Code No: R21044 **R10** SET - 1

II B. Tech I Semester Supplementary Examinations, Jan - 2015
SIGNALS AND SYSTEMS
(Com. to ECE, EIE, ECC, BME)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks

1. a) Derive the relation between unit step function and signum function along with their appropriate definitions.
   b) Explain how a function can be represented by a closed or a complete set of mutually orthogonal functions.

2. a) Determine the complex Fourier series expansion of a triangular signal with period T = 4 and fundamental frequency of $\omega_0 = \frac{\pi}{2}$
   b) Determine the complex exponential Fourier series representation for each of the following signals: i) $x(t) = \cos(2t + \pi/4)$ ii) $x(t) = \cos 4t + \sin 6t$ iii) $x(t) = \sin^2 t$

3. a) Determine the inverse Fourier Transform of the spectrum shown in Figure 1:

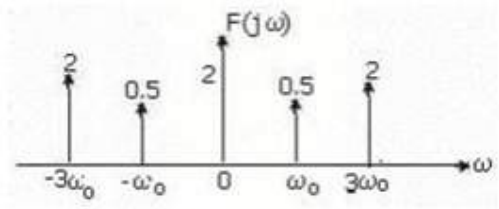

Figure 1

   b) State and prove the following properties of Fourier Transform:
      i) Multiplication in time domain ii) Convolution in time domain.

4. a) Check whether the following systems are linear time invariant systems or not.
      i) $y(t) = \sin x(t)$ ii) $y(t) = tx(t)$ iii) $y(t) = x(t)\cos 200\pi$ iv) $y(t) = te^{-2t}$
   b) Clearly discuss the filter characteristics of linear systems and mention conditions for distortion less transmission of a signal through the system.

5. a) State and prove convolution property of Fourier transform.
   b) Find the power, rms value and sketch the PSD for the following signal;
      x(t)=(A+sin 100t) cos 200t.

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6. a) Discuss sampling of continuous time signals.
   b) Find the Nyquist rate and the Nyquist interval for the signal

$$x(t) = \frac{1}{2\pi}\cos(400\pi t)\ \cos(1000\pi t)$$

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 the unit impulse function, find the Laplace transform of $\frac{d^2}{dt}[\delta(t)]$

8. a) Explain the concept of Z-transform of a discrete time sequence.
   b) Find the transform X(z) and sketch the pole-zero plot with the ROC for each of the following sequences.

i) $x(n) = \left(\frac{1}{2}\right)^n u(n) + \left(\frac{1}{3}\right)^n u(n)$ ii) $x(n) = \left(\frac{1}{3}\right)^n u(n) + \left(\frac{1}{3}\right)^n u(-n-1)$

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1. a) Find whether the following signals are even or odd
   i) $x(n) = Sin(-2\pi n)$ ii) $x(n) = Cos(2\pi n)$
   b) Define Mean square error and derive the expression for evaluating mean square error.

2. The complex exponential representation of a signal $f(t)$ over the interval (0,T) is given by
   $f(t) = \sum_{n=-\infty}^{\infty} (\frac{3}{4} + (n\pi)2)t$
   a) Find the numerical value of T.
   b) One of the components of $f(t)$ is $A\cos 3\pi t$. Determine the value of A.
   c) Determine the minimum number 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).

3. a) Explain the concept of time scaling and time shifting with an example for each.
   b) Using the properties of FT, compute the FT for the following signals
   i) $x(t) = \sin(2\pi t)e^{-t}u(t)$ ii) $x(t) = te^{-3|t-1|}$

4. a) Find the impulse response of the system shown in Figure 1. Find the transfer function. What would be its frequency response? Sketch the response.

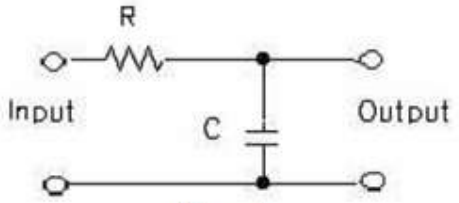

Figure 1

   b) Obtain the relationship between rise time and band width of a low pass filter when unit step signal is applied.

5. a) If $y(t) = x(t) * h(t)$ then show that $x(t-t_1) * h(t-t_2) = y(t-t_1-t_2)$
   b) Derive an expression that relates Energy Spectral Density and Autocorrelation function.

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6. a) Define Nyquist rate. Compare the merits and demerits of performing sampling using impuse, natural and flat-top sampling techniques.
   b) Determine the minimum sampling rate and Nyquist interval of the signal given by sin (200t) + sin (1000t).

7. a) Find the initial and final values of signal x(t) whose Laplace transform is
   $X(s) = (5s+1)/[s(s+2)]$
   b) Find inverse of following Laplace transform
   $X(s) = \frac{1}{s+1} - \frac{2}{s-1}$, If ROC is $1 < \mathrm{Re}(s)$
   c) Find the Laplace transform of the signal
   $x(t) = e^{-t}\,u(t) + e^{-2t}\,u(-t)$

8. a) Explain different properties of ROC of Z-transform
   b) Find the inverse Z-transform of the function $X(z) = \log(\frac{z+3}{z})$ for $|z|>3$

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1. a) A rectangular function *f(t)* is defined by

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

Approximate this function by a waveform sin *t* over the interval (0, 2π) such that the mean square error is minimum.
b) Explain how vector analogy with signal is useful for spectral or signal analysis.

2. a) Find the exponential Fourier series of a signal of $x(t) = cos5t \sin 3t$.
b) Determine the trigonometric and exponential Fourier series of the function shown in Figure 1.

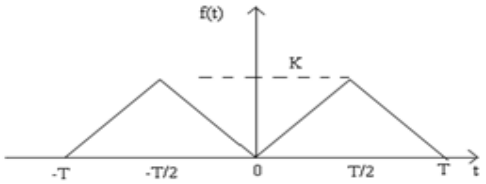

Figure 1

3. a) Consider a continuous time LTI system described by $\frac{dy(t)}{dt} + 2y(t) = x(t)$. Using the Fourier transform, find the output y(t) to each of the following input signals:
i) $x(t) = e^{-t}u(t)$ ii) $x(t) = u(t)$
b) Derive the FT from the Fourier series.

4. a) What is an LTI system? Explain its properties.
b) Test the linearity, causality, time-variance of the system governed by the equation
i) $y(n) = x(n - n_0)$ ii) $y(n) = \cos(n\omega_0)x(n)$ iii) $y(n) = a[x(n)]^2 + b$

5. a) State and Prove frequency convolution theorem.
b) Discuss cross correlation and its properties.

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6. a) Explain flat top sampling.
   b) State and prove sampling theorem for low pass signals. Also, explain the recovery of original signal from its sampled signal. Draw neat diagrams wherever necessary.

7. a) Find the Laplace transform of the following, $f(t) = 3.e^{-4t}.t.\cos(2(t-1))$
   b) Obtain inverse Laplace transform, $X(s) = \dfrac{3s^2 + 22s + 27}{(s^2 + 3s + 2)(s^2 + 2s + 5)}$

8. a) What is region of convergence? List the advantages of Laplace transform.
   b) Determine the inverse Z-Transform of the following X(z) by the partial fraction expansion method, $X(z) = \dfrac{z+2}{2z^2 - 7z + 2}$. If the ROCs is i) |z| > 3, ii) |z| < 1/ 2

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Answer any **FIVE** Questions
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1. a) Derive the condition for the two signals $f_1(t)$ and $f_2(t)$ to be orthogonal to each other.
   b) Sketch the following signal $x(t) = e^{-a|t|}$ for a > 0.
   Also determine whether the signal is a power signal or an energy signal or neither.

2. a) Determine the Fourier series representation of $x(t) = 2Sin(2\pi t - 3) + Sin(4\pi t)$
   b) Write Drichlet's conditions to obtain Fourier series representation of any signal.

3. a) Find the Fourier Transform of the following waveforms shown in Figure 1.

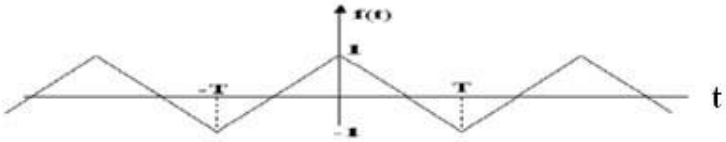

Figure 1

   b) If $f(t) \leftrightarrow F(\omega)$, show that $\frac{d^n t}{dt^n} \leftrightarrow (j\omega)^n F(\omega)$

4. a) The frequency response of a causal and stable continuous time LTI system is expressed as $H(j\omega) = \frac{1 - j\omega}{1 + j\omega}$
   i) Determine the magnitude of $H(j\omega)$ ii) Find phase response of $H(j\omega)$
   b) Discuss the characteristics of band pass filter.

5. a) State and prove Parseval's Theorem for continuous domain periodic signal.
   b) Find the convolution of two signals x(n)={2,1,0,-1,1} and h(n)= {1,-2,-3,5} and represent them graphically.

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6. a) Discuss the process of reconstructing the signal from its samples.
   b) Discuss the effect of under sampling.

7. a) Find the Laplace transform of $[4e^{-2t}\cos 5t - 3e^{-2t}\sin 5t]*u(t)$ and its ROC
   b) Find the inverse Laplace transform of X(s) = (-5s – 7)/ [(s + 1) (s - 1) (s - 2)]

8. a) State and prove any four z-transform properties
   b) The z-transform of a particular discrete time signal x(n) is expressed as
   $X(z) = \frac{1+0.5z^{-1}}{1-0.5z^{-1}}$ Determine the x(n) using time shifting property.