

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.

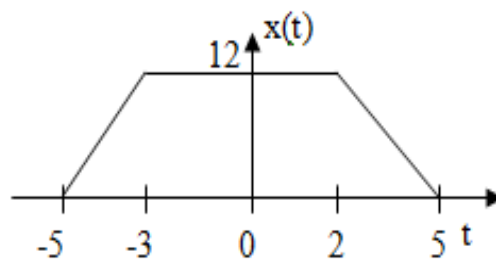
Group - A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Fourier series of an odd periodic function contains only
(a) Odd harmonics (b) even harmonics
(c) Cosine term (d) sine term.
- (ii) The area under the curve $\int_{-\infty}^{\infty} \delta(t) dt$ is
(a) infinity (b) unity (c) zero (d) undefined.
- (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) Given the energy of a signal $x(t)$ is said to be E , then what is the energy of the signal $x(at)$
(a) E (b) E/a (c) aE (d) infinity.
- (v) The z-transform of $\delta(n-m)$ is
(a) z^{-m} (b) z^{m-n} (c) z^{n-m} (d) z^{m-n} .
- (vi) The time period of a function $x[n] = e^{jwn}$ is
(a) $\Pi/2w$ (b) Π/w (c) $2\Pi/w$ (d) $4\Pi/w$.

- (vii) What is the frequency shifting property of continuous time Fourier series?
 (a) Multiplication in the time domain by a real sinusoid
 (b) Multiplication in the time domain by a complex sinusoid
 (c) Multiplication in the time domain by a sinusoid
 (d) Addition in the time domain by a complex sinusoid.
- (viii) A system is stable if ROC
 (a) includes the unit circle
 (b) excludes the unit circle
 (c) lies on circle
 (d) entire plane .
- (ix) Find the Nyquist rate and Nyquist interval of $\text{sinc}[t]$.
 (a) 1 Hz, 1 sec (b) 2 Hz, 2 sec
 (c) 0.5 Hz, 2 sec (d) 2 Hz, 1sec.
- (x) The type of systems which are capable of taking any value in a particular set of values are called as
 (a) analog (b) discrete
 (c) digital (d) continuous

Group - B

2. (a) The trapezoidal pulse $x(t)$ is applied to a differentiator defined by $y(t) = \frac{dx(t)}{dt}$ as shown below



- (i) Sketch the output $y(t)$ of the differentiator and state whether it is an energy or a power signal.
 (ii) Determine the total energy or power of the signal.
- (b) Use graphical method to solve the convolution of $x_1(n) = \{1, -1, 2, 3\}$ and $x_2(n) = \{1, -2, 3, -1\}$.

$(3 + 2) + 7 = 12$

3. (a) Impulse response of a LTI system is $h(t) = e^{-t} \cos 2t u(t)$, Check whether the system is stable or not?
- (b) What do you mean by causal and non-causal system? Check whether the following system is causal or not.

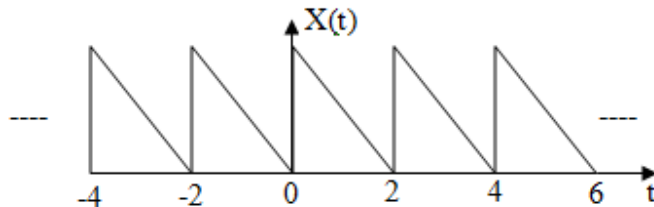
$$y(n) = x(n^2)$$
- (c) Find the relation between step, ramp and delta function.

$$3 + (2 + 3) + 4 = 12$$

Group - C

4. (a) The unit step response of an LTI system is $s(t) = 2e^{-t} u(t)$. Determine its system function and impulse response.
- (b) Explain the dirichlet condition for Fourier Transform.
- (c) Consider an LTI system whose input $x(t)$ and output $y(t)$ are related by the differential equation $\frac{dy(t)}{dt} + 4y(t) = x(t)$. Find $y(t)$ if the input is $x(t) = e^{-3t}$ and the initial conditions are given by $y(0^+) = 3 ; \frac{dy(0^+)}{dx} = 0$

$$4 + 2 + 6 = 12$$
5. (a) Find the Fourier series for the wave form shown below



- (b) For a system with transfer function $H(s) = \frac{s+2}{s^2+4s+3}$ find the zero state response if the input $x(t) = \{ \exp(-t) \} u(t)$

$$6 + 6 = 12$$

Group - D

6. (a) Given the impulse response of a system $h(n) = \left(\frac{1}{2}\right)^n u(n)$. Using convolution theorem determine the response of the system to the input $x(n) = \left(\frac{3}{4}\right)^n u(n)$.
- (b) State what is the ROC of the z-transform of a Right sided causal signal. Prove your statement.

$$6 + 6 = 12$$

7. (a) Find the z-transform and ROC and location of poles and zeros in the z-plane.

(b) $x(n) = (3)^n u(n) - 4 \cdot (2)^{n-1} u(n-1)$

Find the inverse Z transform using Residue method.

$$\frac{4z^{-1}}{(1-2z^{-1})(1-5z^{-1})} \quad \text{ROC: } 2 < |Z| < 5$$

6 + 6 = 12

Group - E

8. (a) (i) State sampling theorem. What is aliasing effect?
 (ii) Find the Nyquist rate and the Nyquist interval for the signal $x(t) = \cos(4000\pi t) \cdot \cos(1000\pi t)$

(b) A low pass filter is described by the equation $y[n] = 0.9y(n-1) + 0.1x(n)$

(i) What is the impulse response of the filter?

(ii) Differentiate between Natural sampling and Flat-top sampling.

(2 + 2 + 3) + 3 + 2 = 12

9. (a) A 600Ω resistor is connected across the 600Ω antenna input of a radio receiver. The bandwidth of the radio receiver is 20 kHz and the resistor is at room temperature of 27°C. Calculate the noise power and the noise voltage applied at the input of the receiver.

(b) A continuous random variable has the probability density function defined by $f(x) = \frac{2}{9(x-1)} \cdot 1 < x < 4 = 0$ otherwise

Determine the probability distribution function, the mean and variance of the random variable.

6 + 6 = 12

Department & Section	Submission Link
ECE A	https://classroom.google.com/u/0/w/MTlyODI0MTk2OTI3/tc/MjcyNzUwOTAzMzYz
ECE B	https://classroom.google.com/w/MTlyMjl1OTQzMzg4/tc/MjcyNzUwMjM1MTYz
ECE C	https://classroom.google.com/c/MTlyNDIwNDQ4OTk3/a/Mjg2Mjc2ODQyNzU3/details

Department & Section	Submission Link (Backlog)
ECE	https://classroom.google.com/c/MjkxNDI0ODExMzg3?cjc=nwmfwac