) = \begin{cases} 0; t < 0 \\ 1.5; 0 \le t \le 2 \\ -1; t > 2 \end{cases}$. Sketch the signal.
Find and sketch $y_1(t) = 3x(t)$ and $y_2(t) = x(t) \cdot 2$

IT 3105: Signals and Systems CT02 Time: 1 hour Full Marks: 20

1. Draw the following signals: [4×3=12]

   a. $x(t) = \begin{cases} t & t \geq 0 \\ 0 & t < 0 \end{cases}$

   b. $x(t) = A\,rect\left[\frac{t}{T}\right]$

   c. $x(t) = e^{\alpha t};\ \alpha > 0$

   d. $x[n] = \{0, \underset{\uparrow}{0}, 1, 2, 3, 4, \ldots\ldots\}$

2. How impulse signal, ramp signal and parabolic signal can be expressed using unit step signal? [3]

3. Express the signals shown in Fig. 1 in terms of unit step functions. [2]

4. The impulse response $h[n]$ and input signal $x[n]$ of a discrete-time LTI system given in fig. 2. Find $y[n] = x[n] * h[n]$. [3]

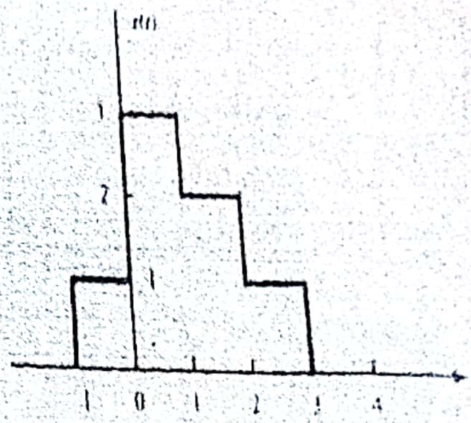


Fig. 1

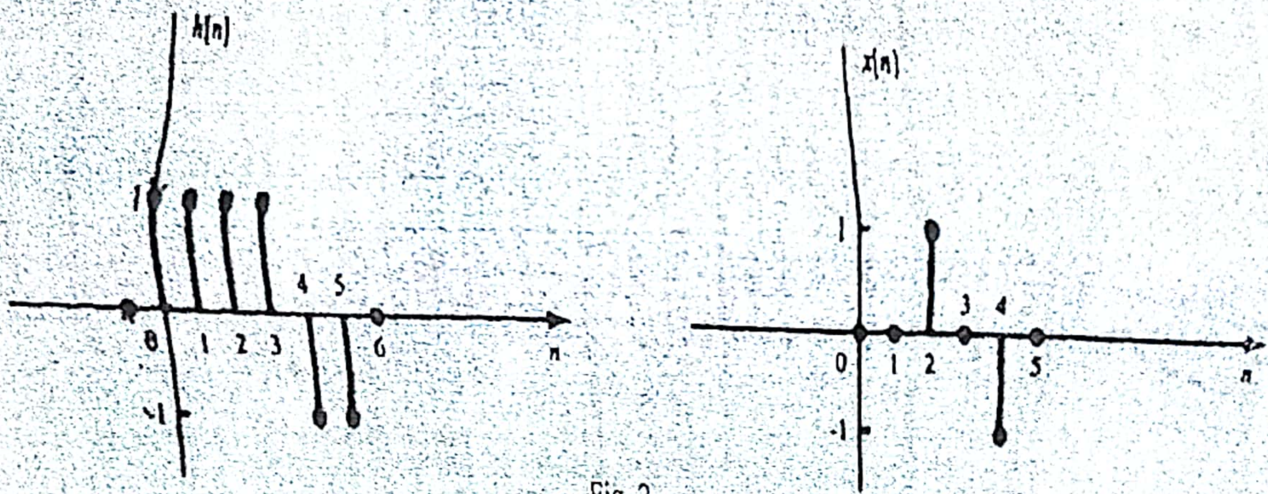


Fig. 2

IT 3105: Signals and Systems **CT03 (SET A)** Time: 1 hour Full Marks: 20

1. Prove the following properties of Fourier Transform for continuous time signals:
   a. Linearity
   b. Shifting in time and frequency
2. Drive the Perseval's theorem. Find the average power of the signal $x(t)$ where C_n is given in fig. 1.

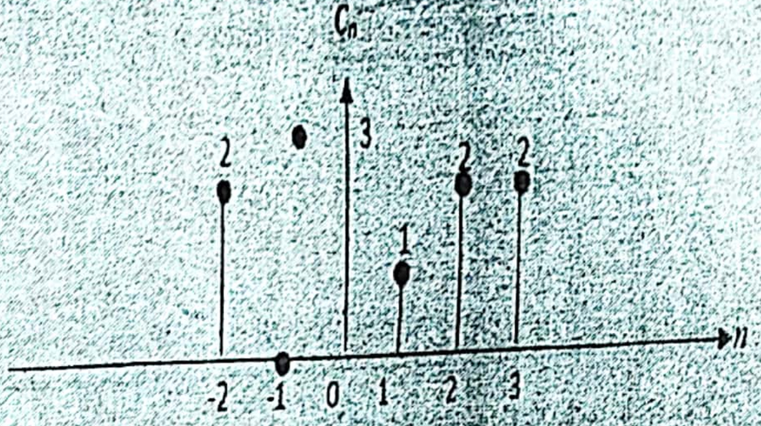


Fig. 1

3. Derive the expression of complex coefficient of Fourier series for the following signal given in fig. 2.

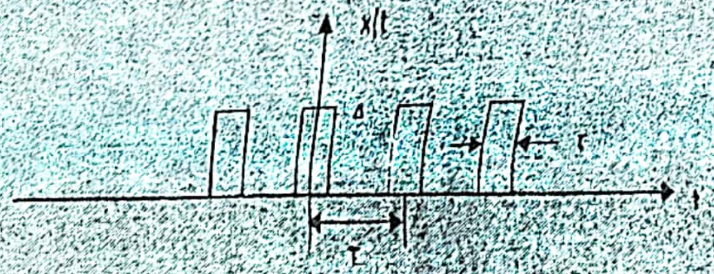


Fig. 2

4. Find the Fourier transform of the signal, $x(t) = e^{-a|t|}$, $a > 0$.

IT 3105: Signals and Systems CT03 (SET B) Time: 1 hour Full Marks: 20

1. Prove the following properties of Fourier Transform for continuous time signals:
   a. Time Scaling
   b. Time and frequency differentiation
2. Consider the periodic square wave x(t) shown in Fig. 1. Determine the trigonometric Fourier series of x(t).

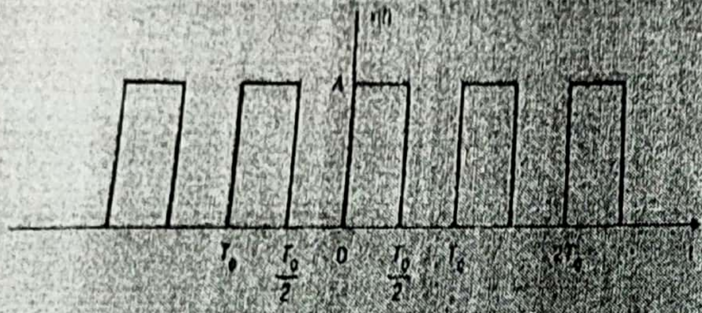


Fig. 1

3. Determine C_n of periodic impulses shown fig. 2

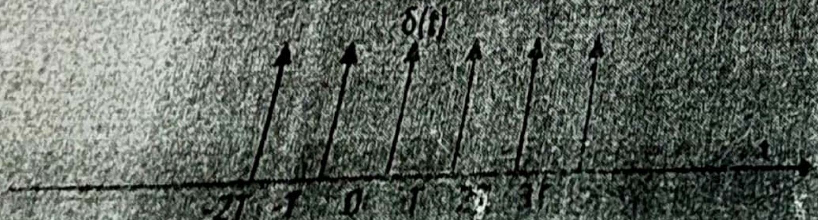


Fig. 3

4. Find Fourier Trans...

IT 3105: Signals and Systems CT01 (SET B)

Time: 1 Hour Full Marks: 20

1. A discrete-time signal $x[n]$ is shown in Fig. 1-19. Sketch and label each of the following signals.
(a) $x[n-2]$; (b) $x[2n]$; (c) $x[-n]$; (d) $x[-n+2]$
2. Consider the following signals x1(t) and x2(t) given in fig. 2. Find and sketch (a) $y1(t) = x1(t) - x2(t)$; (b) $y2(t) = x1(t) \times x2(t)$

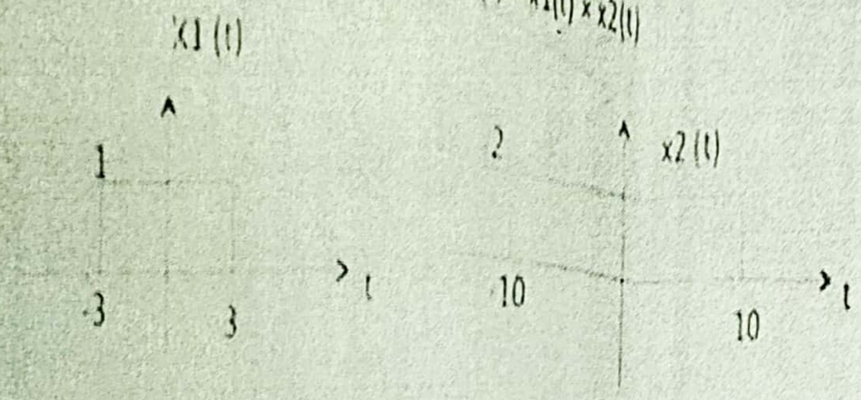


Fig. 2

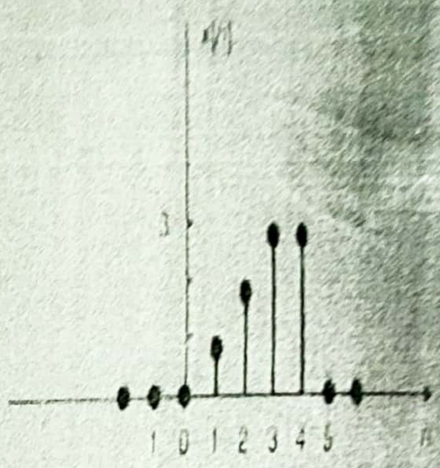


Fig. 1

3. Consider the continuous signal in fig. 3 and sketch the following forms:
(a) $x(t-2)$; (b) $x(2t)$; (c) $x(t/2)$; (d) $x(-t)$
4. Plot the discrete signal given as $x[n]=\{0,\ldots, 0, -1, 3, 2, 2, \underline{1}, 1, 3, 4, -2, -1, 0, \ldots 0\}$.
Then sketch the following signals (a) $y_1[n] = 3.x[n]$ (b) $y_2[n] = x[n] + 3$

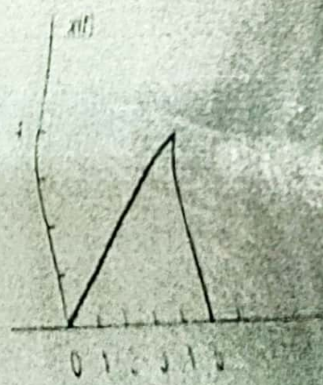


Fig. 3