Code No: R059210403

Set No. 1

II B.Tech I Semester Regular Examinations, November 2006
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) 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) With regard to Fourier series representation, justify the following statements.

   i. Odd functions have only Sine term
   ii. Even functions have no Sine terms
   iii. Functions with half wave Symmetry have only odd harmonics. [3+3+3]

   (b) Show that the Fourier series for a real valued signal can be written as $x(t) = B(0) + \sum\limits_{n=1}^{\alpha} B(n)\,Cos(n\omega ot) + A(n)\,Sin(n\omega ot)$ where B(n) and A(n) are real valued coefficients and express c_n in terms of B(n) and A(n). [7]

3. (a) State and prove time convolution and time differentiation properties of Fourier Transform.

   (b) Find and sketch the Inverse Fourier Transform of the Waveform shown in figure 3b. [8+8]

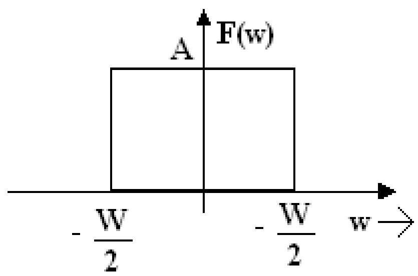

Figure 3b

4. (a) What is a LTI System? Explain its properties. Derive an expression for the transfer function of a LTI system.
   (b) Find the impulse response to the RL filter shown figure 4b. [8+8]

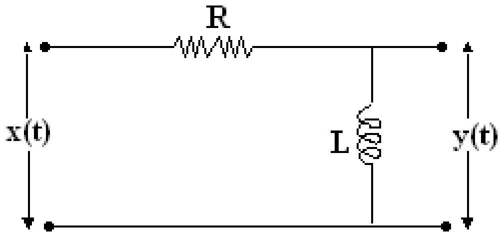

Figure 4b

5. (a) Using frequency domain convolution, find X(f) for x(t) = A Sinc^2 2wt
   (b) Show that correlation can be written in terms of convolution as
   R(τ) = Lt 1/T [x(t) * x(-t)]
   $T \to \infty$
   (c) The input to an RC Low pass filter is x(t)= sinc 2 wt. Find output energy Ey. [6+5+5]

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
   $y_p(t) = \sum\limits_{n=-\infty}^{\infty} y(nT)\delta(t - nT)$
   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. $\frac{(s+1)^2}{s^2-s+1}$ Re$\{S\} > 1/2$
      ii. $\frac{s^2-s+1}{(s+1)^2}$ Re$\{S\} > -1$

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

(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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Code No: R059210403 **Set No. 2**

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1. (a) Distinguish between orthogonal vectors and orthogonal functions.
   (b) Consider the complex valued exponential signal
   x(t) = A $e^{\alpha t+j\omega t}$, a >0 Evaluate the real and imaginary components of x(t) for the following cases
      i. α real , $\alpha = \alpha_1$
      ii. α imaginary α=jω_1
      iii. α complex, α=α_1 + jω
   (c) Consider the rectangular pulse x(t) as shown in figure 1c. [6+6+4]

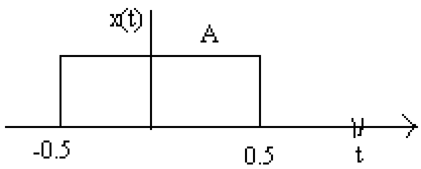

Figure 1c

Represent the above rectangular pulse in terms of weighted sum of two step functions.

2. (a) Write short notes on "Exponential Fourier Spectrum".
   (b) Find the Fourier series expansion of the periodic triangular wave shown figure 2. [6+10]

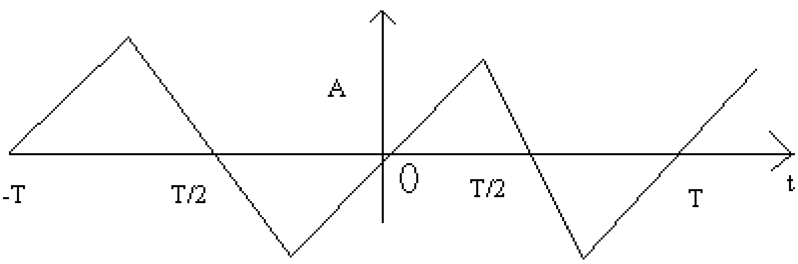

Figure 2

3. (a) State and prove time convolution and time differentiation properties of Fourier Transform.
   (b) Find and sketch the Inverse Fourier Transform of the Waveform shown in figure 3b. [8+8]

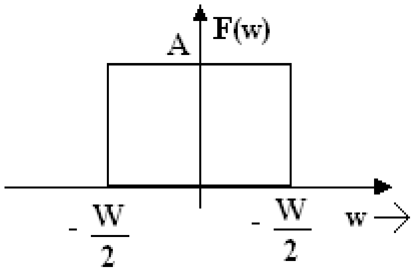

Figure 3b

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. Find the power of periodic signal g(t) shown in figure 5c. Find also the powers of [4×4]

   (a) -g(t)
   (b) 2g(t)
   (c) g(t).

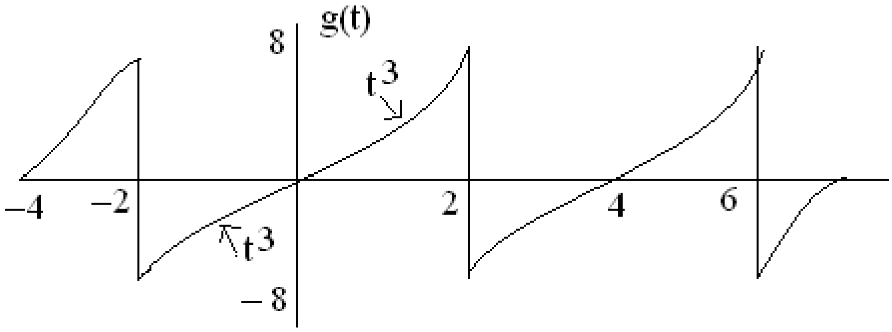

Figure 5c

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
   $y_p(t) = \sum\limits_{n=-\infty}^{\infty} y(nT)\delta(t - nT)$

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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1. (a) Sketch the following signals
   i. $\Pi\left(\frac{t-1}{2}\right) + \Pi(t-1)$
   ii. $f(t) = 3u(t) + tu(t) - (t-1)u(t-1) - 5u(t-2)$
   (b) Evaluate the following Integrals [8+8]
   i. $\int_{0}^{5} \delta(t) Sin 2\Pi t \text{dt}$
   ii. $\int_{-\alpha}^{\alpha} e^{-\alpha t^2} \delta(t-10) dt$
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 time differentiation property of Fourier Transform. [12+4]
4. (a) Explain the characteristics of an ideal LPF. Explain why it can't be realized.
   (b) Differentiate between signal bandwidth and system bandwidth. [12+4]
5. (a) Determine an expression for the correlation function of a square wave having the values 1 or 0 and a period T.
   (b) The energy of a non periodic wave form $v(t)$ is $E = \int_{-\infty}^{\infty} v^2(t) dt$. [8+8]
   i. Show that this can be written as $E = \int_{-\infty}^{\infty} dt\, v(t) \int_{-\infty}^{\infty} v(f) e^{j2\pi f t} df$
   ii. Show that by interchanging the order by integration we have $E = \int_{-\infty}^{\infty} v(f) v*$ $(f) df = \int_{-\infty}^{\infty} |v(f)|^2 df$

6. (a) A signal x(t)= 2 cos 400 π t + 6 cos 640 π t. is ideally sampled at $f_s = 500Hz$. If the sampled signal is passed through an ideal low pass filter with a cut off frequency of 400 Hz, what frequency components will appear in the output.

   (b) A rectangular pulse waveform shown in figure 6b is sampled once every T_S seconds and reconstructed using an ideal LPF with a cutoff frequency of $f_s/2$. Sketch the reconstructed waveform for $T_s = \frac{1}{6}$ sec $and\, T_s = \frac{1}{12}$ sec. [8+8]

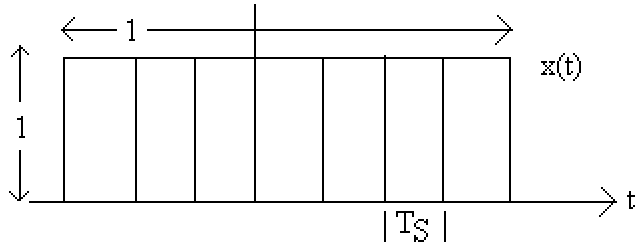

Figure 6b

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) 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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Set No. 4

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1. (a) Define and sketch the following signals
   i. Real exponential signals for $C \neq 0\, \alpha > 0$
   ii. Even continuous time signal
   iii. Unit doublet
   iv. Real part of damped complex exponential for $\alpha \quad 0$

   (b) Evaluate the following integrals
   i. $\int_{\alpha}^{\alpha} \delta(t+3) \overset{-t}{e}\, dt$
   ii. $\int_{\alpha}^{\alpha} [\delta(t) \cos t + \delta(t-1) \sin t]\, dt$

   (c) Discuss the signal with a neat sketch. [8+4+4]

2. (a) State the properties of Complex Fourier series.

   (b) Determine the Fourier series of the function shown in figure 2. [6+10]

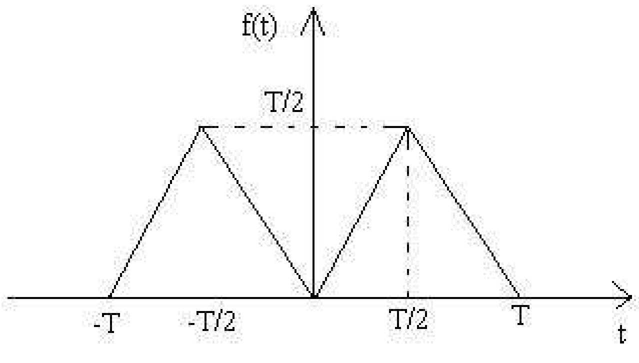

Figure 2

3. (a) Find Fourier Transform of the following time function
   $x(t) = e^{-3t} [u(t+2) - u(t-3)]$

   (b) State and prove frequency and time shifting properties of Fourier Transform. [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]

5. (a) Using frequency domain convolution, find X(f) for x(t) = A Sinc^2 2wt
   (b) Show that correlation can be written in terms of convolution as
   R(τ) = Lt 1/T [x(t) * x(-t)]
   $T \rightarrow \infty$
   (c) The input to an RC Low pass filter is x(t)= sinc 2 wt. Find output energy Ey. [6+5+5]

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. Determine the function of time x(t) for each of the following Laplace transforms and their associated regions of convergence.
   (a) $\frac{1}{s^2+9}$ $\quad$ Re$\{S\} > 0$
   (b) $\frac{S}{S^2+9}$ $\quad$ Re$\{S\} < 0$
   (c) $\frac{s+1}{(s+1)^2+9}$ $\quad$ Re$\{S\} < -1$. [4+6+6]

8. (a) A finite sequence x[n] is defined as x[n] = {5,3,-2,0,4,-3} Find X[Z] and its ROC.
   (b) Consider the sequence x[n] = $\begin{cases} a^n & 0 \leq n \leq N-1,\ a > 0 \\ 0 & otherwise \end{cases}$
   Find X[Z].
   (c) Find the Z-transform of $x(n) = \cos(n\omega)u(n)$. [5+5+6]

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