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

Time Allotted : 2<sup>1</sup>/<sub>2</sub> hrs

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

## Group – A

#### 1. Answer any twelve:

#### Choose the correct alternative for the following

(i)	The function sin(πu)/πu is denoted by (a) sinc(u) (c) signum		(b) sinc(πu) (d) none of these.			
(ii)	Fourier series applies to (a) only periodic signals (c) both periodic and aperiodic signals		(b) only aperiodic signals (d) only random signals.			
(iii)	The time derivative of unit step function i (a) unit impulse (c) ramp function			s a (b) step function (d) sine function.		
(iv)	Given x(n)= a <sup> n </sup> ,  a <1 is (a) an energy signal (c) neither energy nor a power signal		(b) a power signal (d) both energy and power signal.			
(v)	The convolution of a finite sequence with an infinite sequence(a) may be a finite or infinite sequence(b) infinite sequence(c) finite sequence(d) cannot be found					
(vi)	Fourier Transform (a) zero	m of a d.c signal w (b) 1	ith uni (c)	ty strength is $2\pi\delta(\omega)$	(d) $2\delta(\omega)$	
(vii)	What is the perio (a) $4\pi$	d of cos3t + sin14t (b) π	t? (c) 21	π	(d) 3π.	
(viii)	A bandpass signal extends from 1 to 2 KHz. The minimum sampling frequency needed to retain all information in the sampled signal is (a) 1 kHZ (b) 2 kHZ (c) 3 kHZ (d) 4 kHZ.					
(ix)	If the system is causal and stable, the system poles must lie(a) on the jw axis(b) on the left half of s-plane(c) on the right half of s-plane(d) both (a) and (c).					

 $12 \times 1 = 12$ 

Full Marks : 60

The region of convergence of a causal finite duration discrete time signal is (x) (a) the entire z-plane except z=0 (b) the entire z-plane except  $z=\infty$ (c) the entire z-plane (d) ring in z-plane.

#### Fill in the blanks with the correct word

- (xi) For any given signal, average power in its 6 harmonic components as 10 mW each and fundamental component also has 10 mV power. Then, average power in the periodic signal is \_\_\_\_\_.
- The z-transform of  $\delta(n-m)$  is \_\_\_\_\_. (xii)
- Given that X(s) is the Laplace transform of the signal cos 2t u (t). The signal (xiii) X(3s) corresponds is \_\_\_\_\_
- The Inverse Fourier transform of the signal  $e^{-2|\omega|}$  is \_\_\_\_\_ (xiv)
- u(t) \* u(t) is \_\_\_\_\_. (xv)

### **Group - B**

- 2. (a) Prove that (odd signal x odd signal=even signal). [(CO2)(Understand/LOCQ)]
  - $x(n) = \{-2, 1, 2, -1, 3\}$ . Calculate the even and odd part of the signal. [(CO2)(Apply/IOCQ)] (b)
  - State whether  $y(t)=x^{2}(t)+x(t-2)$  is causal or non-causal system. (c)

[(C01,C02)(Apply/IOCQ)] 4 + 5 + 3 = 12

3 + 6 + 3 = 12

- 3. (a) Determine whether the following system is linear or not.  $\frac{d^2y(t)}{dt^2} + 2ty(t) = t^2x(t) \,.$ [(CO3)(Analyse/IOCQ)]
  - (b) Evaluate the causality and stability of the following system. y(n) = x(n) - x(-n-1) + x(n-1).[(CO4)(Evaluate/HOCQ)] (c) [(CO4)(Evaluate/HOCQ)]
    - Draw the signal x(n)=u(n+4)-u(n-2).

#### Group - C

State the Dirichlet condition of Fourier series existence. 4. (a) [(CO3)(Remember/LOCQ)] Find the Fourier transform of following signal (b)  $x(t) = e^{-3t}$ [u(t+2)-u(t-3)].[(CO3)(Apply/IOCQ)] State the time convolution theorem and prove it. (c) [(CO4)(Understand/LOCQ)] 3 + 4 + 5 = 12

#### Consider the system described by the following equation 5. (a) $\frac{d^2 y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = \frac{dx(t)}{dt} + 6x(t)$

- Determine the zero-state response of this system for the input, x(t) = u(t). (i)
- (ii) Determine the zero-input response of this system for t>0- given that dy(0-)

$$y(0-)=1, \frac{dy(0-)}{dt}=2$$

(iii) Determine the total response of the system.
(b) Determine the Laplace transform of x(t)= δ(t+1)+ e<sup>-2(t+3)</sup>u(t+3).

## Group - D

6. (a) Let  $x[n]=\delta[n]+2\delta[n-1]-\delta[n-3]$  and  $h[n]=2\delta[n+1]+2\delta[n-1]$ . Evaluate y[n]=x[n]\*h[n] using graphical method. [(CO6)(Evaluate/HOCQ)] (b) Find the Discrete Time Fourier Transform of the following signal.

Find the Discrete Time Fourier Transform of the following signal.  $x(n) = \left(\frac{1}{2}\right)^{n-1} u(n-1)$ [(CO3)(Apply/IOCQ)] 8 + 4 = 12

7. (a) Determine the response of the LTI system in graphical method, whose input x[n] and impulse response h[n] are given by  $X[n] = \{1, 2, 3, 1\}$  and  $h[n] = \{1, 2, 1, -1\}$ . [(CO3)(Synthesis/HOCQ)]

(b) Find the Z-transform of the signal  $x(n) = n(\frac{1}{2})^{n+2} u(n+2)$ . [(CO2)(Apply/IOCQ)] 8 + 4= 12

# Group - E

8. (a) Given the signal  $x(t) = 10\cos(2000\pi)\cos(8000\pi)$ . What is the minimum sampling rate based on sampling theorem. [(CO2)(Apply/IOCQ)] (b) What is Aliasing? How can it be minimized? [(CO4)(Remember/LOCQ)]

(c) Briefly explain the flat top sampling with the help of proper waveform.

[(CO2)(Apply/IOCQ)]4 + (2 + 3) + 3 = 12

 $(3 \times 4) = 12$ 

- 9. Write short notes on any **three** of the following:
  - (i) Stationary and ergodic process
  - (ii) Region Of Convergence
  - (iii) White Gaussian Noise
  - (iv) Causal and anti-causal system
  - (v) Auto-correlation function
  - (vi) Stable and unstable system.

[(C02,C05)(Remember/LOCQ)]

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	30.2	35.42	34.38

#### Course Outcome (CO):

After the completion of the course students will be able to

- 1. Students should be able to apply the previous knowledge of mathematics on differential calculus.
- 2. Students should be able to categorize and identify the different types of signals and systems.

[(CO6)(Evaluate/HOCQ)]

[(CO3)(Apply/IOCQ)]8 + 4 = 12

- 3. Student should be able to analyze the frequency domain characteristics of signals using Fourier series, Fourier transforms, Laplace Transform, Z- Transform.
- 4. Students should be able to implement and extends the concepts of transformation tools to design of communication systems and filters.
- 5. Students should be able to analyze random signals and its properties, hence extending the concept towards in communications systems.
- 6. Students should be able to evaluate the response different systems with the applications of different mathematical tools.

\*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.