

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.

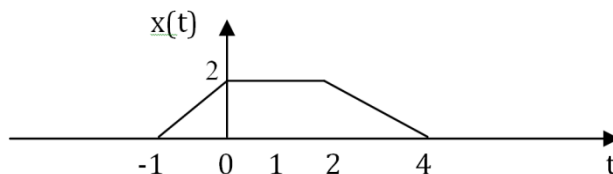
Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Which one of the following is not a ramp function?
(a) $r(t) = t$ when $t \geq 0$ (b) $r(t) = 0$ when $t < 0$
(c) $r(t) = \int u(t)dt$ when $t < 0$ (d) $r(t) = \frac{du(t)}{dt}$
- (ii) The relation between a signum function and a unit step function is, $\text{sgn}(t) =$
(a) $2u(t)-1$ (b) $u(t)-1$ (c) $2u(t)$ (d) $u(t)-u(-t)$
- (iii) $x(t) = e^{-5t}u(t)$ is a
(a) Power Signal (b) Energy Signal
(c) neither (a) or (b) (d) both (a) and (b)
- (iv) The Fourier Transform of $e^{-at}u(t)$ is
(a) $\frac{1}{j\omega}$ (b) $\frac{1}{a-j\omega}$ (c) $\frac{1}{a+j\omega}$ (d) $\frac{1}{a^2-\omega^2}$
- (v) Given that the impulse response of a system is $h(t)$. When the input is $x(t)$, the output $y(t)$ will be
(a) $h(t)x(t)$ (b) $h(t)\delta(t)$ (c) $h(t)*x(t)$ (d) $x(t)\delta(t)$
- (vi) Find the ROC of $x(t) = e^{-2t}u(t) + e^{-3t}u(t)$
(a) $\sigma > 2$ (b) $\sigma > 3$ (c) $\sigma > -3$ (d) $\sigma > -2$
- (vii) What is the Laplace transform of a delayed unit impulse function $\delta(t - 1)$?
(a) 1 (b) Zero (c) $\exp(-s)$ (d) s
- (viii) The convolution with impulse property states that _____
(a) $x(t)*\delta(t)=x(t)$ (b) $x(t)*\delta(t)=x(-t)$
(c) $x(t)*\delta(t)=x(2t)$ (d) $x(t)*\delta(t)=-x(-t)$
- (ix) The z-transform of $\delta[n-k]$ is _____
(a) $Z^k, Z > 0$ (b) $Z^{-k}, Z > 0$ (c) $Z^k, Z \neq 0$ (d) $Z^{-k}, Z \neq 0$

- (x) _____ is the measure of similarity between one signal and the time delayed version of other signal
- (a) Cross-correlation (b) Auto-correlation
(c) Auto or cross-correlation (d) None of the above

Group - B

2. (a) For the signal $x(t)$, find the signals (i) $x(t-2)$ (ii) $x(-2t+3)$ (iii) $x(t/2)$



[[CO2] (Apply/IOCQ)]

- (b) Evaluate the odd and even components of the following sequence

$$X(n) = \{1, 1, 0.5\}$$

↑

[[CO2] (Evaluate/HOCQ)]

- (c) Calculate the energy of the following signal $x(t) = \text{rect}\left(\frac{t}{T_0}\right)$.

[[CO2] (Evaluate /IOCQ)]

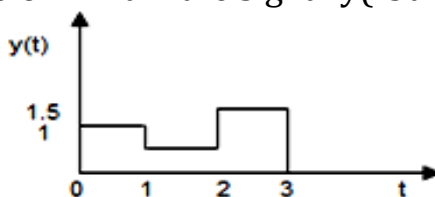
$$6 + 3 + 3 = 12$$

3. (a) $y(t) = t x(t)$
- (i) Check whether the system is linear or not
- (ii) Check whether the system is time invariant or not. [[CO2] (Apply/LOCQ)]
- (b) Check whether the following system is causal or not.

$$y[n] = x[n] + \frac{1}{x[n-1]}$$

[[CO2] (Apply/IOCQ)]

- (c) Given a signal $y(t)$ as below. Draw the signal $y(-3t+2)$

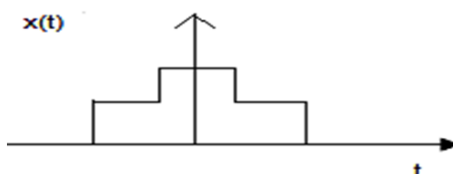


[[CO1](Analyse/IOCQ)]

$$5 + 3 + 4 = 12$$

Group - C

4. (a) Find the Fourier transform of the following signal $x(t)$.



[[CO3] (Apply/IOCQ)]

- (b) Show that an arbitrary signal $x(t)$ can be represented as a linear combination of the scaled and shifted unit impulse function. [(CO1) (understand/LOCQ)]
- (c) Estimate convolution of two signals $x(t)=e^{-3t}u(t)$ and $h(t)=u(t-3)-u(t-5)$ by graphical method. [(CO3) (Analyze/IOCQ)]

3 + 4 + 5 = 12

5. (a) Consider the system described by the following equation

$$\frac{d^2y(t)}{dt^2} + 3\frac{dy(t)}{dt} + 2y(t) = x(t)$$

- i) Obtain the transfer function of the system
 ii) Obtain the impulse response of the system
 iii) Determine the zero-input response of this system for $t > 0^-$ given that

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

- iv) Determine the total response of the system for impulse input.

[(CO6) (Evaluate/HOCQ)]

- (b) Determine the initial and final value of $x(t)$ if its Laplace transform is given by

$$X(s) = \frac{10(2s+3)}{s(s^2+2s+5)}$$

[(CO3) (Apply/IOCQ)]

8 + 4 = 12**Group - D**

6. (a) Obtain the DTFT of $x(n)=\left(\frac{1}{2}\right)^{n-1}u(n-1)$.
 [(CO3) (Apply/IOCQ)]

- (b) Find the convolution of the following two sequences by graphical method.

$$x[n] = \{1, \underset{\uparrow}{1}, 0, -2\}$$

$$h[n] = \{2, \underset{\uparrow}{1}, 5, -1, 0\}$$

[(CO3) (Evaluate/HOCQ)]

4 + 8 = 12

7. (a) Estimate the z-transform and ROC of the signal given by $x[n]=\{1,2,-1,2,3\}$.
 [(CO3)(Understand/LOCQ)]
- (b) A system is defined by the equation expressed as $y[n]=y[n-1]-0.5y[n-2]+x[n]+x[n-1]$. Interpret with the help of pole-zero plot whether the system is stable or not. [(CO6)(Apply/IOCQ)]
- (c) Estimate the step response of a system whose impulse response is described as $h(t)=u(t+1)-u(t-1)$. [(CO6)(Apply/IOCQ)]

4 + 5 + 3 = 12

Group - E

8. (a) Define sampling theorem. Illustrate with the help of diagram the aliasing effect. Outline the causes of aliasing effect. [(CO4) (Understand/LOCQ)]
 (b) A signal $x(t) = \text{sinc}(150\pi t)$ is sampled at a rate of (a) 100 Hz (b) 200 Hz (c) 300Hz. For each three cases, explain if it can be recovered from the sampled signal. [(CO4) (Analyze/IOCQ)]

6 + 6 = 12

9. (a) What do you mean by probability density function? Write down the properties of autocorrelation function. [(CO5) (Remember/LOCQ)]
 (b) A continuous random variable has the (b) probability density function

$$F(x) = 2(1 - x)^2 \quad 0 < x < 1$$

$$= 0 \text{ otherwise.}$$
 Find $E[6x + 3x^2]$. [(CO5) (Evaluate/HOCQ)]

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	21%	56%	23%

Course Outcome (CO):

After the completion of the course students will be able to

- Students should be able to apply the previous knowledge of mathematics on differential calculus.
- Students should be able to categorize and identify the different types of signals and systems.
- Student should be able to analyze the frequency domain characteristics of signals using Fourier series, Fourier transforms, Laplace Transform, Z- Transform.
- Students should be able to implement and extends the concepts of transformation tools to design of communication systems and filters.
- Students should be able to analyze random signals and its properties, hence extending the concept towards in communications systems.
- 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

Department & Section	Submission Link
ECE - A	https://classroom.google.com/w/NDE3NTQ2MzQ2MTI1/tc/NDYzNjY4MzM0NjE2
ECE - B	https://classroom.google.com/u/0/w/NDA1MTMyNTc2MTQ5/tc/NDY4MDA0NTc1NDc0
ECE - C	https://classroom.google.com/u/0/w/NDA1MzY1OTk4ODQy/tc/NDc0ODUyMzU1MzU0
BACKLOG	https://classroom.google.com/c/NDM2NjQ4Nzg1MTkx?cjc=rgkztjx