**SIGNALS & SYSTEMS**
**(ECEN 2103)**

**Time Allotted : 3 hrs** **Full Marks : 70**

***Figures out of the right margin indicate full marks.***

***Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.***

***Candidates are required to give answer in their own words as far as practicable.***

## Group – A
## (Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) x(t)=a sin ωt is an
(a) odd signal (b) even signal
(c) both (a & (b) (d) either (a) or (b).

(ii) The period of the signal $x(t) = \sin 12\pi t$ is
(a) $\frac{1}{6}\ sec$ (b) $\frac{1}{7}\ sec$ (c) $\frac{4}{7}\ sec$ (d) $\frac{1}{5}\ sec$.

(iii) The system defined as $y(n) = 2x(n) + 3x(n^2)$ is
(a) static, causal (b) dynamic, causal
(c) static, non-causal (d) dynamic, non-causal.

(iv) Represent δ(n) by using unit-step function
(a) u(n)+u(n-1) (b) u(n)u(n-1)
(c) u(n)-u(n-1) (d) u(n-1)+u(n).

(v) The frequency spectrum of a periodic signal is
(a) continuous (b) discrete
(c) both continuous and discrete (d) none.

(vi) $y(n) = x(n+2)$ is for a
(a) linear system (b) dynamic system
(c) both linear and dynamic system (d) non-linear system.

(vii) Fourier series applies to
(a) only periodic signals (b) only aperiodic signals
(c) both periodic and aperiodic signals (d) only random signals.





(viii) Laplace transform of $e^{-at}$ is
(a) $\frac{1}{(S+a)}$ (b) $\frac{1}{(S-a)}$ (c) $\frac{a}{(S+a)}$ (d) $\frac{a}{(S-a)}$.

(ix) The Nyquist rate of a signal is
(a) $\frac{f_m}{2}$ (b) $2f_m$ (c) $f_m$ (d) $f_m \times f_m$.

(x) The Nyquist rate of $x(t) = 2sinc(100\Pi t)$
(a) 100Hz (b) 200Hz (c)300Hz (d) 50Hz.

## Group - B

2. (a) For the signal x(t) shown in the fig. 1, find the signals $2x(2t+2)$ and $x(\frac{1}{2}t-2)$.

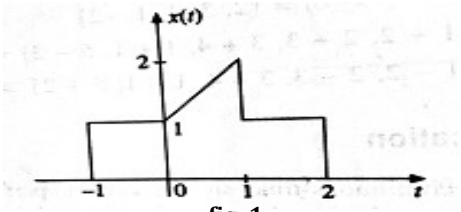


**fig. 1**

(b) (i) Sketch the following Signal, $r(t) - r(t-1) - r(t-3) + r(t-4)$.
(ii) Determine the power and rms value of the signal:

$$x(t) = 12\cos\left(20t + \frac{\Pi}{3}\right) + 16\sin\left(30t + \frac{\Pi}{2}\right)$$

**6 + ( 3 + 3) = 12**

3. (a) What is time invariant system? Determine whether the following signal is time invariant or not: y(t) = x(-t).

(b) "LTI system can be completely characterized by its impulse response"– explain. Sketch the signal $u(-t+2)$.

**(2 + 3) + (5 + 2) = 12**

## Group - C

4. (a) Write the properties of Convolutions.

(b) The convolution has the property that the area of the convolution integral is equal to the product of the two signals entering into the convolution. We define the area under a continuous time signal y(t) as

$$A_y = \int_{-\infty}^{\infty} y(t)dt$$

Show that if y(t)=x(t)*h(t), then $A_y = A_x A_h$

(c) Find the convolution of the two continuous time signal $x(t) = e^{-t^2}$ and $h(t) = 3t^2$ for all value of 't'.

**2 + 5 + 5 = 12**

5. (a) Find the Cosine Fourier Series for the waveform shown in the fig. 2 below:

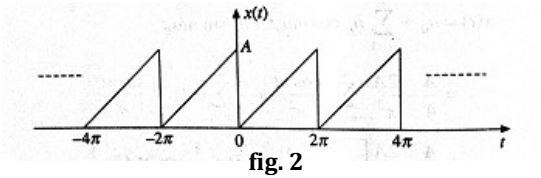


**fig. 2**

(b) Explain Dirichlet's conditions for existence of fourier series.

**8 + 4 = 12**

## Group – D

6. (a) (i) State the Sampling Theorem.

(ii) Determine the Nyquiest Rate and Nyquiest Interval for the given signal:
$x(t) = 1 + \cos 2000\Pi t + \sin 4000\Pi t$

(b) Let $h(n) = 0.8\delta(n) + 0.36(-0.8)^{n-1}u(n-1)$. Identify the filter type and establish whether the impulse response is a linear phase sequence.

**(3 + 4) + 5 = 12**

7. (a) The output of an LTI system in response to an input $x(t) = e^{-2t}u(t)$ is $y(t) = e^{-t}u(t)$. Find the frequency response and impulse response of this system.

(b) Find the Fourier transform of the rectangular pulse as shown in fig. 3

$$x[n] = u[n + N_1) - u(n - N_1 - 1) = \begin{cases} 1, & |n| \le N_1 \\ 0, & |n| > N_1 \end{cases}$$

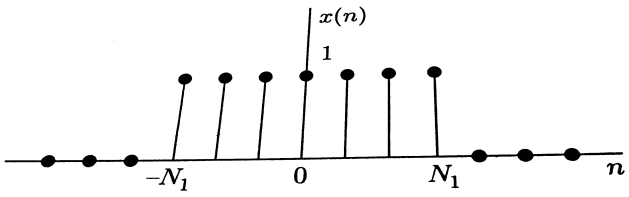


**fig. 3**

**5 + 7 = 12**





## Group – E

8. Write short note on ***(any three)***: **(3 × 4) = 12**

(i) Discrete time fourier series
(ii) Autocorrelation Function
(iii) Parseval's Theorem
(iv) Properties of Hilbert Transform
(v) Limitations of Laplace Transforms

9. (a) Determine the Hilbert transform of $g(t) = \sin(\omega_c t)$.

(b) Write short note on ***(any two)***:
(i) Sampling Theorem
(ii) Probability Density Function
(iii) Power Spectral Density and Energy Spectral Density
(iv) System with and without memory.

**4 + ( 4 + 4) = 12**