(viii) "The Fourier transform of a function exists" - implies that

(a) $\int_{-T}^{T} f(t)dt$ exists

(b) $\int_{-T/2}^{T/2} |f(t)|dt$ exists

(c) $\int_{-\infty}^{\infty} f(t)dt$ exists

(d) $\int_{-\infty}^{\infty} |F(\omega)|d\omega$ exists

(ix) The impulse response of a system is h(t). When the input is δ(t) the output y(t) will be
(a) y(t)
(b) δ(t)
(c) h(t)
(d) none of the above.

(x) The transfer function of a system is $H(s) = \dfrac{1}{s^2(s+2)^2}$. The impulse response of the system is

(a) $t^2 u(t) * e^{-2t}u(t)$

(b) $tu(t) * te^{-2t}u(t)$

(c) $(te^{-2t})^2 u(t)$

(d) $te^{-2t}u(t) * te^{-2t}u(t)$.

Group - B

2. (a) The trapezoidal pulse $x(t)$ is applied to a differentiator defined by $y(t) = \dfrac{dx(t)}{dt}$ as shown below
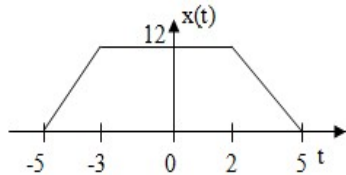
i) Sketch the output $y(t)$ of the differentiator and state whether it is an energy or a power signal.
ii) Determine the total energy or power of the signal.

(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) Sketch the signal $r(-2t + 3)$.

(b) Check for the periodicity of the signal $x(t) = 4\cos(5\pi t)$.

(c) Check whether the following system having an impulse res h(t) = $e^{-2t}u(t-1)$ is stable or not.

4 + 4 + 4

Group - C

4. (a) State sampling theorem. Explain what happens if sampling th is violated. Explain reconstruction filter.

(b) A continuous time signal x(t) is obtained at the output of an LPF with a cut-off frequency w_c = 1000π. If instantaneous san is performed on x(t), what is the sampling interval that wil recover x(t) from its sampled version?

(2 + 2 + 3) + !

5. (a) Distinguish between analog and digital filter.

(b) Given a filter with finite impulse response h(n) = {1, 4, 2, 3, 1, 2, Find the transfer function H(z) for the filter.

(c) What is meant by Nyquist rate? Determine the Nyquist rate f signals
(i) x(t) = 2sinc (100πt)   (ii) x(t) = 1 + cos 2000πt + sin 4000πt.

4 + 3 + !

Group – D

6. (a) Find the trigonometric Fourier series coefficients for a tr impulses $\delta_T(t)$ shown in figure below.
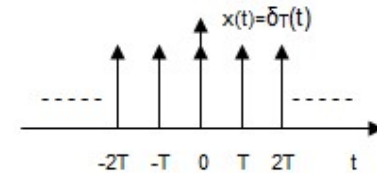
(b) Find the Fourier transform of signum function.

(c) State and prove Duality property of Fourier Transform. Henc the Fourier transform of $\dfrac{j}{\pi t}$.

3 + 4 + !

7. (a) Find the convolution of the following signals using graphical method
$x(t) = e^{-3t}u(t)$, $h(t) = u(t+3)$.

(b) Determine X(s), H(s) and hence verify the output of convolution obtained using time convolution theorem.

6 + 6 = 12

Group - E

8. (a) Consider a first-order stable system with system function $H(z) = K\dfrac{1+az^{-1}}{1+bz^{-1}}$. Find out for what values of K, a, b, does this system act as an all-pass filter, that is, $|H(e^{j\omega})| = 1$.

(b) A low pass filter is described by the equation
$y[n] = 0.9y(n-1) + 0.1x(n)$
   i) By performing a frequency translation of Π/2, transform the filter into a bandpass filter.
   ii) What is the impulse response of the bandpass filter?

6 + (3 + 3) = 12

9. Write short notes on any **four** of the following: **4 × 3 = 12**
   i) Correlation.
   ii) Region of Convergence.
   iii) BIBO Stability.
   iv) Dirichlet's Condition.
   v) Static and Dynamic System
   vi) Compare Fourier and Laplace Transform.

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 <u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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) The Fourier transform of a conjugate symmetric function is
   (a) imaginary   (b) real
   (c) conjugate symmetric   (d) conjugate asymmetric.

   (ii) The signal $\alpha^n u[n]$ is an energy signal if
   (a) $|\alpha| < 1$ (b) $|\alpha| > 1$ (c) $|\alpha| = 1$ (d) $|\alpha| = 0$.

   (iii) A system is stable if ROC
   (a) includes the unit circle   (b) excludes the unit circle
   (c) lies on circle   (d) entire plane.

   (iv) The Laplace Transform of a unit step is
   (a) 1   (b) 1/s   (c) s   (d)$1/s^2$.

   (v) The type of systems which are capable of taking any value in a particular set of values are called
   (a) analog   (b) discrete
   (c) digital   (d) continuous.

   (vi) A system whose output depend on future inputs is a
   (a) static system   (b) dynamic system
   (c) non-causal system   (d) both (b) and (c).

   (vii) The harmonics of the Fourier series of an even signal consists of
   (a) sine terms only   (b) cosine terms only
   (c) both sine and cosine terms   (d) neither sine and cosine terms.