

SIGNALS AND 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) A system is expressed with the equation $y(n) = x(n + 2)$. The system is
(a) linear system (b) dynamic system
(c) both linear and dynamic system (d) non-linear system.
- (ii) A time invariant system is a system whose output
(a) increases with a delay in input
(b) decreases with a delay in input
(c) remains same with a delay in input
(d) vanishes with a delay in input.
- (iii) Unit Impulse $\delta(n) =$
(a) $u(n) + u(n-1)$ (b) $u(n)u(n-1)$
(c) $u(n) - u(n-1)$ (d) $u(n-1) + u(n)$.
- (iv) Fourier transform is applicable to
(a) Only periodic signals
(b) Only aperiodic signals
(c) Both periodic & aperiodic signals
(d) Only random signals.
- (v) The fundamental period of a sinusoidal signal is $T =$
(a) π/ω (b) $2\pi/\omega$
(c) $3\pi/\omega$ (d) $4\pi/\omega$.

- (vi) The frequency spectrum of an aperiodic signal will be
 (a) continuous (b) discrete
 (c) both continuous & discrete (d) none.
- (vii) The Laplace transform of $u(t)$ is
 (a) $1/s$ (b) s (c) $1/s^2$ (d) 1.
- (viii) Fourier series applies to
 (a) only periodic signals
 (b) only aperiodic signals
 (c) both periodic and aperiodic signals
 (d) only random signals.
- (ix) The ROC of the sum of two or more sequence will be equal to
 (a) intersection of those ROCs
 (b) Union of those ROCs
 (c) Sum of those ROCs
 (d) Product of those ROCs.
- (x) The Nyquist rate of $x(t) = 5\sin 200\pi t + 8\cos 500\pi t$
 (a) 200Hz (b) 500Hz
 (c) 700Hz (d) 300Hz.

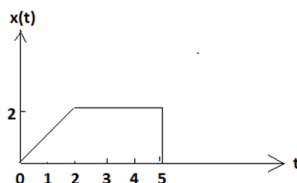
Group – B

2. (a) Prove that the power of the energy signal is zero over infinite time.
- (b) Find whether the signal $x(t)=u(t)$ is energy or power signal. Also find the energy of the signal.

$$x[n] = \begin{cases} \left(\frac{1}{2}\right)^n & \text{for } n \geq 0 \\ 0 & \text{for } n < 0 \end{cases}$$

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

3. (a) For the analog signal $x(t)$ shown in figure,



transform the signal as

- (i). $x(3t)$ (ii). $x(t/3)$ (iii). $3x(t)$ (iv). $x(-3t-3)$ (v). $x(3+t)$

Show all the steps of transformation of the signals.

- (b) Determine the linearity of $\frac{dy(t)}{dt} + y(t) = x(t)\frac{dx(t)}{dt}$
(2+2+2+2+2) + 2 = 12

Group – C

4. (a) Obtain the convolution of the following two functions using Graphical method.

$$x(t) = \begin{cases} 1, & -3 \leq t \leq 3 \\ 0, & \text{elsewhere} \end{cases}$$

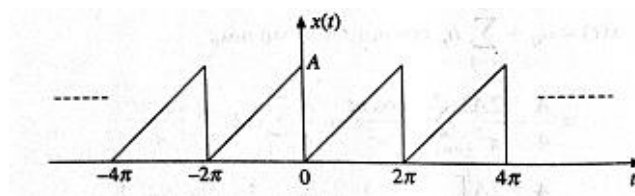
$$h(t) = \begin{cases} 2, & 0 \leq t \leq 3 \\ 0, & \text{elsewhere} \end{cases}$$

- (b) State the Parseval's power theorem and prove it.

$$8 + 4 = 12$$

5. (a) Using Laplace Transform, find the impulse response of an LTI system described by the differential equation $\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = x(t)$

- (b) Find the Cosine Fourier Series for the waveform shown in the figure below:



$$4 + 8 = 12$$

Group – D

6. (a) State the Sampling Theorem. Explain aliasing effect with proper waveforms and how can it be eliminated?

- (b) Determine the Nyquist Rate and Nyquist Interval for the given signal:
 $x(t) = 1 + \cos 2000\pi t + \sin 4000\pi t$

$$(2 + 4 + 2) + (2 + 2) = 12$$

7. (a) The signal $x(t)$ with Fourier transform $X(\omega) = u(\omega + \omega_0) - u(\omega - \omega_0)$ can undergo impulse sampling without aliasing provided that the sampling period $T < (\frac{\pi}{\omega_0})$. Justify.

- (b) Distinguish between Natural sampling and Flat top sampling.

$$6 + 6 = 12$$

Group – E

8. (a) A radio receiver with 10kHz bandwidth has a noise figure of 30dB. Determine the signal power required at the input of receiver to achieve input SNR of 30dB.
- (b) Explain the relation between Autocorrelation function and Energy Spectral Density function of a signal.

6 + 6 = 12

9. Write Short Note: (Any Three)
- (i) Autocorrelation Function
 - (ii) White Gaussian Noise
 - (iii) Region Of Convergence
 - (iv) Parseval's Theorem
 - (v) Causal and anti-causal system

4 + 4 + 4 = 12

Department & Section	Submission Link (for Backlog)
ECE	https://classroom.google.com/c/Mjc0MTY3MDAxNjIw?cjc=lodryl4