Code No: A109210402 **R09** **Set No. 2**

II B.Tech I Semester Examinations,MAY 2011
SIGNALS AND SYSTEMS
Common to BME, ICE, ETM, EIE, ECE

Time: 3 hours **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) With the help of graphical example explain sampling theorem for Band limited signals.
   (b) Explain briefly Band pass sampling. [8+7]

2. (a) The network shown in figure 2a is excited by a voltage source e^{-t}. The switch is closed at t=0.

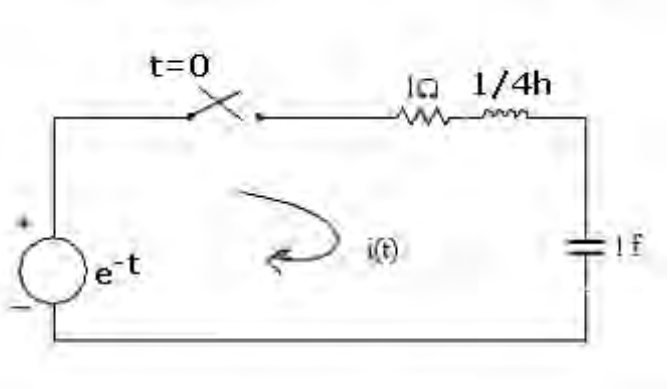

Figure 2a

Find:
   i. The transfer function
   ii. The current i(t)

   (b) Is there any test which can distinguish the physically realizable characteristic from an unrealizable one? Discuss the test with necessary expressions and figures. [8+7]

3. (a) Explain how Fourier Transform is developed from Fourier series.
   (b) Power Signals will have Fourier Transforms and energy signals will here Fourier series in the frequency domain. Justify this statement. [10+5]

4. (a) Find the component of a waveform Sin ω_2t contained in another waveform Sin ω_1t over the interval (-T, T) for all real values of ω_1 and ω_2 ($\omega_1 \neq \omega_2$). How does this component change with T.
   (b) Determine whether the following functions are periodic or non periodic
      i. a Cos 2t + b Sin 7t + c sin 13t
      ii. (a Sin t)^3
      iii. (a Sin 2t + b Sin 5t)^2.
      Where a, b andc are constants. [10+5]

5. (a) A signal y(t) given by $y(t) = C_0 + \sum_{n=1}^{\infty} C_n Cos(n\omega_0 t + \theta_n)$. Find the auto-correlation and PSD of y(t).
   (b) Explain the Graphical representation of convolution with an example. [8+7]

6. (a) A periodic waveform is formed by eliminating the alternate cycle of a Sinusoidal waveform as shown in figure 6a.

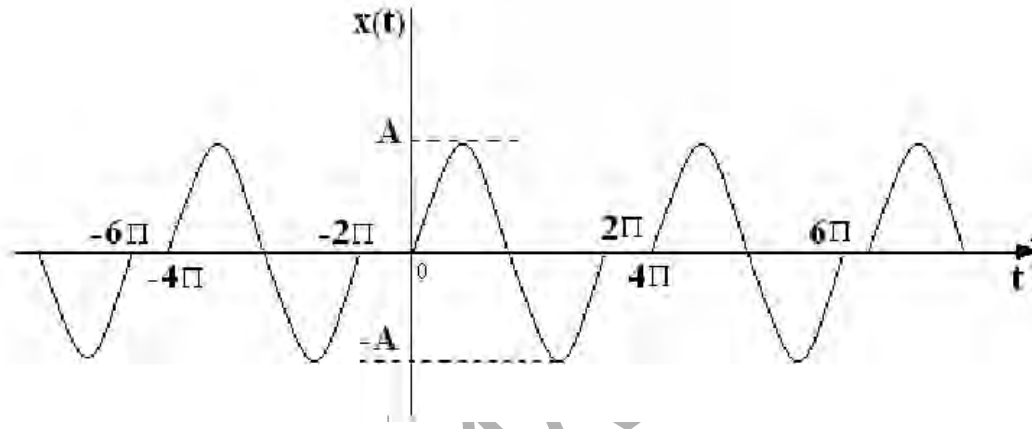

Figure 6a

   i. Find the Fourier series (exponential) by direct evaluation of the coefficients.
   ii. If the waveform is shifted to the left by π seconds, the new waveform f(t+π) is odd function of the time whose Fourier series contains only sine terms. Find the Fourier series of f(t+π). From this series, write down the Fourier series for f(t). [8+7]

7. Determine the constraint on $r = |z|$ for each of the following sums to converge:
   (a) $\sum_{n=-1}^{\infty} \left(\frac{1}{2}\right)^{n+1} z^{-n}$
   (b) $\sum_{n=1}^{\infty} \left(\frac{1}{2}\right)^{-n+1} z^{n}$
   (c) $\sum_{n=0}^{\infty} \left(\frac{1+(-1)^n}{2}\right) z^{-n}$
   (d) $\sum_{n=-\infty}^{\infty} \left(\frac{1}{2}\right)^{|n|} Cos\left(\frac{\pi}{4}n\right) z^{-n}$ [3+4+4+4]

8. (a) Consider an LTI system with input $x(t) = e^{-t}u(t)$ and impulse response $h(t) = e^{-2t}u(t)$. Determine the Laplace transforms of x(t) and h(t). Using convolution property, determine the Laplace transform of the response,Y(s).
   (b) Determine the Laplace transform and the associated ROC and pole-zero plot for the following functions
      i. $x(t) = t\, e^{-2|t|}$
      ii. $x(t) = e^{-4t}u(t) + e^{-5t}(Sin5t)u(t)$ [6+9]

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1. (a) What is orthonormal vector and orthonormal set of vectors.
   (b) Consider the rectangular pulse x(t) as shown in figure 1b.Approximate the above function by A sin 2πt, show that the mean square error is minimum. [7+8]

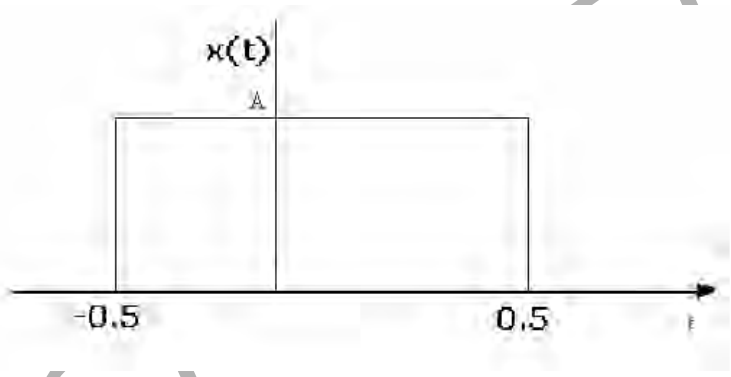

Figure 1b

2. (a) For the following signal, find the power, rms value and sketch the PSD. A Cos 40t + B Sin 60t.
   (b) If the waveform V(t) has the Fourier Transform V(f), then show that the waveform delayed by time t_d i.e V(t-t_d) has the transform of $V(f).e^{-jwt_\alpha}$ [7+8]

3. (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+7]

4. Find the power of periodic signal g(t) shown in figure4. Find also the powers of
   (a) -g(t)
   (b) 2g(t)
   (c) g(-t)
   (d) g(t)/2. [15]

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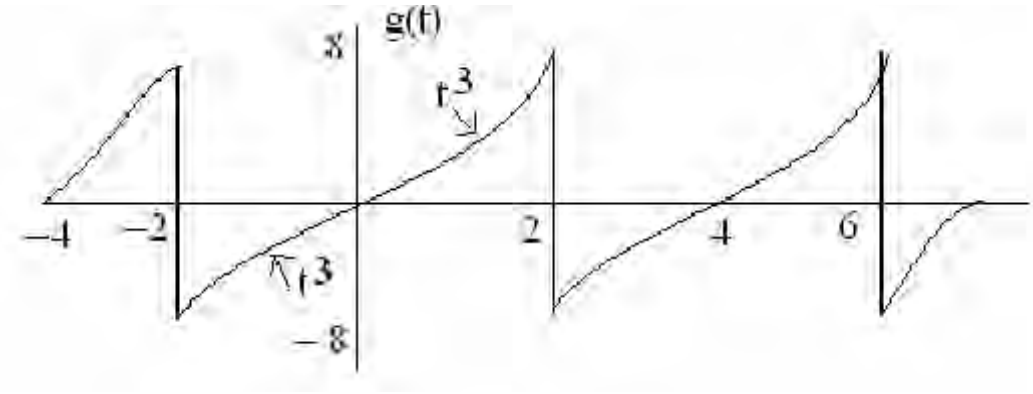

Figure 4

5. (a) Find the Fourier series of the wave shown in figure 5a.

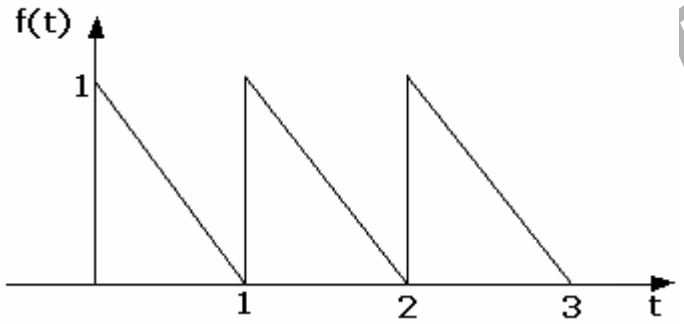

Figure 5a

(b) Determine the Fourier series representation of
x(t) = 2 Sin (2πt-3) + Sin (6πt). [8+7]

6. (a) How we can reconstruct the original signal from sampled signal.

(b) What is an apecture effect? Explain why flat top samples get the aperture effect. [7+8]

7. (a) Find the Z-transform of an $\sin(\eta\omega_0).u(n)$

(b) Find the inverse Z-transform of X(Z) = $(2+Z^3+3Z^4)/(Z^2+4Z+3)$, $|Z| > 0$.

(c) Find the Z-transform of the following signal x(n) = 1 for $0 \leq n <$ N - 1
= 0 elsewhere. [6+5+4]

8. (a) Consider the signal $x(t) = e^{-5t}u(t) + e^{-3t}u(t)$ and denote its Laplace transform by X(s). What are the constraints placed on the real and imaginary parts of ? if the ROC of X(s) is Re{s} > -3?

(b) The system function of a causal LTI system is $H(s) = \frac{(s+1)}{(s^2+2s+2)}$.
Determine and sketch the response y(t) when the input is $x(t) = e^{-|t|}$, $-\infty < t < \infty$. [7+8]

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1. (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+3+4]

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 waveform.
   (b) Determine the exponential form of Fourier series for the waveform in below figure 2b. [8+7]

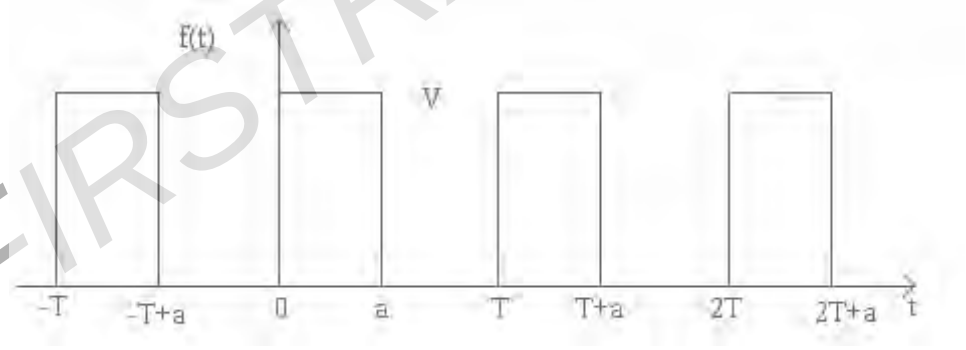

Figure 2b

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+7]

4. (a) Find the Z transform of t^2e^{-at}.
   (b) Find the final value and initial value of x(n) for $X(z) = \frac{z^2}{(z-1)(z-0.2)}$. [7+8]

5. (a) Let two signals be defined by
   $x_1(t) = \begin{cases} 1 & Cos(2\pi t) \geq 1 \\ 0 & Cos(2\pi t) < 1 \end{cases}$
   $x_2(t) = Sin(2\pi t/10)$
   Graph these products over the time range -5 < t <5
   i. $x_1((t-2)/5)\ x_2(20t)$
   ii. $x_1(2t)\ x_2(-t)$

iii. $x_1(t/5)\ x_2(20t)$

iv. $x_1(t/5)\ x_2(\ 20(t+1))$.

(b) Find the signal energy of each of these signals:

i. $x(t) = 2\ \text{Sin}\ (200\pi t)$

ii. $x(t) = 3\ \text{rect}\ (t/4)$. [8+7]

6. (a) Find the current i(t) in a series RLC circuit as shown in figure 6a when a voltage of 100 volts is switched on across the terminals a a[1] at t=0.

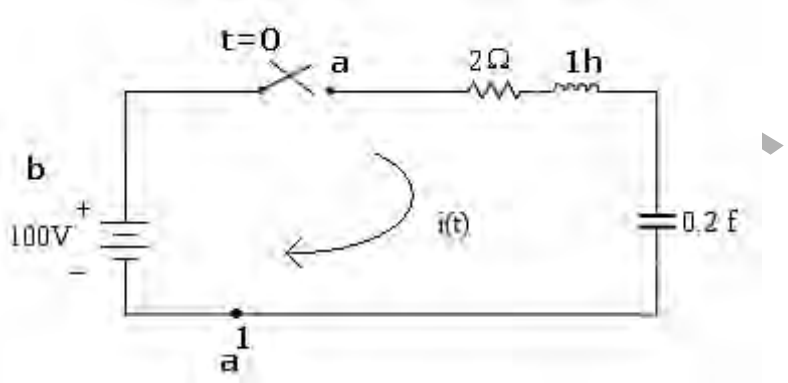

Figure 6a

(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 pass filter. The transfer function of such filter is given by $H(j\omega) = K\ GW\ (\omega)\ e^{-jwt_0}$ Find the response. [8+7]

7. (a) State and Prove Properties of cross correlation function.

(b) If $v(f) = AT\frac{\sin 2\pi fT}{2\pi fT}$ find the energy contained in V(t). [7+8]

8. (a) A low pass signal x(t) has a spectrum x(f) given by

$$x(f) = \begin{matrix} 1 - |f|/200 & |f| < 200 \\ 0 & \text{else} \end{matrix}$$

where

Assume that x(t) is ideally sampled at $f_s = 300$ Hz. Sketch the spectrum of $X_\delta(t)$ for $|f| < 200$

(b) The uniform sampling theorem says that a band limited signal x(t) can be completely specified by its sampled values in the time domain. Now consider a time limited signal x(t) that is zero for $|t| \geq T$. Show that the spectrum x(f) of x(t) can be completely specified by the sampled values $x(kf_0)$ where $f_0 \geq 1/2T$. Where k is an integer. [8+7]

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1. (a) Explain the concept of Fourier Transform for periodic signals.
   (b) Find out the Fourier Transform of the periodic pulse train shown in figure 1b. [8+7]

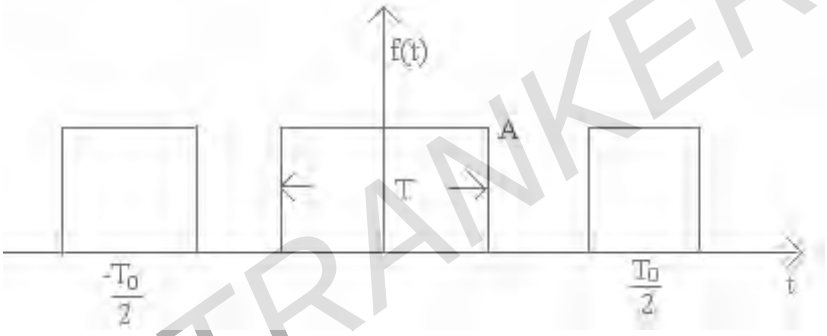

Figure 1b

2. Write about the following:
   (a) Properties of LTI system
   (b) Explain the following:
      i. Causality
      ii. Stability
      iii. Invertability for an LTI system. [7+8]

3. (a) Show that the exponential Fourier series for the symmetric square wave shown in figure 3a.

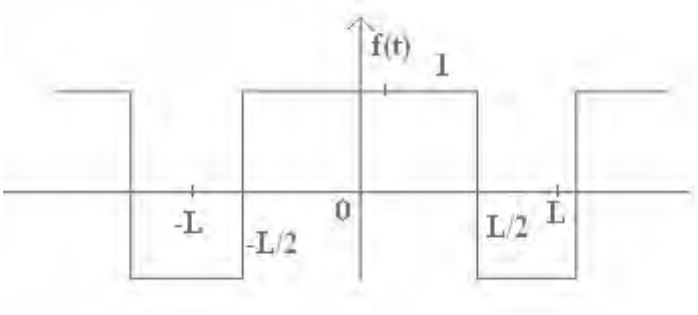

Figure 3a

$$f(t) = \frac{2}{\pi} \sum_{n=-\infty}^{\infty} \frac{(-1)^n}{2n+1} e^{j(2n+1)\frac{\pi}{2}}$$

(b) Show that the Fourier series of a periodic signal with rotational symmetry contain only odd harmonics. [10+5]

4. (a) Derive Parseval's theorem from the frequency convolution property.
   (b) Find the cross correlation between [u(t) + u(t- τ)] and e^{-t} u(t). [7+8]

5. (a) The signal $g(t) = 10\,Cos20\pi t\,Cos200\pi t$ is sampled at the rate of 250 samples per second.
      i. Determine the spectrum of the resulting sampled signal.
      ii. Specify the cut-off frequency of the ideal reconstruction filter so as to recover g(t) from its sampled version.
      iii. What is the Nyquist rate of g(t)?
   (b) What is Natural sampling? [8+7]

6. (a) Obtain the inverse laplace transform of $F(s) = 1/s^2(s+2)$ by convolution integral.
   (b) Using convolution theorem find inverse laplace transform of $s/(s^2+a^2)^2$.
   (c) Define laplace transform of signal f(t) and its region of convergence. [5+6+4]

7. (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+7]

8. (a) Which of the following signals or functions are periodic and if what is its fundamental period.
      i. $g(t) = e^{-j60\pi t}$
      ii. g(t) = 10 Sin (12πt) + 4 Cos (18t)
   (b) Let two functions be defined by:
   $x_1(t) = 1$, Sin $(20\pi t) \geq 0$
   -1 , Sin $(20\pi t) < 0$
   $X_2(t) = t$, Sin $(2\pi t) \geq 0$
   -t Sin $(2\pi t) < 0$
   Graph the product of these two functions vs time over the time interval $-2 < t < 2$. [8+7]

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