

SIGNALS AND SYSTEMS
(ECE2103)

Time Allotted : 2½ hrs

Full Marks : 60

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:

12 × 1 = 12

Choose the correct alternative for the following

- (i) If a signal $f(t)$ has energy E , the energy of the signal $f(0.5t)$ is equal to
(a) $2E$ (b) $E/4$ (c) $E/2$ (d) E
- (ii) 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)
- (iii) Fourier Transform of a d.c signal with unity strength is
(a) zero (b) 1 (c) $2\pi\delta(\omega)$ (d) $2\delta(\omega)$
- (iv) If $f(t)=e^{at}$, its Laplace Transform (for $s>a$) is given by
(a) $(s-a)+(a/s^2)$ (b) $\frac{\sqrt{\pi}}{2(s-a)}$
(c) $\frac{1}{(s-a)}$ (d) does not exist
- (v) Two systems with impulse responses $h_1(t)$ and $h_2(t)$ are connected in cascade. Then the overall impulse response of the cascaded system is given by
(a) product of $h_1(t)$ and $h_2(t)$ (b) sum of $h_1(t)$ and $h_2(t)$
(c) convolution of $h_1(t)$ and $h_2(t)$ (d) subtraction of $h_1(t)$ and $h_2(t)$
- (vi) The R.O.C of z-transform for the discrete signal $x(n)=2(3^n)u(-n)$ (non-causal signal) is
(a) R.O.C: Outside the unit circle of z-plane
(b) R.O.C: $|z| > 3$
(c) R.O.C: Complete z-complex plane
(d) R.O.C: $|z| < 3$
- (vii) 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).

- (viii) What is the Nyquist rate of the following signal? $X(t) = 3\cos(50\pi t) + 10\sin(300\pi t) - \cos(100\pi t)$?
 (a) 50 Hz (b) 100 Hz
 (c) 200 Hz (d) 300 Hz.
- (ix) The autocorrelation function of white noise is
 (a) a delta function (b) a constant
 (c) gaussian (d) $\exp(-|T|)$ with usual notation
- (x) 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

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 _____.
- (xii) In force-current analogy, mass is analogous to _____.
- (xiii) $u(t) * u(t)$ is _____.
- (xiv) The period of $\cos 3t + \sin 14t$ is _____.
- (xv) The energy of the signal $e^{-3t}u(t)$ is _____.

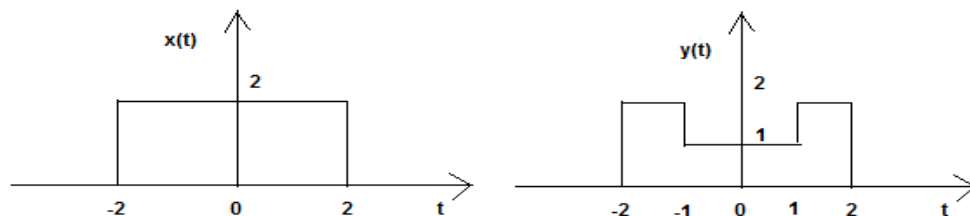
Group - B

2. (a) Examine whether the following signals are periodic or not? If periodic determine the fundamental Period:

(i) $5 \sin 10\pi t + 2 \cos 20\pi t$ (ii) $x(n) = 1 + e^{\frac{j4\pi n}{7}} - e^{\frac{j2\pi n}{5}}$ [[CO2](Analyse/IOCQ)]

- (b) Find the odd and even components of the signal $x(n) = \{-3, 1, 2, -4, 2\}$. [[CO2](Understand/LOCQ)]

- (c) Given below two signals $x(t)$ and $y(t)$. Draw (i) $x(t) + 2y(t)$ (ii) $x(t) - y(t)$.



[[CO1](Understand/LOCQ)]

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

3. (a) Check the stability of the system defined by

$$y(n) = x(n) + \frac{1}{2}x(n-1) + \frac{1}{4}x(n-2)$$
 [[CO2](Evaluate/HOCQ)]
- (b) Show that the following system is linear - time- invariant system:

$$y(t) = \begin{cases} x(t) + x(t-2) & \text{for } t \geq 0 \\ 0 & \text{for } t < 0 \end{cases}$$
 [[CO2](Analyse/IOCQ)]

- (c) Determine whether the following system is causal or non-causal:

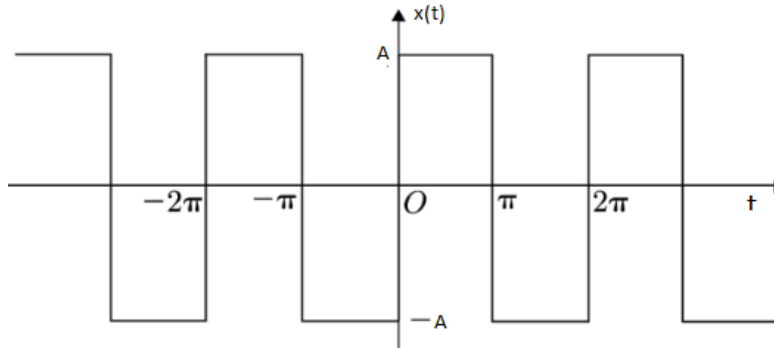
$$y(t) = at^2x(t) + btx(t-4)$$

[[CO2](Analyse/IOCQ)]

$$3 + 5 + 4 = 12$$

Group - C

4. (a) Find the trigonometric Fourier Series for the following periodic function.



[[CO3](Evaluate/HOCQ)]

- (b) Using Laplace Transform, find the impulse response of an LTI system described

by the differential equation $\frac{d^2y(t)}{dt^2} - \frac{dy(t)}{dt} - 2y(t) = x(t)$

[[CO3](Remember/LOCQ)]

- (c) Compute the Inverse Fourier transform of $X(\omega) = \frac{j\omega}{(a+j\omega)^2}$.

[[CO3](Apply/IOCQ)]

$$6 + 3 + 3 = 12$$

5. (a) Determine the Laplace transforms of following sinusoidal functions:

$$x(t) = A \sin \omega_0 t u(t)$$

[[CO3](Evaluate/HOCQ)]

- (b) Using Property of Fourier transform find the convolution of the signals

$$x_1(t) = e^{-at}u(t) \text{ and } x_2(t) = e^{-bt}u(t)$$

[[CO3](Apply/IOCQ)]

- (c) Suppose $\cos 2t \cdot u(t) \xrightarrow{\mathcal{L}} X(s)$, determine $Y(s) = \frac{d}{ds} [e^{-3s} X(s)]$.

[[CO3](Apply/IOCQ)]

$$4 + 4 + 4 = 12$$

Group - D

6. (a) Determine the discrete time convolution of $x(n) = \{1, \underset{\uparrow}{1}, 1, 1\}$ and $h(n) = \{2, 2, \underset{\uparrow}{2}, 2\}$.

[[CO3](Apply/IOCQ)]

- (b) Find the Fourier transform of (i) $\delta(t-5)$ (ii) $\cos 2t u(t)$.

[[CO3](Apply/IOCQ)]

$$6 + 6 = 12$$

7. (a) Determine the transfer function and impulse response for the causal LTI system described by the difference equation

$$y(n) - \frac{1}{2}y(n-1) = x(n) + 2x(n-1)$$

[[CO6](Evaluate/HOCQ)]

- (b) For the following system function, check whether the corresponding LTI system is causal or non-causal

$$H(z) = \frac{3-4z^{-1}}{1.5z^{-2}-3.5z^{-1}+1} \quad |z| > 3$$

[[CO6](Analyse/IOCQ)]

$$6 + 6 = 12$$

Group - E

8. (a) Explain the aliasing error in sampling process. How can it be minimized?
[[CO4](Understand/LOCQ)]
- (b) State sampling theorem. Find the Nyquist rate and the Nyquist interval for the signal
 $x(t) = \cos(4000\pi t) \cdot \cos(1000\pi t)$
[[CO4](Apply/LOCQ)]
(3 + 3) + (2 + 4) = 12
9. (a) Outline the various sources of noise that can affect a communication circuit.
[[CO4](Understand/LOCQ)]
- (b) What do you mean by time average, ensemble average of a random process?
[[CO5](Remember/LOCQ)]
- (c) A continuous random variable has the probability density function defined by

$$f(x) = \frac{2}{9(x-1)} \quad 1 < x < 4$$

$$= 0 \text{ otherwise}$$
Determine the probability distribution function, the mean and variance of the random variable.
[[CO5](Apply/IOCQ)]
3 + 3 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	30.21	50	19.79