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**

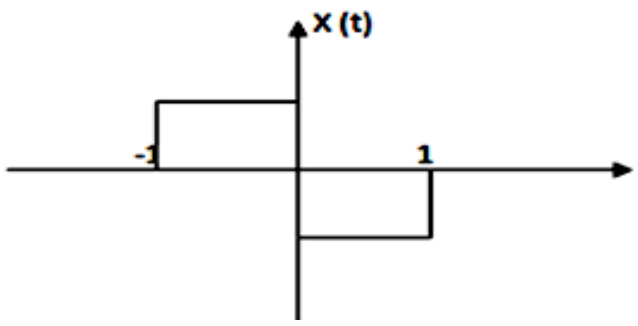
(i) The area under the curve $\int_{-\infty}^{\infty} \delta(t)dt$ is

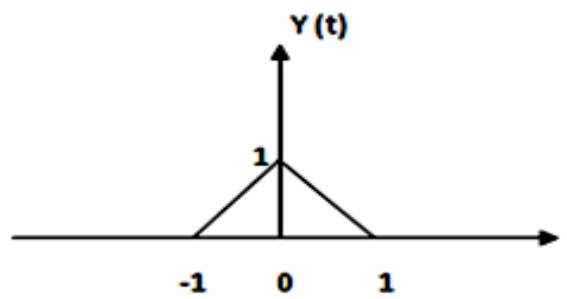
(a) infinity (b) unity (c) zero (d) undefined.

(ii) The period of the signal $x(t) = sin12\pi t$ is

(a) $\frac{1}{6}\ sec$ (b) $\frac{1}{7}\ sec$ (c) $\frac{4}{7}\ sec$ (d) $\frac{1}{5}\ sec$

(iii) The given pair x(t) and y(t) is related by





(a) Y (t) = d/dt (x(t)) (b) Y (t) = x (t) + 1
(c) Y (t) = ∫x (t) dt (d) Y (t)= x(t)+ ramp (t)

(iv) Region Of Convergence of a causal LTI system

(a) is entire s-plane (b) is right half of s-plane
(c) is left half of s-plane (d) does not exist.

(v) Fourier Transform of a d.c signal with unity strength is

(a) zero (b) 1 (c) $2\pi\delta(\omega)$ (d) $2\delta(\omega)$

(vi) Fourier transform of continuous time aperiodic signal is

(a) continuous and aperiodic (b) discrete and aperiodic
(c) continuous and periodic (d) discrete and periodic.

(vii) A baseband signal has a spectral range that extends from 20 Hz to 82 kHz. The acceptable range of sampling frequency (fs) will be

(a) 40 Hz<fs<82 kHz (b) fs<40 Hz, fs>82 kHz
(c) fs≥164 kHz (d) fs≤164 kHz.

(viii) $y(n) = x(n+2)$ is for a

(a) linear system (b) dynamic system

(c) both linear and dynamic system (d) non-linear system.

(ix) Discrete time signal is derived from continuous time signal by _____ process.

(a) Addition (b) Multiplying

(c) Sampling (d) Addition and multiplication

(x) The condition for orthogonality of two functions $x_1(t)$ and $x_2(t)$ in terms of correlation is

(a) $R_{12}(\tau) = \infty$ (b) $R_{12}(\tau) = 0$ (c) $R_{12}(\tau) = 1$ (d) $R_{12}(\tau) = finite$

Group- B

2. (a) Sketch the signal x(t)=r(t)-r(t-2) and verify whether it is an energy or power signal. [(CO1)(Apply/IOCQ)]

(b) Evaluate the step response of the system defined by the impulse response, $h(t) = e^{-3t}u(t) - e^{-2t}u(t)$. [(CO2)(Evaluate/HOCQ)]

(3 + 4) + 5 = 12

3. (a) Determine the linearity of the system $\frac{d^2y}{dt^2} + 2ty(t) = t^2x(t)$. [(CO2)(Remember/LOCQ)]

(b) Justify that the energy of the power signal is infinite over infinite time. [(CO2)(Evaluate/HOCQ)]

(c) Evaluate the power and rms value of the following signal $x(t) = e^{j2t}cos10t$. [(CO2)(Evaluate/HOCQ)]

4 + 4 + 4 = 12

Group - C

4. (a) Using frequency shifting property calculate the Fourier transform of $x(t) = \cos(\omega_o t)u(t)$. [(CO3)(Analyse/IOCQ)]

(b) Compute the output of an LTI system if x[n]= [1,1,2,1] and h[n]=[2,3,1,2] . [(CO4)(Analyse/IOCQ)]

(c) What are the properties of ROC associated to the Laplace transform. [(CO4)(Understand/LOCQ)]

4 + 6 + 2 = 12

5. (a) Solve and obtain the convolution in graphical method of the following two functions.

$$x(t) = \begin{cases} 1 \; for -3 \le t \le 3 \\ 0 \qquad elsewhere \end{cases}.$$ [(CO3)(Analyze/IOCQ)]

(b) Given signal is $\delta(t+2) + \delta(t+1) + \delta(t-1) + \delta(t-2)$. Using Fourier Transform, convert the signal in to frequency domain. [(CO3)(Understand/LOCQ)]

7 + 5 = 12

Group - D

6. (a) Given $x(n)= (2/3)^n u(n)+(-1/2)^n u(n)$
Compute (i) Z-transform of x(n)
(ii) ROC
(iii) pole-zero location of X(z). [(CO5)(Apply/IOCQ)]

(b) Sketch the sequence $x(n)= \sum_{k=-\infty}^{\infty} \delta(n-3k)$ and find its discrete Fourier series.

[(CO5)(Apply/IOCQ)]
6 + 6 = 12

7. (a) Write and explain the Z-transform and ROC and poles and zeros of x(z) for the sequence $x[n] = 3(\frac{5}{7})^n u(n) + 2\left(-\frac{1}{3}\right)^n u(n)$. [(CO3)(Synthesis/HOCQ)]

(b) Evaluate the impulse response and step response of the causal system given below and explain on stability

$$y(n) - y(n-1) - 2y(n-2) = x(n-1) + 2x(n-2)$$

[(CO6)(Evaluation/HOCQ)]
6 + 6 = 12

Group - E

8. (a) Evaluate the Nyquist rate for a continuous-time signal
$x(t)= 6\cos 50\pi t + 20\sin 300\pi t - 10\cos 100\pi t$. [(CO4)(Evaluate/HOCQ)]

(b) Explain aliasing with proper waveforms and how can it be eliminated?
[(CO4)(Understand/LOCQ)]

(c) Distinguish between Natural sampling and Flat top sampling.
[(CO4)(Analyse/IOCQ)]
4 + 4 + 4 = 12

9. (a) A random variable has a probability distribution function given by

$$F(x) = 0 \qquad -\infty < x \leq 0$$
$$= 1 - e^{-2x} \qquad 0 \leq x < \infty$$

Find (i) the probability that $x > 0.6$
(ii) the probability that $0.4 < x \leq 0.8$. [(CO5)(Remember/LOCQ)]

(b) State the properties of probability distribution function. [(CO5)(Understand/LOCQ)]

(c) Briefly explain White Noise and draw the power spectral density of White Noise.
[(CO5)(Analyse/IOCQ)]
(3 + 3) + 3 + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	29.17	40.63	30.20

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.
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