Code No: R059210403 **Set No. 1**

II B.Tech I Semester Supplimentary Examinations, February 2008
SIGNALS AND SYSTEMS
(Common to Electronics & Communication Engineering, Electronics & Instrumentation Engineering, Bio-Medical Engineering, Electronics & Control Engineering and Electronics & Telematics)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Define orthogonal signal space and bring out clearly its application in representing a signal.
   (b) Obtain the condition under which two signals f1(t) & f2 (t) are said to be orthogonal to each other. Hence, prove that Sin nω_0t and Cos mω_0t are orthogonal to each other for all integer values of m,n. [6+10]

2. (a) Explain about even and odd functions.
   (b) Obtain the trigonometric fourier series for the periodic waveform as shown in figure 2 [6+10]

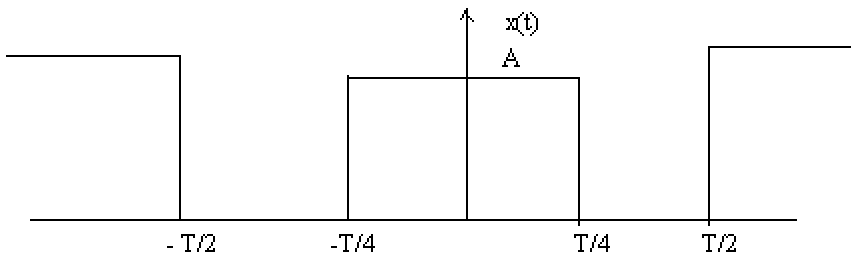

Figure 2

3. (a) Distinguish between Fourier series and Fourier transform.
   (b) State the conditions for the existence of Fourier transform of a signal.
   (c) Find the Fourier transform of the signum function and plot it's amplitude and phase spectra. [4+4+8]

4. (a) There are several possible ways of estimating an essential bandwidth of non-band limited signal. For a low pass signal, for example, the essential bandwidth may be chosen as a frequency where the amplitude spectrum of the signal decays to k percent of its peak value. The choice of k depends on the nature of application. Choosing k= 5 determine the essential bandwidth of g(t)=exp(-at) u(t).
   (b) Differentiate between signal bandwidth and system bandwidth. [12+4]

5. (a) The signal $v(t) = \cos\omega_0 t + 2\sin 3\omega_0 t + 0.5\sin 4\omega_0 t$ is filtered by an RC low pass filter with 3 dB frequency f_C=2f_O
      i. Find G_i(f)
      ii. Find G_0(f)

(b) Let G(f) denote the Fourier transform of real valued energy signal g(t), and R_g (τ) its autocorrelation function, show that [8+8]
$\int\limits_{-\infty}^{\infty} \left[\frac{dR_g(\tau)}{d\tau}\right]^2 d\tau = 4\pi^2 \int\limits_{-\infty}^{\infty} f^2 \left|G(f)\right|^4 df.$

6. (a) Explain briefly impulse sampling.

   (b) Define sampling theorem for time limited signal and find the nyquist rate for the following signals. [8+8]

   i. rect300t

   ii. -10 sin 40πt cos 300πt.

7. (a) The system function of a causal LTI system is $H(s) = \frac{s+1}{s^2+2s+2}$. Determine the response y(t) when the input is x(t) = e$^{-|t|}$

   (b) State and prove initial value and final value theorems. [8+8]

8. (a) Using the Power Series expansion technique, find the inverse Z-transform of the following X(Z):

   i. $X(Z) = \frac{Z}{2Z^2-3Z+1}$ $|Z| < \frac{1}{2}$

   ii. $X(Z) = \frac{Z}{2Z^2-3Z+1}$ $|Z| > 1$

   (b) Find the inverse Z-transform of [8+8]
   $X(Z) = \frac{Z}{Z(Z-1)(Z-2)^2}$ $|Z| > 2$

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Set No. 2

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1. (a) A rectangular function defined as

$$f(t) = \begin{cases} A & 0 < t < \frac{\Pi}{2} \\ -A & \frac{\Pi}{2} < t < \frac{3\Pi}{2} \\ A & \frac{3\Pi}{2} < t < 2\Pi \end{cases}$$

Approximate the above function by A cost between the intervals $(0,2\pi)$ such that the mean square error is minimum. [8]

(b) Prove the following [4+4]

i. $\delta(n) = u(n) - u(n-1)$

ii. $u(n) = \sum_{k=\alpha}^{n} \delta(K)$

2. (a) Prove that Sinc(o)=1 and plot Sinc function.

(b) Determine the Fourier series representation of that Signal x(t) = 3 Cos(Πt/2 + Π/4) using the method of inspection. [6+10]

3. (a) Explain how Fourier Transform can be derived from Fourier Series.

(b) Find the Fourier Transform of the signal x(t) = $\frac{2}{1+t^2}$ [8+8]

4. (a) Find the impulse response of the system shown figure 4a. Find the transfer function. What would be its frequency response? Sketch the response.

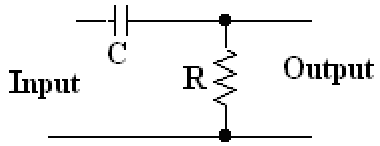

Figure 4a

(b) Differentiate between signal bandwidth and system bandwidth. [12+4]

5. (a) State and Prove Properties of cross correlation function.

(b) If V(f) = AT sin 2π fT/2π fT find the energy contained in V(t). [8+8]

6. (a) Determine the Nyquist rate corresponding to each of the following signals.

i. x(t) = 1 + cos 2000 pt + sin 4000 πt

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

(b) The signal. Y(t) is generated by convolving a band limited signal x_1(t) with another band limited signal x_2(t) that is
y(t) = x_1(t) * x_2(t)
where
$x_1(j\omega) = 0 \ \ for \ \ |\omega| > 1000\Pi$
$x_2(j\omega) = 0 \ \ for \ \ |\omega| > 2000\Pi$
Impulse train sampling is performed on y(t) to obtain
$y_p(t) = \sum_{n=-\infty}^{\infty} y(nT)\delta(t - nT)$
Specify the range of values for sampling period T which ensures that y(t) is recoverable from y_p(t). [8+8]

7. (a) State the properties of the ROC of L.T.
   (b) Determine the function of time x(t) for each of the following laplace transforms and their associated regions of convergence. [8+8]
      i. $\frac{(s+1)^2}{s^2-s+1}$ $\quad$ $\mathrm{Re}\{S\} > 1/2$
      ii. $\frac{s^2-s+1}{(s+1)^2}$ $\quad$ $\mathrm{Re}\{S\} > -1$

8. (a) Find the Z-transform of the following Sequences.
      i. x[n] = a^{-n} u[-n-1]
      ii. x[n] = u[-n]
      iii. x[n] = - a^n u[-n-1]
   (b) Derive relationship between z and Laplace Transform. [8+8]

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Code No: R059210403 **Set No. 3**

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1. (a) Sketch the single sided and double sided spectra of the following signal x(t)=2Sin(10πt - π/6)
   (b) Show that the functions Sin nω_0t and Sin mω_0t are orthogonal over any interval (to , to + $2\pi/\omega_0$) for integer values of n and m. [8+8]
2. (a) Derive polar Fourier series from the exponential Fourier series representation and hence prove that $D_n = 2\,|C_n|$
   (b) Show that the magnitude spectrum of every periodic function is Symmetrical about the vertical axis passing through the origin. [8+8]
3. (a) Obtain the Fourier Transform of the following:
      i. x(t) = A Sin ($2\pi f_c$t) u(t)
      ii. x(t) = f(t) Cos ($2\pi f_c$t +ϕ)
   (b) State and prove the following properties of Fourier Transform [8+8]
      i. Multiplication in time domain
      ii. Convolution in time domain.
4. (a) Explain the difference between the following systems.
      i. Linear and Non-linear systems.
      ii. Causal and Non-Causal systems.
   (b) Consider a stable LTI system characterized by the differential equation $\frac{dy(t)}{dt} + 2\,y\,(t) = x\,(t)$. Find its impulse response. [8+8]
5. (a) Explain briefly detection of periodic signals in the presence of noise by correlation.
   (b) Explain briefly extraction of a signal from noise by filtering. [8+8]
6. Determine the Nyquist sampling rate and Nyquist sampling interval for the signals [4×4]
   (a) $\sin c(100\Pi t)$.
   (b) $\sin \tau(100\Pi t)$.
   (c) $\sin c(100\Pi t) + \sin c(50\Pi t)$.

(d) $\sin c(100\Pi t) + 3\sin c^2(60\Pi t)$.

7. (a) State the properties of the ROC of L.T.

   (b) Determine the function of time x(t) for each of the following laplace transforms and their associated regions of convergence. [8+8]

   i. $\frac{(s+1)^2}{s^2-s+1}$ $\quad$ $\text{Re}\{S\} > 1/2$

   ii. $\frac{s^2-s+1}{(s+1)^2}$ $\quad$ $\text{Re}\{S\} > -1$

8. (a) Find the Z-transform of the following Sequences.

   i. x[n] = a^{-n} u[-n-1]

   ii. x[n] = u[-n]

   iii. x[n] = - a^n u[-n-1]

   (b) Derive relationship between z and Laplace Transform. [8+8]

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Code No: R059210403

Set No. 4

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Answer any FIVE Questions

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   (b) Obtain the condition under which two signals f1(t) & f2 (t) are said to be orthogonal to each other. Hence, prove that Sin nω_0t and Cos mω_0t are orthogonal to each other for all integer values of m,n. [6+10]
2. (a) Derive polar Fourier series from the exponential Fourier series representation and hence prove that $D_n = 2\,|C_n|$
   (b) Show that the magnitude spectrum of every periodic function is Symmetrical about the vertical axis passing through the origin. [8+8]
3. (a) Obtain the Fourier transform of the following functions:
      i. Impulse function δ(t)
      ii. DC Signal
      iii. Unit step function.
   (b) State and prove frequency-shifting property of Fourier Transform. [12+4]
4. (a) What is a LTI System? Explain its properties. Derive an expression for the transfer function of a LTI system.
   (b) Obtain the conditions for the distortion less transmission through a system. What do you understand by the term signal bandwidth? [8+8]
5. (a) For the signal g(t) = 2a/(t^2+a^2),determine the essential Band width B Hz of g(t) such that the energy contained in the spectral components of g(t) of frequencies below B Hz is 99% of signal energy E_g.
   (b) Show that the auto correlation function of g(t)=C cos (ω_0t+ θ_0) is given by $R_g(\tau)$=(c^2/2) cos ω_0 τ ,and the corresponding PSD is
   $S_g\,(\omega) = (c^2\pi/2)\,[\delta\,(\omega - \omega_0) + \delta\,(\omega + \omega_o)\,.$ [8+8]
6. (a) Explain Flat top sampling.
   (b) A Band pass signal with a spectrum shown in figure 6b is ideally sampled. Sketch the spectrum of the sampled signal when f_s = 20,30 and 40 Hz. Indicate if and how the signal can be recovered. [8+8]

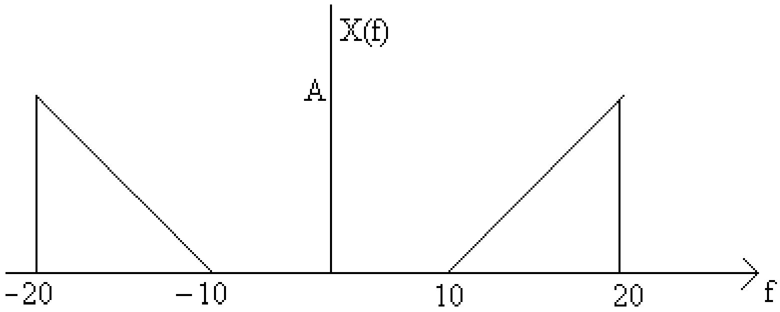

Figure 6b

7. Consider the following signals, find laplace transform and region of convergence for each signal
   (a) $e^{-2t}u(t) + e^{-3t}u(t)$
   (b) $e^{-4t}u(t) + e^{-5t}\sin 5t\ \ u(t)$
   (c) State properties of laplace transform. [6+6+4]

8. (a) Using the Power Series expansion technique, find the inverse Z-transform of the following X(Z):
      i. $X(Z) = \frac{Z}{2Z^2-3Z+1}$ $\quad |Z| < \frac{1}{2}$
      ii. $X(Z) = \frac{Z}{2Z^2-3Z+1}$ $\quad |Z| > 1$
   (b) Find the inverse Z-transform of [8+8]
   $X(Z) = \frac{Z}{Z(Z-1)(Z-2)^2}$ $\quad |Z| > 2$

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