

II B.Tech I Semester Supplementary Examinations, February 2008
SIGNALS AND 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

1. (a) Explain orthogonality property between two complex functions $f_1(t)$ and $f_2(t)$ for a real variable 't'. [6M]
 (b) Discuss how an unknown function $f(t)$ can be expressed using infinite mutually Orthogonal function. Hence show the representation of a wave forms $f(t)$ using Trigonometric Fourier series. [10M]
2. Find out the exponential Fourier series for the impulse train and plot its magnitude and phase spectrum and find the normalized average power of the signal shown below the figure2: [16M]

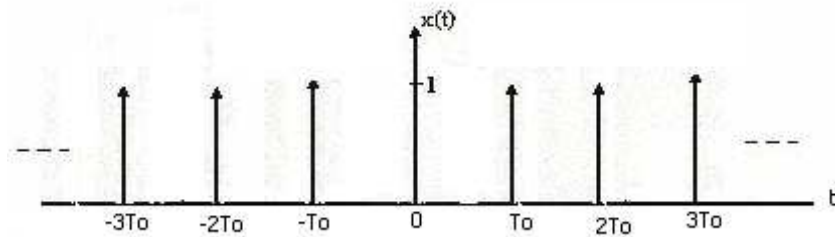


Figure 2

3. (a) Obtain the Fourier transform of the following:
 - i. $x(t) = A \sin(2\pi f_c t) \cdot u(t)$. [4M]
 - ii. $x(t) = f(t) \cdot \cos(2\pi f_c t + \Phi)$. [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) Find the impulse response of the system shown in figure4a. Find the transfer function. What would be its frequency response? Sketch the response. [2+4+2=8M]

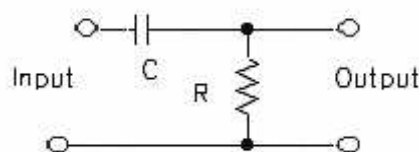


Figure 4a

(b) State and prove sampling theorem. [2+6=8M]

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 figure 5a. Where A and N are constants. Determine the PSD and the mean square value of its derivative $d(g(t))/dt$. [5+5=10M]

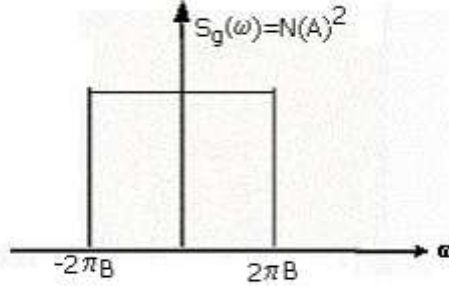


Figure 5a

(b) Derive the relation between power and power density spectrum. [6M]

6. (a) Determine the auto correlation function of a sinc pulse $A \text{sinc}(2\pi t)$. [8M]

(b) List out the properties of auto correlation function. [8M]

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

$$X(s) = \frac{3s^2 + 22s + 27}{(s^2 + 3s + 2)(s^2 + 2s + 5)} \quad [8M]$$

8. (a) Given $H(z) = z^2 / [z - 0.5 - j0.5][z - 0.5 + j0.5]$ find $h(n)$. [8M]

(b) Derive the time domain condition for the stability of LTI discrete time system. [8M]

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1. (a) A rectangular function defined by [10M]

$$f(t) = \begin{cases} 1 & 0 < t < \pi \\ -1 & \pi < t < 2\pi \end{cases}$$

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. Find the trigonometric Fourier series for the waveform shown below and hence determine the exponential Fourier series. Also find a_n and b_n of the trigonometric series and compare the results the following figure2. [16M]

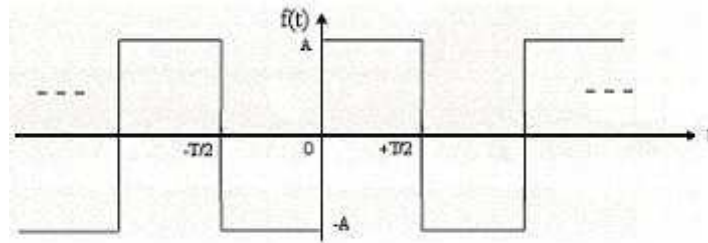


Figure 2

3. (a) Obtain the Fourier transform of the following:
- $x(t) = A \sin(2\pi f_c t) \cdot u(t)$. [4M]
 - $x(t) = f(t) \cdot \cos(2\pi f_c t + \Phi)$. [4M]
- (b) State and prove the following properties of Fourier transform.
- Multiplication in time domain. [4M]
 - Convolution in time domain. [4M]
4. (a) Find the impulse response of the system shown in figure4a. Find the transfer function. What would be its frequency response? Sketch the response. [2+4+2=8M]

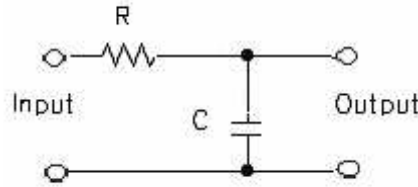


Figure 4a

- (b) The transfer function of a system is given by $H(w)=k$. Where k is a constant. Sketch the magnitude and phase function of this transfer function. Evaluate the impulse response of this filter. Sketch this response and state whether the filter is physically realizable. [4+2+2=8M]
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 figure5a. Where A and N are constants. Determine the PSD and the mean square value of its derivative $d(g(t))/dt$. [5+5=10M]

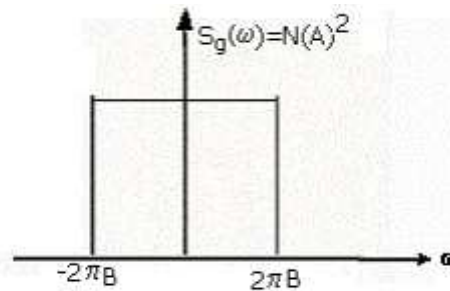


Figure 5a

- (b) Derive the relation between power and power density spectrum. [6M]
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 $\int_{-\infty}^{\infty} R_{12}(\tau) d\tau = [\int_{-\infty}^{\infty} g_1(t) dt][\int_{-\infty}^{\infty} g_2(t) dt]^*$. [8M]
- (b) Show that $R_{12}(\lambda) = R_{21}^*(-\lambda)$. [8M]
7. (a) A Laplace transform is characterized by the differential equation $\frac{d^2 y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = x(t)$, 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) What are the methods by which inverse Z- transformation can be found out? [3+3+2=8M]
- (b) Given $X(z) = \frac{1}{1-az^{-1}}$, $|z| > |a|$. Find $x(n)$ using long division method. [8M]

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1. (a) Explain the significance of spectrum analysis of signal with regard to synthesis of systems. [4M]
- (b) Define orthogonal signal space and bring out clearly its application in representing a signal. [6M]
- (c) Obtain the condition under which two signals $f_1(t)$ & $f_2(t)$ are said to be orthogonal to each other. Hence prove that $\sin n\omega_0 t$ and $\cos m\omega_0 t$ are orthogonal to each other for all integer values of m, n . [6M]
2. (a) Find the Fourier series for the periodic signal shown below the figure 2a: [10M]

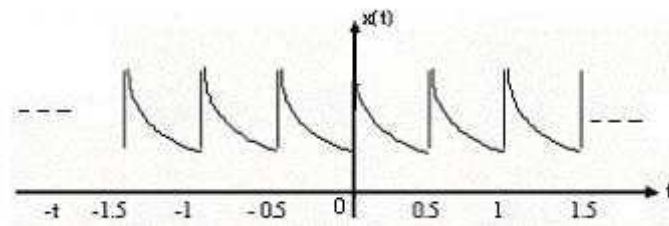


Figure 2a

- (b) With regard to Fourier series representation, justify the following statements:
 - i. Odd functions have only sine terms.
 - ii. Even functions have no sine terms
 - iii. Functions with half wave symmetry have only odd harmonics. [2+2+2]
3. (a) Determine the magnitude and phase spectrum of the pulse shown in the following figure 3a. [8M]

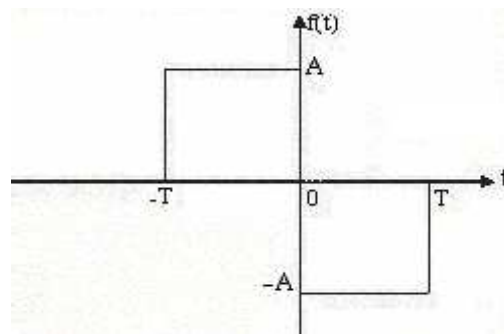


Figure 3a

- (b) Prove that the magnitude of F.T. is even function and that of phase is an odd function. [8M]

4. Determine the maximum bandwidth of signals that can be transmitted through the lowpass RC filter shown in the figure4., if over this bandwidth the gain variation is to be within 10 percent and the phase variation is to be within 7 percent of the ideal characteristics. [16M]

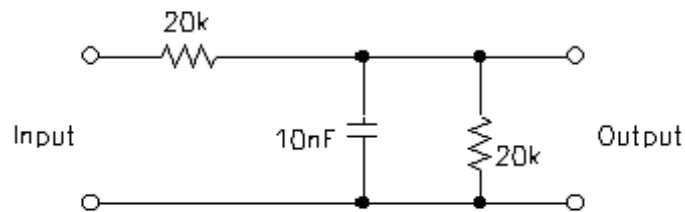


Figure 4

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 figure5a. Where A and N are constants. Determine the PSD and the mean square value of its derivative $d(g(t))/dt$. [5+5=10M]

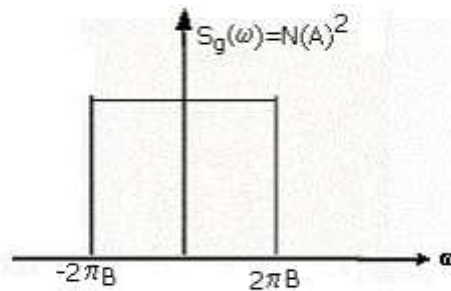


Figure 5a

- (b) Derive the relation between power and power density spectrum. [6M]
6. (a) Determine and sketch the auto-correlation function of given exponential function: $f(t) = e^{-at} \cdot u(t)$. [8M]
- (b) Show that auto-correlation function and power spectral density form a Fourier transform pair. [8M]
7. (a) The signal $x(t) = \sin 2t$ oscillates between +1 and -1 as $t \rightarrow \infty$. So it does not have a final value. Show that the application of the final value theorem gives an incorrect result for the signal. [8M]
- (b) State and prove the time-differentiation and time-integration properties. [4+4=8M]
8. (a) Explain in detail, the contour integration method of finding inverse z transform. [6M]
- (b) For the given signal as under,
- Determine the parameter values for which z transform will exist
 - Find the z transform (c) Plot ROC
- $x(n) = -(b^n) u(-n-1) + (0.5^n) u(n)$ [10M]

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- (b) Define orthogonal signal space and bring out clearly its application in representing a signal. [6M]
- (c) Obtain the condition under which two signals $f_1(t)$ & $f_2(t)$ are said to be orthogonal to each other. Hence prove that $\sin n\omega t$ and $\cos m\omega t$ are orthogonal to each other for all integer values of m, n . [6M]
2. (a) Find the exponential Fourier series and plot the magnitude and phase spectrums for the full wave rectified sine wave the following figure2a. [10M]

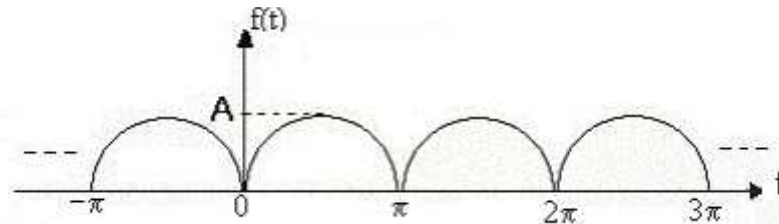


Figure 2a

- (b) Explain the conditions under which any periodic waveform can be expressed using Fourier series. [6M]
3. (a) Find the Fourier transform of the waveform shown in figure3a .

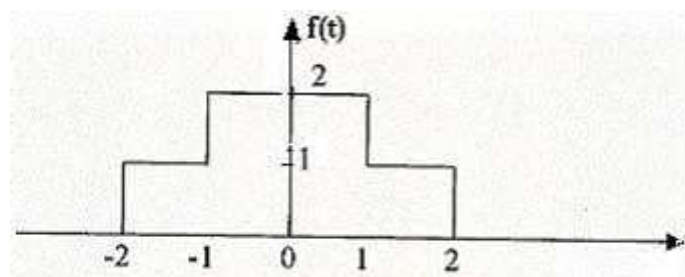


Figure 3a

- (b) State and prove time shifting and convolution properties of Fourier Transform. [8M]
4. (a) Find the impulse response of the system shown in figure4a. Find the transfer function. What would be its frequency response? Sketch the response. [2+4+2=8M]

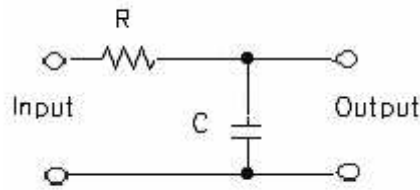


Figure 4a

- (b) The transfer function of a system is given by $H(w)=k$. Where k is a constant. Sketch the magnitude and phase function of this transfer function. Evaluate the impulse response of this filter. Sketch this response and state whether the filter is physically realizable. [4+2+2=8M]
5. (a) State and prove Rayleigh's energy theorem. [8M]
 (b) Find the total energy of the Sinc pulse($A \text{ Sinc}(2wt)$). [8M]
6. Determine the cross correlation function $R_{12}(\lambda)$ of two signals $g_1(t)$ and $g_2(t)$ defined by
- $$g_1(t) = \begin{cases} A \cos(2\pi f_1 t + \theta_1), & 0 \leq t \leq T \\ 0, & \text{elsewhere} \end{cases} \quad g_2(t) = \begin{cases} A \cos(2\pi f_2 t + \theta_2), & 0 \leq t \leq T \\ 0, & \text{elsewhere} \end{cases}$$
- How does varying the frequency difference $|f_1 - f_2|$ affect this cross-correlation function? [16M]
7. (a) The signal $x(t) = \sin 2t$ oscillates between +1 and -1 as $t \rightarrow \infty$. So it does not have a final value. Show that the application of the final value theorem gives an incorrect result for the signal. [8M]
 (b) State and prove the time-differentiation and time-integration properties. [4+4=8M]
8. (a) For the sequence $x(n) = 2^n$ $n < 0$ [10M]
 $= (1/2)^n, n = 0, 2, 4, \dots$
 $= (1/3)^n, n = 1, 3, 5, \dots$
 (b) Prove that the absolute convergence region is given by $(1/2) < z < 2$. [6M]
