Code No: 07A3EC12 **Set No. 1**

II B.Tech I Semester Regular Examinations, November 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) Obtain the condition under which two signals $f_1(t)$ and $f_2(t)$ are said to be orthogonal to each other. Hence prove that Sin n ω_0t and Cos m ω_0t are orthogonal to each other over an interval (t_0, $\frac{2\pi}{\omega_0}$) for all integer values of m, n.
   (b) Explain the concepts of Impulse function. [10+6]

2. The complex exponential representation of a signal f(t) over the interval (0,T) $f(t) = \sum\limits_{n=-\alpha}^{\alpha} \left(\frac{3}{4} + (n\pi)^2\right) e^{j\pi nt}$
   (a) What is the numerical value of T
   (b) One of the components of f(t) is A Cos 3πt. Determine the value of A.
   (c) Determine the minimum no. of terms which must be maintained in representation of f(t) in order to include 99.9% of the energy in the interval (0,T). [6+5+5]

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+8]

4. (a) Explain causality and physical reliability of a system and hence give poly-wiener criterion.
   (b) Obtain the relationship between the bandwidth and rise time of ideal low pass filter. [8+8]

5. (a) Prove that for a signal, auto correlation function and power spectral density form a Fourier transform pair.
   (b) A filter with $H(\omega) = \frac{1}{1+j\omega}$ is given an input $x(t) = e^{-2t}\,u(t)$. Find the energy spectral density of the output. [8+8]

6. (a) Explain Flat top sampling.

(b) A Band pass signal with a spectrum shown in figure 6b below 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]

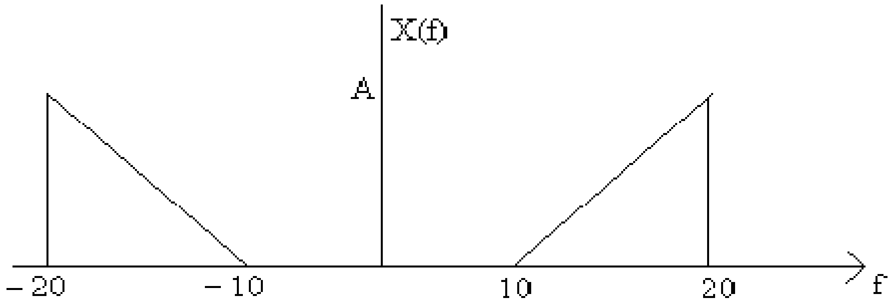

Figure 6b

7. (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 d^2/dt^2 [δ(t)]. [4+4+4+4]

8. (a) Explain the Periodicity property of discrete time signal using complex exponential signal.
   (b) Consider a left sided sequence x[n] with Z transform
   $X(z) = \frac{1}{\left(1-\frac{1}{2}z^{-1}\right)(1-z^{-1})}$
      i. Express X(z) as a ratio of polynomials in z instead z^{-1}
      ii. Use partial fraction method to express X(z) as a sum of terms
      iii. Determine x(n) [4+12]

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1. (a) Define orthogonal signal space and bring out clearly its application in representing a signal.

   (b) Explain the analogy between vectors and signals in terms of orthogonality and evaluation of component. [8+8]

2. (a) Derive polar Fourier series from the exponential Fourier series representation and hence prove that $D_n = 2|C_n|$.

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

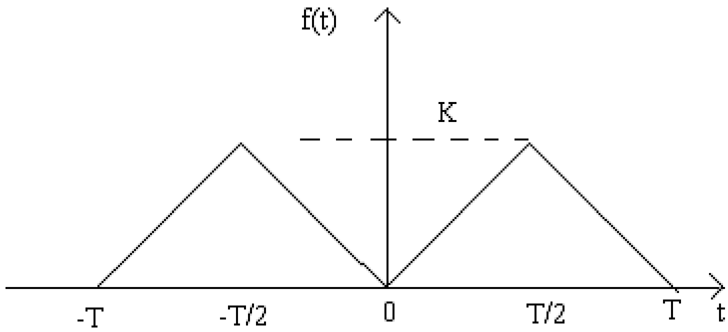

Figure 2b

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. [9+7]

4. (a) Find the current i(t) in a series RLC circuit as shown in figure 4a when a voltage of 100 volts is switched on across the terminals a a[1] at t=0.

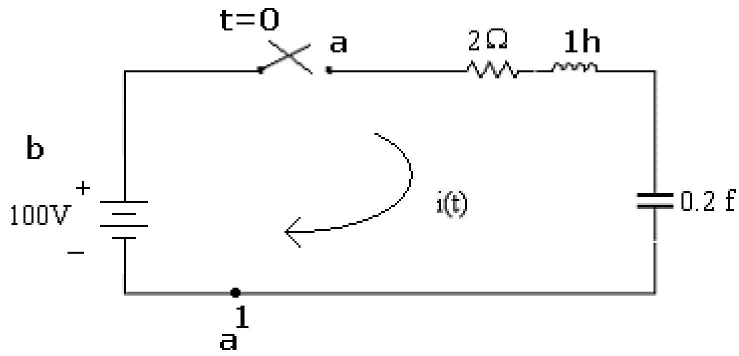

Figure 4a

(b) A signal $f(t) = \left(\frac{2\pi}{w}\right)\delta(t) - S_a\left(\frac{Wt}{2}\right)$ is applied at the input terminals of the ideal low filter. The transfer function of such filter is given by H(jω) = K GW (ω) e$^{-jwt_0}$ Find the 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.

   (a) sinc(100πt).

   (b) sinc^2(100πt).

   (c) sinc(100πt) + sinc(50πt).

   (d) sinc(100πt) + 3 sinc^2(60πt). [4+4+4+4]

7. (a) Determine the Laplace transform of $v(t) = e^{-5t}u(t) - e^{-5(t-1)}u(t-1)$. If this voltage is applied to a network whose impedance is $Z(s) = \frac{s^2+4s+3}{s(s^2+6s+8)}$, then find current I(s) and also i(t).

   (b) Explain the Frequency differentiation and Time convolution properties of Laplace transforms. [8+8]

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) Approximate the rectangular function shown in figure 1a is orthogonal set of sinsoidal signals and show that mean square error is minimum..

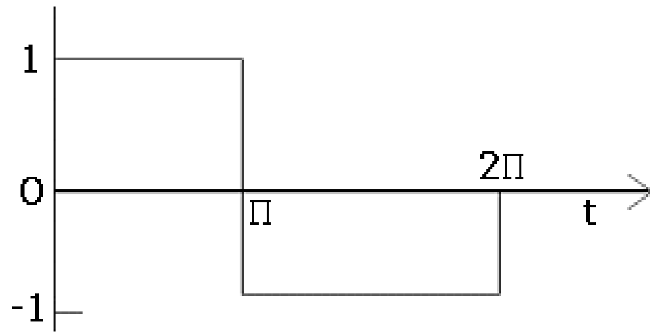

Figure 1a

(b) Prove that if $f_1(t)$ and $f_2(t)$ are complex functions of real variable t, then the component of $f_2(t)$ contained in $f_1(t)$ over the interval (t_1, t_2) is given by:
$C_{12} = \frac{\int_{t_1}^{t_2} f_1(t) f_2^* dt}{\int_{t_1}^{t_2} f_2(t) f_2^* dt}$. [8+8]

2. (a) Find the trigonometric Fourier series of the waveform shown in figure 2a.

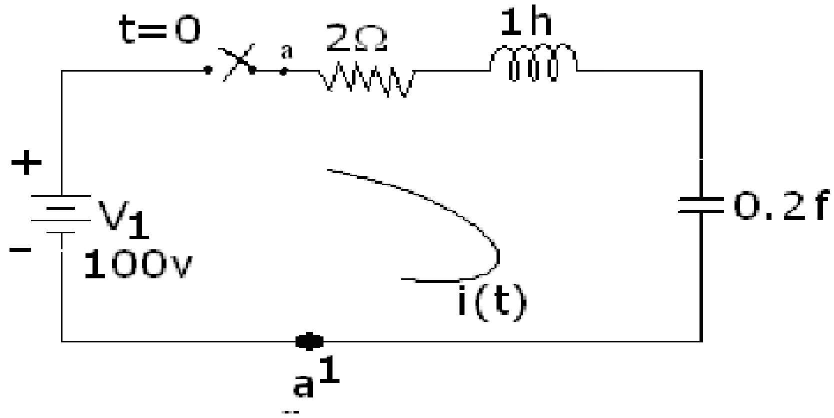

Figure 2a

(b) What is meant by Fourier Series of non sinusoidal periodic waveform? Explain the significance of the term ?Half wave Symmetry? used in determining the Fourier series of the given waveform. [10+6]

3. (a) Find the Fourier Transform of the following waveforms shown in figure 3a.

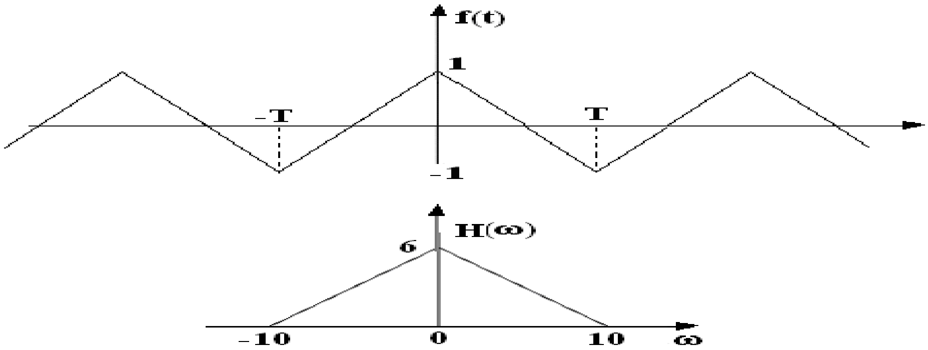

Figure 3a

   (b) $If\ f(t) \leftrightarrow F(\omega)\ Show\ that$
   $\frac{d^n t}{dt^n} \leftrightarrow (j\omega)^n F(\omega)$. [10+6]

4. (a) Define causality and stability with reference to a Linear system and its impulse response.
   (b) Consider an LTI system with the input and output related through the relation.
   $y(t) = \int_{-\alpha}^{\infty} e^{-(t-\tau)} x(\tau - 2) d\tau$
   What is the impulse response h(t) for this system. [8+8]

5. (a) If V(t) = Sin ω ot.
      i. find R(τ)
      ii. Find energy spectral density G$_E$(f) = Fourier transform of R(τ)
   (b) Applying the convolution theorem find Fourier Transform of
   $\left[A\, e^{-|at|} \sin c\, 2Wt\right]$.
   (c) Use the convolution theorem to find the spectrum of x(t) = A Cos^2 ωct. [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) Obtain the Laplace transform of $e^{-at}\, Cos\,(\omega_c t + \theta)$
   (b) Find the Inverse Laplace transform of
      i. $\frac{s^3+1}{s(s+1)(s+2)}$
      ii. $\frac{s-1}{(s+1)(s^2+2s+5)}$ [8+8]

8. (a) Find the inverse z - transform of
   $X(z) = \frac{1}{1024}\left[\frac{1024 - z^{-10}}{1 - \frac{1}{2}z^{-1}}\right]$, $|z| > 0$.
   (b) Distinction between Laplace, Fourier and Z transforms. [8+8]

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

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1. (a) State the properties of impulse function.
   (b) Sketch the following signals:
      i. $\pi\left(\frac{t-1}{2}\right) + \pi(t-1)$
      ii. 3u(t)+t.u (t)-u(t-1) + u(t+1)-5u(t-2). [8+8]

2. (a) Use the defining equation for the Fourier series coefficients to evaluate the Fourier series representation for the following signals.
      i. x(t) = sin (3πt) + Cos (4πt)
      ii. $x(t) = \sum_{m=-\alpha}^{\alpha} \delta\left(t - \frac{m}{3}\right) + \delta(t - \frac{2m}{3})$
   (b) Obtain the Fourier series representation of an impulse train given by $x(t) = \sum_{n=-\alpha}^{\alpha} \delta(t - n\tau_0)$. [8+8]

3. (a) Explain how Fourier Transform is developed from Fourier series.
   (b) Find the Fourier Transform of Cos ω_0t and draw the spectral density function. [8+8]

4. (a) Distinguish between linear and non linear systems with examples.
   (b) Consider a stable LTI System characterized by the differential equation $\frac{dy(t)}{dt} + 2y(t) = x(t)$. Find its impulse response. [8+8]

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

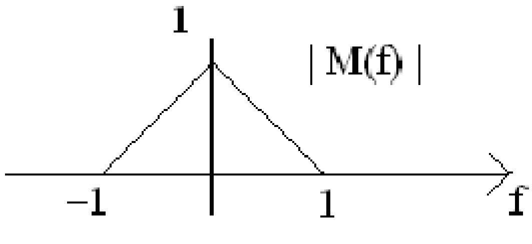

Figure 5a

   (b) The signal V(t) = cos ω_0 t + 2sin 3 ω_0 t + 0.5 sin 4ω_0 t is filtered by an RC low pass filter with a 3 dB frequency. f_c =2f0. Find the output power S_o.

(c) State Parseval?s theorem for energy and power signals. [6+6+4]

6. (a) Explain briefly impulse sampling.
   (b) Define sampling theorem for time limited signal and find the nyquist rate for the following signals.
      i. rect 300t
      ii. 10 sin 40 πt cos 300πt. [8+8]

7. (a) Find the initial values and final values of the function $F(s) = \frac{17s^3 + 7s^2 + s + 6}{s^5 + 3s^4 + 5s^3 + 4s^2 + 2s}$
   (b) Explain the Step and Impulse responses of Series R-C circuit using Laplace transforms. [4+6+6]

8. (a) Explain the properties of the ROC of Z transforms.
   (b) Z transform of a signal x(n) if $X(z) = \frac{1+z^{-1}}{1+\frac{1}{3}z^{-1}}$.
   Use long division method to determine the values of
      i. x[0], x[1], and x[2], assuming the ROC to be $|z| > \frac{1}{3}$
      ii. x[0], x[-1], and x[-2] , assuming the ROC to be $|z| < \frac{1}{3}$. [8+8]

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