II B.Tech I Semester Regular Examinations, November 2005
SIGNALS & SYSTEMS
(Common to Electronics & Communication Engineering, Electronics & Instrumentation Engineering, Electronics & Control Engineering, Electronics & Telematics and Instrumentation & Control Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks
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1. (a) Define Mean square error and derive the expression for evaluating Mean square error. [8M]

   (b) A rectangular function defined as,
   $$f(\mathrm{t}) = \begin{cases} A & 0 < t < \frac{\pi}{2} \\ -A & \frac{\pi}{2} < t < \frac{3\pi}{2} \\ A & \frac{3\pi}{2} < t < 2\pi \end{cases}$$
   Approximate above function by A Cos t between the intervals(0,2π) such that mean square error is minimum. [8M]

2. (a) Obtain the Fourier components of the periodic rectangular waveform shown in figure1: [10M]

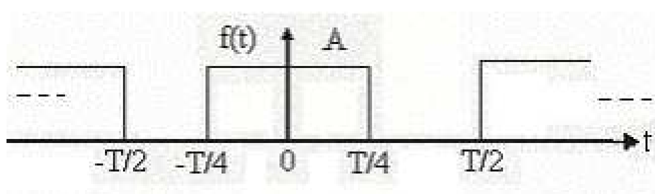

Figure 1:

   (b) Write a short notes on Dirichlets' conditions. [6M]

3. (a) Determine the Fourier transform of a square wave shown in figure 2 [8M]:

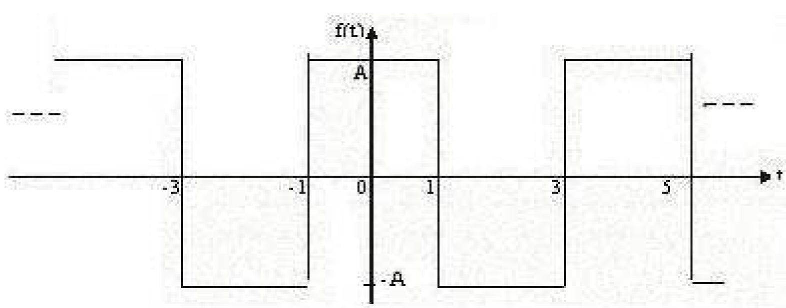

Figure 2:

   (b) Find the Fourier Transform. of 5 $\sin^2(3t)$. [8M]

4. (a) What is an LTI system? Explain its properties. Derive an expression for the transfer function of an LTI system. [2+4+4=10M]
   (b) Obtain the conditions for the distortionless transmission through a system. What do you understand by the term signal bandwidth? [4+2=6M]

5. For the following signal find the power, and rms value, and sketch the PSD
   (a) A cos 100 t + B sin 80 t. [8M]
   (b) Derive the relation between bandwidth and rise time of a system. [8M]

6. (a) Let $R_{12}(\lambda\ )$ and $R_{21}(\lambda\ )$ denote the cross correlate function of two energy signals $g_1(t)$ and $g_2(t)$. Show that the total area under $R_{12}(\lambda\ )$ is defined by $\int\limits_{-\infty}^{\infty} R_{12}(\tau)d\tau = [\int\limits_{-\infty}^{\infty} g_1(t)dt][\int\limits_{-\infty}^{\infty} g_2(t)dt]^*$. [8M]
   (b) Show that $R_{12}(\lambda\ )=R_{21}{}^*(-\lambda)$. [8M]

7. (a) Use geometric evaluation from the pole-zero plot to determine the magnitude of the Fourier transform of the signal whose Laplace transform is specified as $X(s) = \frac{s^2-s+1}{s^2+s+1}$ $\Re$ e{s} > -(1/2). [6+2=8M]
   (b) Determine the Laplace transform and associated region of convergence
   And pole-zero plot for the following function of time $x(t)=e^{-2t}\ u(t)+e^{-3t}\ u(t)$. [6+2=8M]

8. (a) Given X (z) = z / [z-1]ˆ3, find x (n) using contour integration method. [8M]
   (b) Distinguish between one-sided and two –sided z-transforms. What are this applications. [8M]

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   (b) A rectangular function defined as,

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

   Approximate above function by A Cos t between the intervals(0,2π) such that mean square error is minimum. [8M]

2. (a) Deduce the Fourier series for the waveform of a positive going rectangular pulse train the following figure1. [10M]

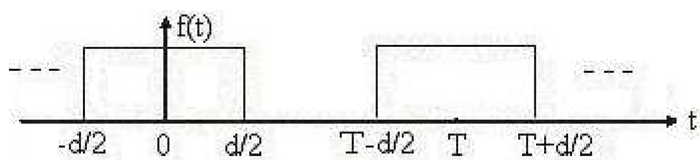

Figure 1:

   (b) Distinguish between the expression form of Fourier series and Fourier transform. What is the nature of the “transform pair” in the above two cases? [6M]

3. Determine the inverse Fourier transform of the spectrum shown in figure2: [8+8=16M]

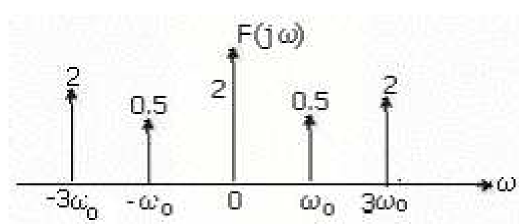

Figure 2:

4. Determine the maximum bandwidth of signals that can be transmitted through the lowpass RC filter shown in the figure3., if over this bandwidth the gain variation is to be with in 10 percent and the phase variation is to be within 7 percent of the ideal characteristics. [16M]

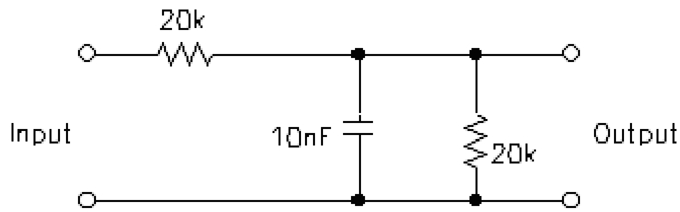

Figure 3:

5. (a) What do you understand by Energy spectral density and power spectral density? State and prove Parseval's theorem for energy signal. [2+2+6=10M]
   (b) If a signal g(f) is passed through an ideal LPF of bandwidth f_cHz, determine the energy density of the o/p signal. [6M]

6. (a) Let G(f) denote the Fourier Transform of real valued signal g(t) and R(λ) is its auto correlate function. Show that
   $\int_{-\infty}^{\infty} [dR(\lambda)/d\lambda]^2 d\,\lambda = 4\,\pi^2 \int_{-\infty}^{\infty} f^2 |G(f)|^4 d(f)$ [8M]
   (b) Consider an energy signal g(t) whose auto correlation function is given by R(λ). [8M]
   Show that $|R(\lambda)|$ <=R(0) using Schwarz's inequality.

7. (a) Find the Laplace transform of [4e^{-2t}cos 5t-3e^{-2t}sin 5t]u(t) and its ROC.[6+2=8M]
   (b) Find the signal x(t) that corresponds to the Laplace transform
   $X(s) = \frac{3s^2+22s+27}{(s^2+3s+2)(s^2+2s+5)}$ [8M]

8. (a) Explain the properties of the region of convergence of X (z). [8M]
   (b) Discuss in detail about the double sided and single sided Z- transform. Correlate Laplace transform and Z-transform in their end use. [6+2=8M]

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Code No: RR210402 **Set No. 3**

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1. (a) A rectangular function defined by [10M]
$f(\mathrm{t})= \begin{cases} 1 & 0 < t < \pi \\ -1 & \pi < t < 2\pi \end{cases}$
Approximate above rectangular function by a single sinusoid sin t,Evaluate Mean square error in this approximation. Also show what happens when more number of sinusoidal are used for approximations.
(b) Discuss GIBB'S Phenomena in the above problem. [6M]

2. (a) Deduce the Fourier series for the waveform of a positive going rectangular pulse train the following figure1. [10M]

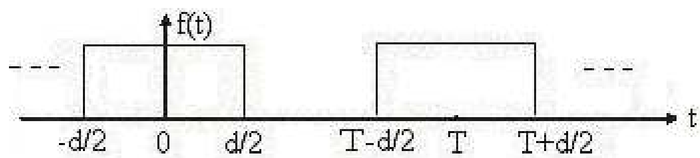

Figure 1:

(b) Distinguish between the expression form of Fourier series and Fourier transform. What is the nature of the "transform pair" in the above two cases? [6M]

3. (a) Obtain the Fourier transform of the following:
i. x(t)=A Sin ($2\pi f_c t$). u(t). [4M]
ii. x(t)=f(t).Cos($2\pi f_c t+\Phi$). [4M]
(b) State and prove the following properties of Fourier transform.
i. Multiplication in time domain. [4M]
ii. Convolution in time domain. [4M]

4. (a) What is an LTI system? Explain its properties. Derive an expression for the transfer function of an LTI system. [2+4+4=10M]
(b) Obtain the conditions for the distortionless transmission through a system. What do you understand by the term signal bandwidth? [4+2=6M]

5. (a) A power signal g(t) has a PSD $S_g(\omega) = N/(A^2)$ $-2\pi B \leq \omega \leq 2\pi B$., shown in the figure2. Where A and N are constants. Determine the PSD and the mean square value of its derivative d(g(t)/dt. [5+5=10M]

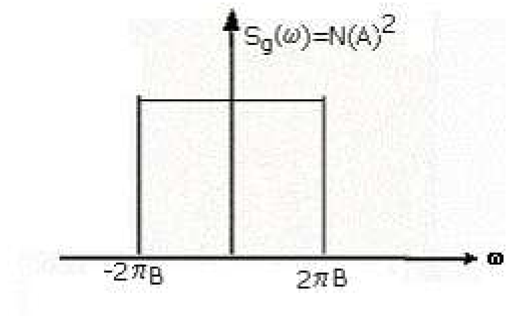

Figure 2:

(b) Derive the relation between power and power density spectrum.

6. Determine the cross correlation function $R_{12}(\lambda\ )$ of two signals $g_1(t)$ and $g_2(t)$ defined by

$g_1(t) = \begin{cases} ACos(2\pi f_1 t + \theta_1), 0 \leq t \leq T \\ 0, \quad elsewhere \end{cases}$ $g_2(t) = \begin{cases} ACos(2\pi f_2 t + \theta_2), 0 \leq t \leq T \\ 0, \quad elsewhere \end{cases}$

How does varying the frequency difference $|\ f_1 - f_2|$ affect this cross-correlation function? [16M]

7. (a) A Laplace transform is characterized by the differential equation $\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = x(t)$, Solve for y(t) for $t \geq 0$ when x(t)=u(t), $y(0^-)=2$ and $\frac{dy(0-)}{dt}$ = -12. [8M]

(b) State and prove convolution and differentiation properties of Laplace transform. [4+4=8M]

8. (a) Find the inverse transform of X (z) = $z^2/[z-a]^2$ ROC: |z| >a and 0<a<1 using the residual method. [8M]

(b) Use convolution theorem, to find the inverse z transform of Y (z) = $z/[z-1]^3$. [8M]

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1. (a) Explain the importance of signal analysis with respect to communication systems and Network analysis. [4M]
   (b) Differentiate Orthogonal signal space and Orthonormal signal spaces. Discuss clearly their application with regard to representing a unknown time varying signal. [6M]
   (c) Derive the condition for orthogonality between two complex signals $f_1(t)$ and $f_2(t)$. [4M]
2. (a) Obtain the Fourier components of the periodic rectangular waveform shown in figure1: [10M]

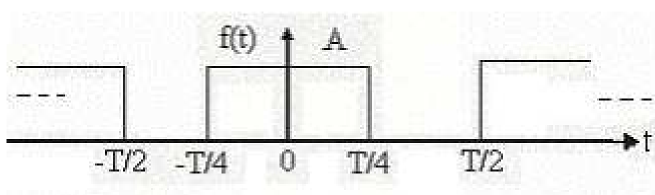

Figure 1:

   (b) Write a short notes on Dirichlets' conditions. [6M]
3. (a) Find the Fourier transform of the waveform shown in figure2 .

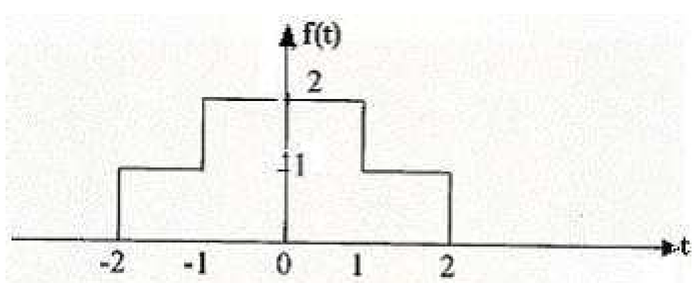

Figure 2:

   (b) State and prove time shifting and convolution properties of Fourier Transform. [8M]

4. Determine the maximum bandwidth of signals that can be transmitted through the lowpass RC filter shown in the figure3., if over this bandwidth the gain variation is to be with in 10 percent and the phase variation is to be within 7 percent of the ideal characteristics. [16M]

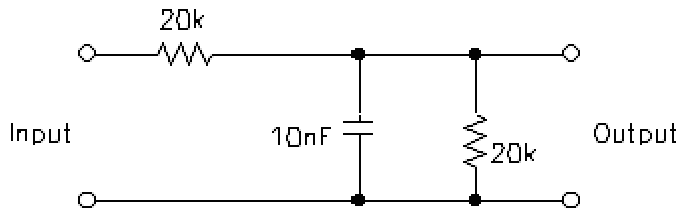

Figure 3:

5. (a) What do you understand by Energy spectral density and power spectral density? State and prove Parseval's theorem for energy signal. [2+2+6=10M]
   (b) If a signal g(f) is passed through an ideal LPF of bandwidth f_cHz, determine the energy density of the o/p signal. [6M]

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$g_1(t) = \begin{cases} ACos(2\pi f_1 t + \theta_1), 0 \leq t \leq T \\ 0, \quad elsewhere \end{cases}$ $g_2(t) = \begin{cases} ACos(2\pi f_2 t + \theta_2), 0 \leq t \leq T \\ 0, \quad elsewhere \end{cases}$
How does varying the frequency difference | f_1-f_2| affect this cross-correlation function? [16M]

7. (a) The Laplace Transform of a signal x(t) is given by $X(s) = \left[\frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2)}\right]$ where ω_n and ξ are the natural frequency and the damping factors respectively. For what values of ξ, -1$\leq \quad \xi \quad \leq$ 1, can the Fourier transform be computed from the Laplace transform? [8M]
   (b) Find the inverse Laplace transform of X(s)=$\frac{1+e^{-2s}}{3s^2+2s}$. [8M]

8. (a) State and prove the convolution theorem and time shifting properties of z transform. [4+4=8M]
   (b) Using the power series method find the first five samples of
   1/[1- $4z^{-1}$ + $6z^{-2}$]. [8M]

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