

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

- With the help of graphical example explain sampling theorem for Band limited signals.
 - Explain briefly Band pass sampling. [8+7]
- The network shown in figure 2a is excited by a voltage source e^{-t} . The switch is closed at $t=0$.

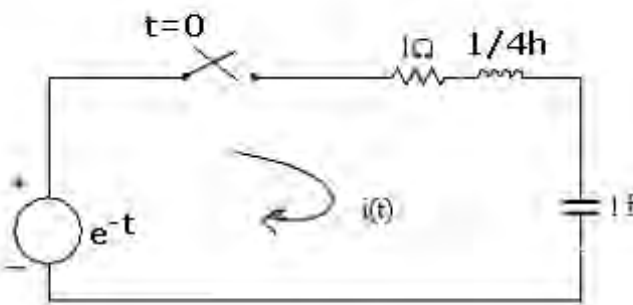


Figure 2a

Find:

- The transfer function
 - The current $i(t)$
- 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]
 - Explain how Fourier Transform is developed from Fourier series.
 - Power Signals will have Fourier Transforms and energy signals will here Fourier series in the frequency domain. Justify this statement. [10+5]
 - Find the component of a waveform $\sin \omega_2 t$ contained in another waveform $\sin \omega_1 t$ 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 .
 - Determine whether the following functions are periodic or non periodic
 - $a \cos 2t + b \sin 7t + c \sin 13t$
 - $(a \sin t)^3$
 - $(a \sin 2t + b \sin 5t)^2$.
 Where a , b and c are constants. [10+5]

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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.

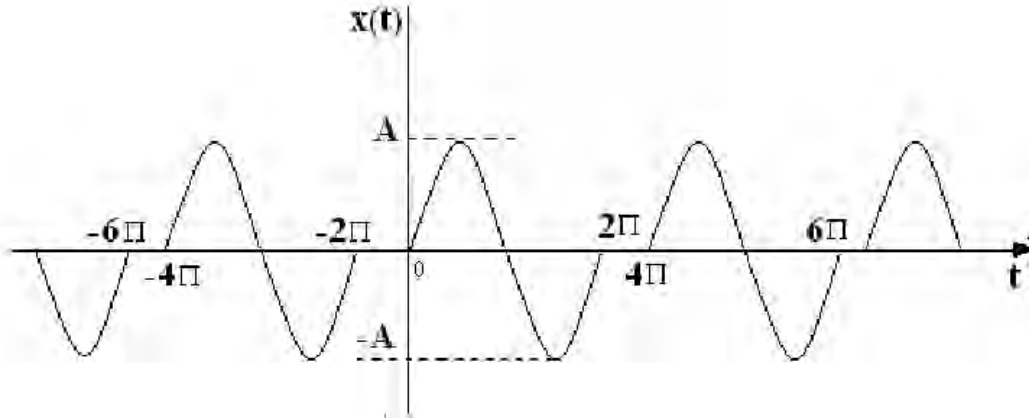


Figure 6a

- 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 $f(t+\pi)$ is odd function of the time whose Fourier series contains only sine terms. Find the Fourier series of $f(t+\pi)$. 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. $x(t) = e^{-4t}u(t) + e^{-5t}(\sin 5t)u(t)$ [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 $A \sin 2\pi t$, show that the mean square error is minimum. [7+8]

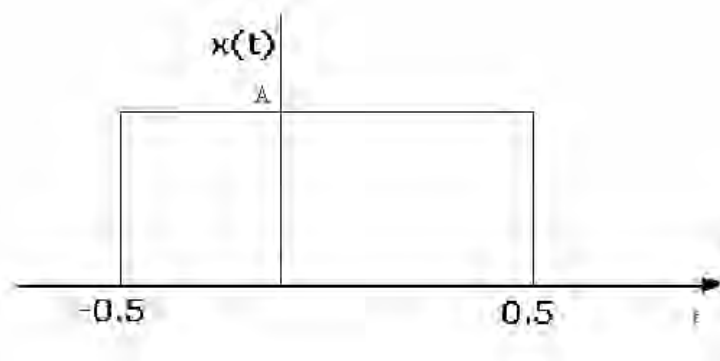


Figure 1b

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 $V(f).e^{-j\omega t_d}$ [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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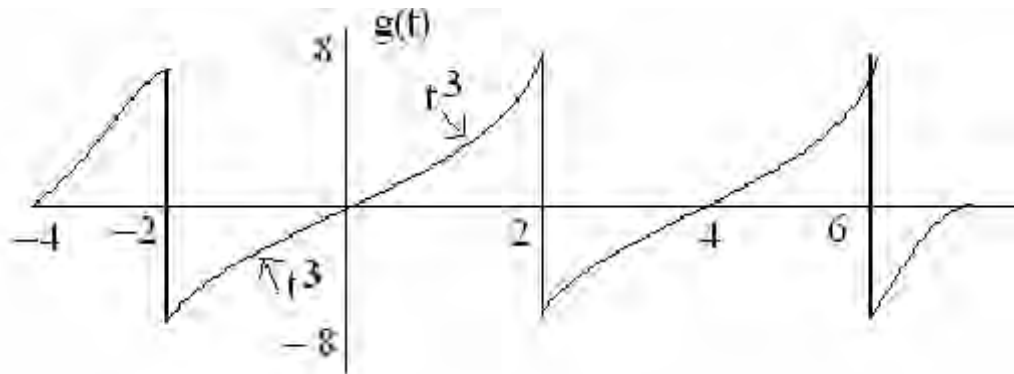


Figure 4

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

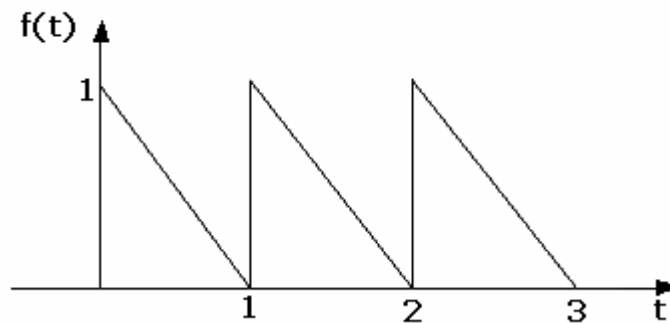


Figure 5a

- (b) Determine the Fourier series representation of $x(t) = 2 \sin(2\pi t - 3) + \sin(6\pi t)$. [8+7]
6. (a) How we can reconstruct the original signal from sampled signal.
 (b) What is an aperture effect? Explain why flat top samples get the aperture effect. [7+8]
7. (a) Find the Z-transform of an $\sin(\eta\omega_0) \cdot u(n)$
 (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 s if the ROC of $X(s)$ is $\text{Re}\{s\} > -3$?
 (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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- When a function $f(t)$ is said to be laplace transformable.
 - What do you mean by region of convergence?
 - List the advantages of Laplace transform.
 - If $\delta(t)$ is a unit impulse function find the laplace transform of $d^2/dt^2 [\delta(t)]$.
[4+4+3+4]
- Prove that the normalized power is given by $P = \sum_{n=-\infty}^{\infty} |C_n|^2$ where $|C_n|$ are complex Fourier coefficients for the periodic waveform.
 - Determine the exponential form of Fourier series for the waveform in below figure 2b. [8+7]

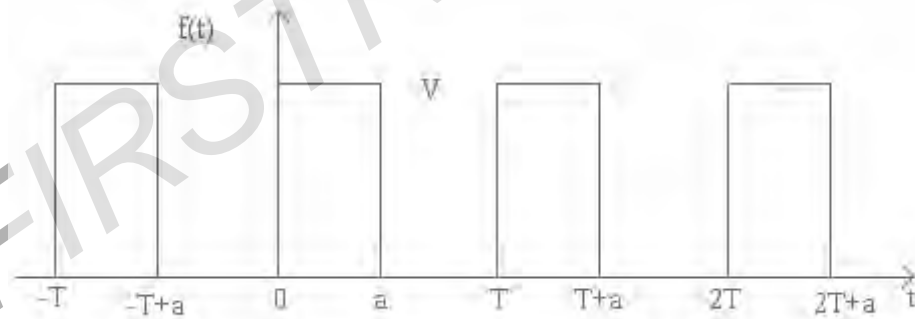


Figure 2b

- Explain how Fourier Transform is developed from Fourier series.
 - Find the Fourier Transform of $\text{Cos } \omega_0 t$ and draw the spectral density function. [8+7]
- Find the Z transform of $t^2 e^{-at}$.
 - Find the final value and initial value of $x(n)$ for $X(z) = \frac{z^2}{(z-1)(z-0.2)}$. [7+8]
- Let two signals be defined by

$$x_1(t) = \begin{cases} 1 & \text{Cos}(2\pi t) \geq 1 \\ 0 & \text{Cos}(2\pi t) < 1 \end{cases}$$

$$x_2(t) = \text{Sin}(2\pi t/10)$$
 Graph these products over the time range $-5 < t < 5$
 - $x_1((t-2)/5) x_2(20t)$
 - $x_1(2t) x_2(-t)$

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- 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. $x(t) = 2 \sin(200\pi t)$

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
- $t=0$
- .

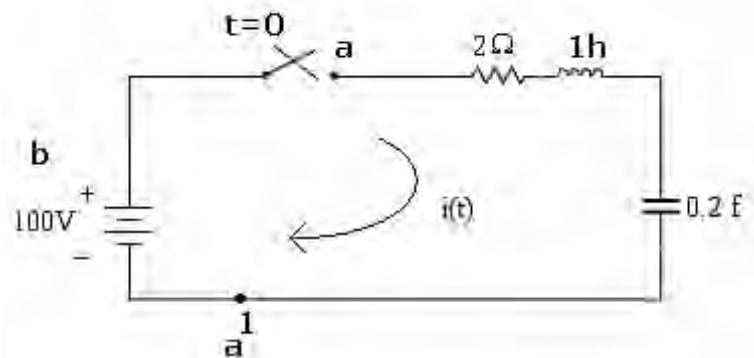


Figure 6a

- (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
- $H(j\omega) = K G W (\omega) e^{-j\omega t_0}$
- 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

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

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]

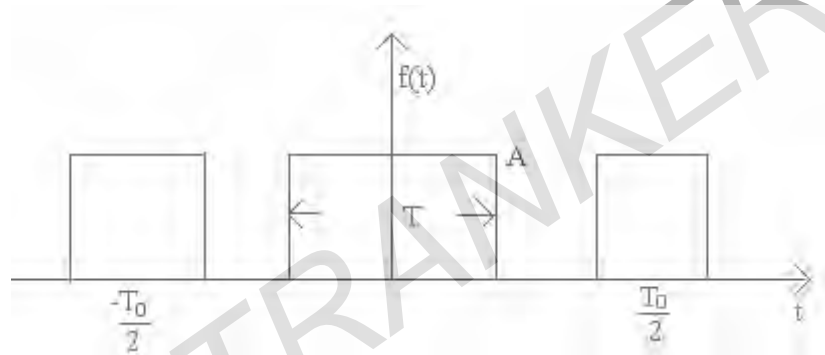


Figure 1b

2. Write about the following:
- Properties of LTI system
 - Explain the following:
 - Causality
 - Stability
 - Invertability for an LTI system. [7+8]
3. (a) Show that the exponential Fourier series for the symmetric square wave shown in figure 3a.

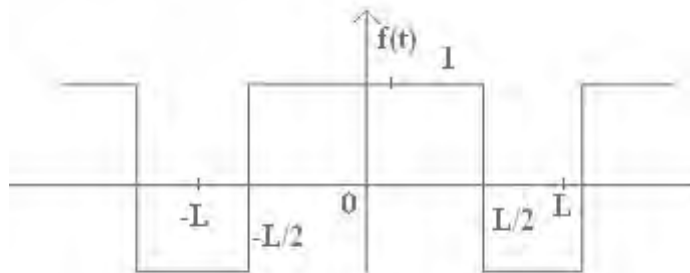


Figure 3a

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

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- (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 $[u(t) + u(t-\tau)]$ and $e^{-t} u(t)$. [7+8]
5. (a) The signal $g(t) = 10 \cos 20\pi t \cos 200\pi t$ 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. $g(t) = 10 \sin (12\pi t) + 4 \cos (18t)$
 (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]
