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

II B.Tech I Semester Supplementary Examinations, February 2007
SIGNALS & 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 and sketch the following elementary signals
   i. Unit impulse signal
   ii. Unit Step signal
   iii. Signum function

   (b) Explain the Analogy of vectors and signals in terms of orthogonality and evaluation of constant. [6+10]

2. Prove the following properties.

   (a) The FS symmetry properties for
   i. Real valued time signals
   ii. Real and even time signals. [5+5]

   (b) Obtain the Fourier series representation of an impulse train given by [6]
   $x(t) = \sum_{n=-\alpha}^{\alpha} \delta(t - nT_0)$

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 time differentiation property of Fourier Transform. [12+4]

4. (a) Explain the difference between the following systems.
   i. Time invariant and time invariant systems.
   ii. Causal and non-causal systems.

   (b) Consider a stable LTI system characterized by the differential equation $\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 3y(t) = \frac{dx(t)}{dt} + 2x(t)$. Find its impulse response and transfer function. [8+8]

5. (a) Find the energies of the signals shown in figures 1, 2.

   (b) Determine the power of the following signals. [8+8]

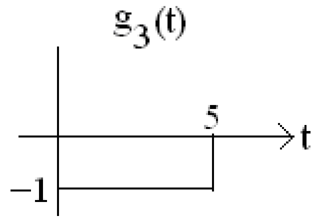

Figure 1:

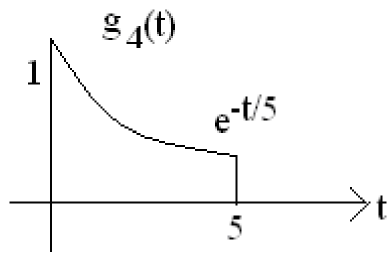

Figure 2:

i. (10+2 sin 3t) Cos 10 t
ii. 10 Cos 5t cos 10t.

6. (a) Consider the signal $x(t) = \left(\frac{\sin 50\Pi t}{\Pi t}\right)^2$ which to be sampled with a sampling frequency of $\omega_s = 150\Pi$ to obtain a signal g(t) with Fourier transform G(jω). Determine the maximum value of ω_0 for which it is guaranteed that $G(j\omega) = 75 \times (j\omega)\ for\ |\omega| \leq \omega_0$ where $X(j\omega)$ is the Fourier transform of x(t).
   (b) The signal $x(t) = u(t + T_0) - u(t - T_0)$ can undergo impulse train sampling without aliasing, provided that the sampling period T< $2T_0$. Justify.
   (c) The signal x(t) with Fourier transform $X(j\omega) = u(\omega + \omega_0) - u(\omega - \omega_0)$ can undergo impulse train sampling without aliasing, provided that the sampling period $T < \pi/\omega_0$. Justify. [6+5+5]

7. (a) When a function f(t) is said to be laplace transformable.
   (b) What do you mean by region of convergence.
   (c) List the advantages of Laplace transform.
   (d) If δ(t) is a unit impulse function find the laplace transform of $\frac{d^2}{dt^2}[\delta(t)]$. [4+4+4+4]

8. (a) Find the inverse Z-transform of $X(Z) = \frac{2Z^3-5Z^2+Z+3}{(Z-1)(Z-2)}$ $|Z| < 1$
   (b) Find the inverse Z-transform of $X(Z) = \frac{3}{Z-2}$ $|Z| > 2$.
   (c) Find the Z-transform of $a^n \sin(n\omega)u(n)$. [6+4+6]

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

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1. (a) Sketch the single sided and double sided spectra of the following signal x(t)=2Sin(10πt - $\pi/6$)
   (b) Show that the functions Sin nω_0t and Sin m ω_0t are orthogonal over any interval (to , to + $2\pi/\omega_0$) for integer values of n and m. [8+8]
2. (a) Explain about even and odd functions.
   (b) Obtain the trigonometric fourier series for the periodic waveform as shown in figure 1 [6+10]

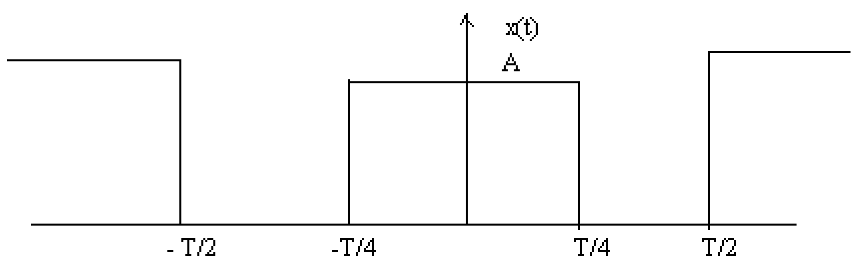

Figure 1:

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 time differentiation property of Fourier Transform. [12+4]
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) A signal y(t) given by $y(t) = C_0 + \sum_{n=1}^{\infty} C_n \cos(n\omega_o t + \theta_n)$. Find the auto correlation and PSD of y(t).

(b) Find the mean square value (or power) of the output voltage y(t) of the system shown in figure 2. If the input voltage PSD. $S_2(\omega) = rect(\omega/2)$. Calculate the power (mean square value) of input signal x(t). [8+8]

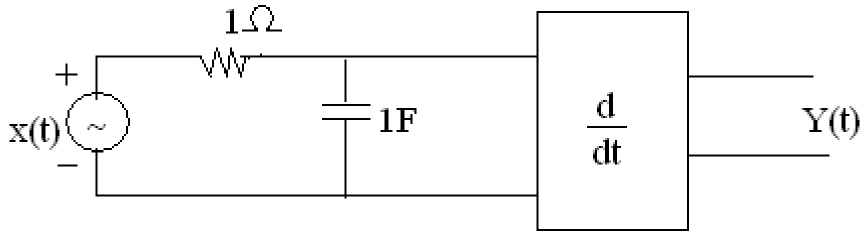

Figure 2:

6. (a) Consider the signal $x(t) = \left(\frac{\sin 50\Pi t}{\Pi t}\right)^2$ which to be sampled with a sampling frequency of $\omega_s = 150\Pi$ to obtain a signal g(t) with Fourier transform G(jω). Determine the maximum value of ω_0 for which it is guaranteed that $G(j\omega) = 75 \times (j\omega)\ for\ |\omega| \leq \omega_0$ where $X(j\omega)$ is the Fourier transform of x(t).

   (b) The signal $x(t) = u(t + T_0) - u(t - T_0)$ can undergo impulse train sampling without aliasing, provided that the sampling period T< $2T_0$. Justify.

   (c) The signal x(t) with Fourier transform $X(j\omega) = u(\omega + \omega_0) - u(\omega - \omega_0)$ can undergo impulse train sampling without aliasing, provided that the sampling period $T < \pi/\omega_0$. Justify. [6+5+5]

7. (a) State and prove the properties of Laplace transforms.

   (b) Derive the relation between Laplace transform and Fourier transform of signal. [8+8]

8. (a) State & Prove the properties of the z-transform.

   (b) Find the Z-transform of the following Sequence.
   x[n] = a^n u[n] [8+8]

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

Answer any FIVE Questions
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1. (a) Write short notes on "Orthogonal functions".
   (b) Define the following Elementary signals [8+8]
      i. Real Exponential Signal
      ii. Continuous time version of a sinusoidal signal and Bring out the relation between Sinusoidal and complex exponential signals.

2. (a) Prove that the normalized power is given by $p = \sum_{n=-\alpha}^{\alpha} |C_n|^2 \, where \, |C_n|$ are complex Fourier coefficients for the periodic wave form.
   (b) Determine the Fourier series expansion for the signal x(t) shown in figure 1. [8+8]

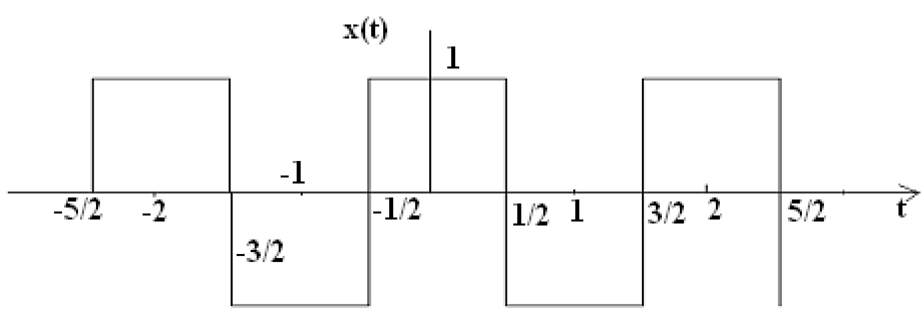

Figure 1:

3. (a) Explain the concept of Fourier Transform for periodic signals.
   (b) Find out the Fourier Transform of the periodic pulse train shown figure 2. [8+8]

4. (a) Explain how input and output signals are related to impulse response of a LTI system.
   (b) Let the system function of a LTI system be $\frac{1}{jw+2}$. What is the output of the system for an input $(0.8)^t \, u(t)$. [8+8]

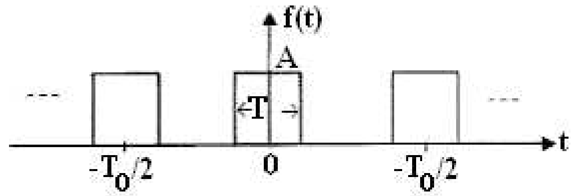

Figure 2:

5. (a) A signal y(t) given by $y(t) = C_0 + \sum_{n=1}^{\infty} C_n \cos(n\omega_o t + \theta_n)$. Find the auto correlation and PSD of y(t).
   (b) Find the mean square value (or power) of the output voltage y(t) of the system shown in figure 3. If the input voltage PSD. $S_2(\omega) = rect(\omega/2)$. Calculate the power (mean square value) of input signal x(t). [8+8]

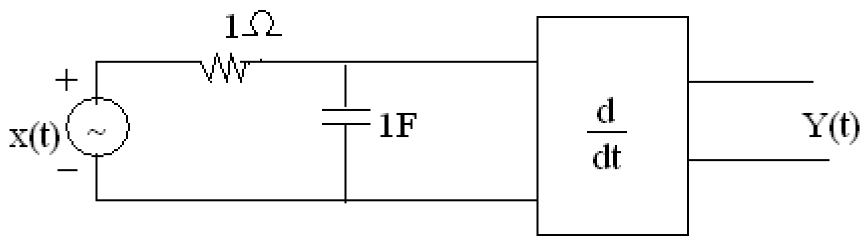

Figure 3:

6. (a) With the help of graphical example explain sampling theorem for Band limited signals.
   (b) Explain briefly Band pass sampling. [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 and ROC of the signal
   $x[n] = [4.(5^n) - 3(4^n)]\, u(n)$
   (b) Find the Z-transform as well as ROC for the following sequences: [8+8]
      i. $\left(\frac{1}{3}\right)^n u(-n)$ and
      ii. $\left(\frac{1}{3}\right)^n [u(-n) - u(n-8)]$

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Code No: R059210403

Set No. 4

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Define and sketch the following elementary signals
    i. Unit impulse signal
    ii. Unit Step signal
    iii. Signum function

   (b) Explain the Analogy of vectors and signals in terms of orthogonality and evaluation of constant. [6+10]

2. (a) State the three important spectral properties of periodic power signals.

   (b) Assuming $T_0 = 2$, determine the Fourier series expansion of the Signal shown in figure 1. [6+10]

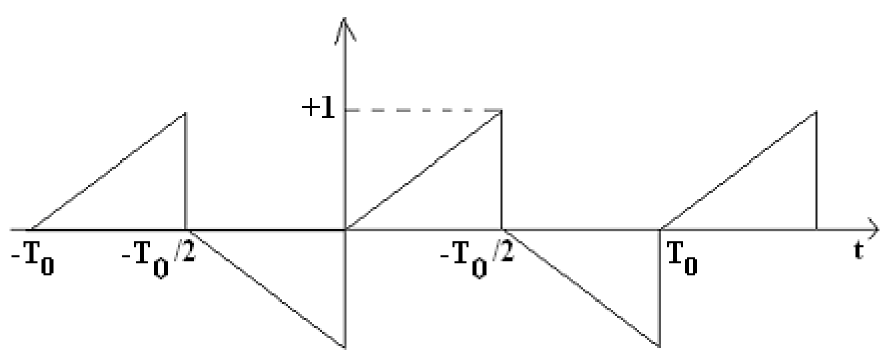

Figure 1:

3. Find the Fourier Transform of the following function

   (a) A single symmetrical Triangular Pulse
   (b) A single symmetrical Gate Pulse
   (c) A single cosine wave at t=0 [8+4+4]

4. (a) Explain how input and output signals are related to impulse response of a LTI system.

(b) Let the system function of a LTI system be $\frac{1}{jw+2}$. What is the output of the system for an input $(0.8)^t\,u(t)$. [8+8]

5. (a) A waveform m(t) has a Fourier transform M(f) whose magnitude is as shown in figure 2. Find the normalized energy content of the waveform.

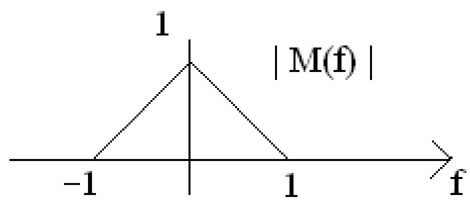

Figure 2:

(b) The signal V(t) = cos ω_0t + 2sin 3 ω_0t + 0.5 sin 4ω_0t is filtered by an RC low pass filter with a 3 dB frequency.
f_c =2f_0. Find the output power S_o.

(c) State parseval's theorem for energy X power signals. [6+6+4]

6. (a) With the help of graphical example explain sampling theorem for Band limited signals.

(b) Explain briefly Band pass sampling. [8+8]

7. (a) Determine the Laplace transform and the associate region convergence for each of the following functions of time.

i. $x(t) = 1 \qquad 0 \le t \le 1$

ii. $x(t) = \begin{matrix} t & 0 \le t \le 1 \\ 2-t & 1 \le t \le 2 \end{matrix}$

(b) State and prove initial value theorem of L.T. [10+6]

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

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

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

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

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