Code No: R7210404 1

II B.Tech I Semester(R07) Regular & Supplementary Examinations, December 2009
SIGNALS AND SYSTEMS
(Common to Electronics & Communication Engineering, Electronics & Instrumentation Engineering, Electronics & Control Engineering)

Time: 3 hours Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

1. (a) The two periodic functions $f_1(t)$ and $f_2(t)$ with zero dc components have arbitrary waveforms with periods T and $\sqrt{2}T$ respectively. Show that the component in $f_1(t)$ of waveform $f_2(t)$ is zero in the interval $(-\alpha < t < a)$.
   (b) complex Sinusoidal signal x(t) has the following components.
   $Re\{x(t)\} = x_R(t) = A\cos(\omega t+\theta)$
   $I_m\{x(t)\} = x_I(t) = A\sin(\omega t+\theta)$
   The amplitude of x(t) is given by the square root of $x_R^2(t) + x_I^2(t)$. Show that this amplitude equals A and is therefore independent of the phase angle θ. [8+8]

2. (a) A Fourier Series of a continuous periodic function f(t) is given by
   $$f(t) = \sum_{n=-\alpha}^{\alpha} F_n e^{jn\omega_0 t}$$
   Show that the function $\frac{df}{dt}$ is also periodic function of the same period and may be expressed by a series.
   $$\frac{df}{dt} = \sum_{n=-\alpha}^{\alpha} (Jn\omega_0 F_n)\, e^{jn\omega_0 t}$$
   (b) Write short notes on ?Complex Fourier Spectrum?. [8+8]

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) Explain how input and output signals are related to impulse response of a LIT system.
   (b) Let the system function of a LTI system be $\frac{1}{j\omega+2}$. What is the output of the system for an input $(0.8)^t u(t)$. [8+8]

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 autocorrelation and PSD of y(t).
   (b) Explain the Graphical representation of convolution with an example. [8+8]

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) 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 $d^2/dt^2\,[\delta(t)]$.
   [4+4+4+4]

8. (a) Find the Z-transform and ROC of the signal
   $x(n) = [4(5^n) - 3(4^n)]\, u(n)$
   (b) Find the Z-transform as well as ROC for the following sequences: [8+8]
   i. $\left(\frac{1}{3}\right)^n u(-n)$
   ii. $\left(\frac{1}{3}\right)^n [u(-n) - u(n-8)]$

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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) Explain the concept of generalized Fourier series representation of signal f(t).
   (b) State the properties of Fourier series. [8+8]

3. (a) What is duality property of Fourier Transform? Explain.
   (b) Obtain the Fourier Transform for
      i. $x(t) = 6 \sin(200\pi t)$
      ii. $x(t) = \frac{1}{2}\delta(t+1) + \delta\left(t+\frac{1}{2}\right) + \delta\left(t+\frac{1}{2}\right) + \delta(t-1) + 5$. [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) Derive Parseval's theorem from the frequency convolution property.
   (b) Find the cross correlation between $[u(t) + u(t-\tau)]$ and $e^{-t}u(t)$. [8+8]

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) Determine the Laplace transform and the associate region convergence for each of the following functions of time.
      i. $x(t) = 1 \quad 0 \le t \le 1$
      ii. $x(t) = t \quad 0 \le t \le 1$
         $= 2 - t \quad 1 \le t \le 2$
   (b) State and prove initial value theorem of Laplace transform. [10+6]

8. (a) Using the Power Series expansion technique, find the inverse Z-transform of the following X(Z):
      i. $X(Z) = \frac{Z}{2Z^2 - 3Z + 1} \qquad |Z| < \frac{1}{2}$
      ii. $X(Z) = \frac{Z}{2Z^2 - 3Z + 1} \qquad |Z| > 1$
   (b) Find the inverse Z-transform of
      $X(Z) = \frac{z}{(z-1)(z-2)} \quad |Z| > 2$. [8+8]

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1. (a) The two periodic functions $f_1(t)$ and $f_2(t)$ with zero dc components have arbitrary waveforms with periods T and 2T respectively. Show that the component in $f_1(t)$ of waveform $f_2(t)$ is zero in the interval $(-\alpha < t < a)$.
   (b) complex Sinusoidal signal x(t) has the following components.
   $Re\{x(t)\} = x_R(t) = A\cos(\omega t+\theta)$
   $I_m\{x(t)\} = x_I(t) = A\sin(\omega t+\theta)$
   The amplitude of x(t) is given by the square root of $x_R^2(t) + x_I^2(t)$. Show that this amplitude equals A and is therefore independent of the phase angle θ.[8+8]

2. (a) Determine the Fourier series representation of the signal
   $x(t) = 5\cos\left(\frac{\pi t}{2} + \frac{\pi}{4}\right)$
   using the method of inspection.
   (b) Write short notes on ?Line Spectrum?. [10+6]

3. (a) Prove that the normalized power is given by $P = \sum_{n=-\alpha}^{\alpha} |C_n|^2$ W here $|C_n|$ are complex Fourier coefficients for the periodic waveform.
   (b) If the waveform V(t) has the Fourier Transform of V(f), then show that the transform of the integral of V(t) is given by.
   $$F\left[\int_{-\alpha}^{t} v(\lambda)d\lambda\right] = \frac{v(f)}{j2\pi f}.$$ [8+8]

4. The output y(t) of a causal LTI system is related to the input by the equation:
   $$\frac{dy(t)}{dt} + 10y(t) = \int_{-\omega}^{+\omega} x(\tau)z(t-\tau)d\tau - x(t) \text{ where } z(t) = e^{-t}u(t) + 3\delta(t).$$
   (a) Find the frequency response of this system H(ω).
   (b) Determine the impulse response of this system. [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) With the help of graphical example explain sampling theorem for Band limited signals.
   (b) Explain briefly Band pass sampling. [8+8]

7. (a) State the properties of the ROC of Laplace Transforms.
   (b) Determine the function of time x(t) for each of the following Laplace transforms and their associated regions of convergence.[8+8]
   i. $\frac{(s+1)^2}{s^2-s+1}$ Re{S} > 1/2
   ii. $\frac{s^2-s+1}{(s+1)^2}$ Re{S} > − 1

8. (a) Determine the discrete time sequence associated with Z transform given below using power series method:
   $X(z) = \frac{1-\left(\frac{1}{2}\right)z^{-1}}{1+\frac{1}{2}z^{-1}}$ with ROC |z| > 1/ 2
   (b) Explain the initial value theorem and final value theorem of Z transform.[8+8]

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1. (a) Prove that sinusoidal functions are orthogonal functions.

   (b) Write short notes on ?Orthogonal functions?. [8+8]

2. The complex exponential representation of a signal f(t) over the interval (0,T) $f(t) = \sum_{n=-\alpha}^{\alpha} \frac{3}{4}(n\pi)^2 e^{j\pi nt}$

   (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. (a) An AM signal is given by
   $f(t) = 15 \sin(2\pi 10^6 t) + [5 \cos 2\pi 10^3 t + 3 \sin 2\pi 10^2 t]$
   $\sin 2\pi 10^6 t$
   Find the Fourier Transform and draw its spectrum.

   (b) Signal x(t) has Fourier Transform $x(f) = \frac{j2\pi f}{3+j/10}$.

      i. What is total net area under the signal x(t).

      ii. Let $y(t) = \int_{-\alpha}^{t} x(\lambda)d\lambda$ what is the total net area under y(t). [8+8]

4. (a) Explain the difference between the following systems.

      i. Time invariant and Time variant systems.
      ii. Causal and non causal systems

   (b) Consider a stable LTI system characterized by the differential equation $\frac{d^2y(t)}{dt^2} + \frac{dy(t)}{dt} + 3y(t) = \frac{dx(t)}{dt^2} + 2x(t)$.
   Find its impulse response and transfer function. [8+8]

5. (a) Derive Parseval's theorem from the frequency convolution property.

   (b) Find the cross correlation between [u(t) + u(t- τ)] and $e^{-t}u(t)$. [8+8]

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) A sinusoidal voltage 25Sint is applied at the instant t = 0 to an RL circuit with R = 5Ω and L = 1H. Determine i(t) by using Laplace transform method.

   (b) Explain the methods of determining the inverse Laplace transform. [8+8]

8. (a) Using the Power Series expansion technique, find the inverse Z-transform of the following X(Z):

      i. $X(Z) = \frac{Z}{2Z^2-3Z+1}$ $|Z| < \frac{1}{2}$
      ii. $X(Z) = \frac{Z}{2Z^2-3Z+1}$ $|Z| > 1$

   (b) Find the inverse Z-transform of
   $zX(Z) = Z(Z-1)(Z-2)|Z| > 2$. [8+8]