B. Tech.

(SEM. IV) EXAMINATION, 2006-07

SIGNAL & SYSTEM

Time : 3 Hours] [Total Marks : 100

Note : (1) Attempt all questions.
(2) All questions carry equal marks.

1. Attempt any four parts of the following : 5×4

(a) Classify signals according to signal characteristics.

(b) A continuous time linear system s with input x(t) and output y(t) yields the following input – output pairs :

\[ x(t) = e^{j2t} \rightarrow y(t) = e^{j3t} \]
\[ x(t) = e^{j2t} \rightarrow y(t) = e^{j3t} \]

(i) if \( x_1(t) = \cos(2t) \) determine the corresponding output \( y_1(t) \) for system s.

(ii) if \( x_2(t) = \cos \left(2 \left(t - \frac{1}{2}\right)\right) \) determine the corresponding output \( y_2(t) \) for system s.

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(c) A discrete time signal is shown in fig.

![Fig. 1](image)

Sketch and label carefully each of the following signal (i) x (2t+1) (ii) x (4-t/2).

(d) Explain the properties of LTI system and find the convolution between of signals.

\[ x[n] = a^n u[n] \]

\[ h[n] = u[n] \]

(e) Consider a causal LTI system with x[n] as input and output y[n] are related by difference equation.

\[ Y[n] = \frac{1}{4} y[n-1] + x[n] \]

Determine y[n] if x[n] = \( \delta \) [\( n-1 \)]

(f) What are Dirichlet’s conditions.

2. Attempt any four parts of the following : 5×4

(a) Obtain the Fourier series component of the periodic square wave signals

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(b) Determine the Fourier transform of the Gate function

(c) Find the Laplace transform of the triangular pulse.

(d) Determine the magnitude spectrum of the pulse signal.

Fig. 2

Fig. 3

Fig. 4

Fig. 5
(e) Find the Fourier transform of the signal $f(t)$ shown in figure-6.

\[ x(t) \]

\[ A \]

\[ T \]

\[ 2T \]

Fig. 6

(f) Find the convolution of the signal given below using Fourier transform

\[ x_1(n) = \left( \frac{1}{2} \right)^n u(n), \quad x_2(n) = \left( \frac{1}{3} \right)^n u(n) \]

3 Attempt any two of the following: 10x2

(a) Determine the frequency response and magnitude response of the system given by

\[ y[n] + \frac{1}{2} y[n-1] = x[n] - x[n-1] \]

(b) (i) Consider a causal LTI system with frequency response

\[ H(jw) = \frac{1}{jw+2} \] for a particular input $x(t)$

this system in observed to produce the output

\[ y(t) = e^{-2t} u(t) - e^{-3t} u(t) \]

Determine $x(t)$
(ii) Find the inverse Laplace transform of
\[ X(S) = \frac{2}{(S+4)(S-1)} \] for all possible signal convergence.

(c) (i) Use the convolution theorem of Laplace transform to find \( y(t) = x_1(t) * x_2(t) \) if \( x_1(t) = e^{-3t}u(t) \) and \( x_2(t) = u(t-2) \)

(ii) For a system \( H(S) = \frac{S+2}{S^2+5S+4} \) find the impulse response for the system function.

4 Attempt any two of the following: 10 × 2

(a) (i) Find the Nyquist frequency and Nyquist rate for each of the following signals:

(i) \( x(t) = 1 + \cos(200\pi t) + \sin(400\pi t) \)

(ii) \( x(t) = \frac{\sin(4000\pi t)}{\pi t} \)

(ii) Impulse train sampling of \( r[n] \) is used to obtain:

\[ g[n] = \sum_{K=-\infty}^{\infty} x(n) \delta[n - KN] \]

if \( x(e^{jw}) = 0 \) for \( 3\pi/7 \leq |w| \leq \pi \)

Determine the largest value for the sampling internal \( N \) which ensures that no aliasing takes place while sampling \( x[n] \).
(b) (i) Find the inverse laplace transform of

\[ G(s) = \frac{10s^2 e^{-s}}{(s+1)(s+3)} \]

(ii) Solve the differential equation

\[ \frac{d^2}{dt^2} x(t) + \frac{7}{dt} x(t) + 12 x(t) = 0 \]

for times \( t > 0 \) subject to the initial condition

\( x(0^-) = 2 \) and

\( \frac{d}{dt} x(t) t = 0^- = -4 \)

(c) Explain the following terms in brief with properties:

(i) LTI system

(ii) ROC in Z transform

(iii) Stability condition for LTI system.

5 Attempt any two of the following: 10x2

(a) Realize the system given as

\[ y(n) - \frac{5}{6} y(n-1) + \frac{1}{6} y(n-2) = x(n) + 2x(n-1) \]

using Z Transform with minimum no. of delay unit, assume initial condition is zero.

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(b) The input and output of a causal LTI system are related by the differential equation.

\[
\frac{d^2 y(t)}{dt^2} + \frac{6}{dt} y(t) + 8y(t) = 2x(t)
\]

What is the response of this system if \(x(t) = te^{-2t}u(t)\); assume initial condition is zero and use Fourier transform method.

(c) (i) Discuss various properties of ideal frequency selective filters in time-domain.

(ii) A causal LTI filter has the frequency response \(H(jw)\) shown in figure-7

\[
H(jw) \quad 2J
\]

\[
-2j \quad w
\]

**Fig. 7**

Determine the filtered output signal \(y(t)\) if \(x(t) = e^{jt}\)