Code No: X0423 **R07** SET - 1

II B. Tech I Semester, Supplementary Examinations, Nov – 2012
SIGNALS AND SYSTEMS
(Com. to ECE, EIE, BME)

Time: 3 hours Max. Marks: 80

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) A rectangular function is defined as

$$f(t) = \begin{cases} A \;\; for \;\; 0 \le t \le \dfrac{\pi}{2} \\ -A \;\; for \;\; \dfrac{\pi}{2} \le t \le 3\dfrac{\pi}{2} \\ A \;\; for \;\; 3\dfrac{\pi}{2} \le t \le 2\pi \end{cases}$$

Approximate above function by A cost between the intervals (0, 2π) such that mean square error is minimum.

b) Explain how a function can be approximated by a set of orthogonal functions.

2. a) Consider the periodic square wave x(t) as shown in Figure 1 given below. Determine the complex exponential Fourier series of x(t).

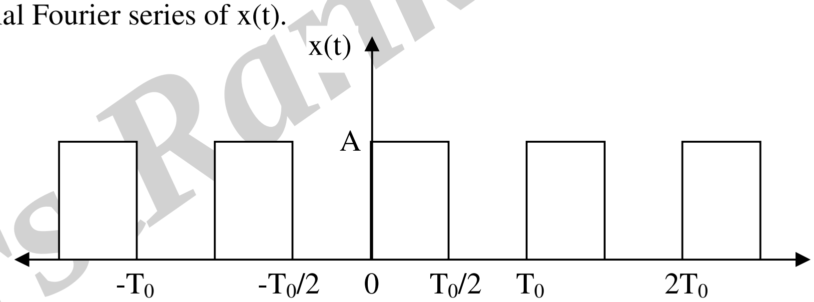

Figure 1

b) State and prove the following Fourier series properties.
i) Time differentiation ii) Frequency shift

3. a) Consider a continuous time LTI system described by $\dfrac{d\,y(t)}{dt} + 2y(t) = x(t)$. 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) State and prove the following properties of Fourier transform:
i) Multiplication in time domain ii) Convolution in time domain
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4. a) The frequency response H(jω) of a causal LTI filter is shown in Figure 2 given below. Find the filtered output signal y(t) for the following input signals

i) $x(t) = \sin(\omega_0 t)u(t)$ ii) $x(j\omega) = \dfrac{1}{2 + j\omega}$

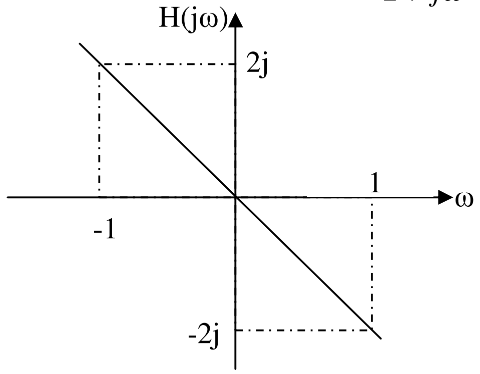

Figure-2

b) Given a continuous LTI system with unit impulse response h(t). A continuous time signal x(t) is applied to the input of this LTI system, where, $x(t) = e^{-at}u(t)$ for a>0 and $h(t) = u(t)$ and evaluate the output.

5. a) Compute the convolution sum y(n) to the following pair of sequences:

i) $x(n) = y(n), \mathrm{h(n)} = 2^n u(-n)$ ii) $x(n) = \left(\frac{1}{2}\right)^n u(n), h(n) = \delta(n) - \frac{1}{2}\delta(n-1)$

b) State and prove convolution property of Fourier transforms.

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

$x(t) = \dfrac{1}{2\pi}\cos(4000\pi t)\cos(1000\pi t)$

7. a) A cosine wave cosωt is applied as the input to the series RL circuit shown in Figure 3 given below. Find the resultant current i (t) if the switch S is closed at t=0

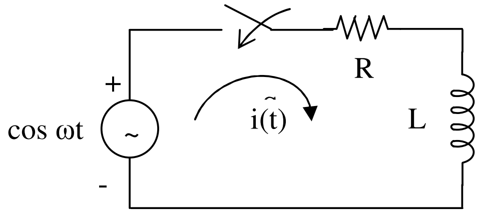

Figure-3

b) State and prove any four Laplace transform properties

8. a) The z-transform of a particular discrete time signal x(n) is expressed as

$X(z) = \dfrac{1 + 0.5Z^{-1}}{1 - 0.5Z^{-1}}$ Determine the x(n) using time shifting property.

b) State and prove any four z-transform properties.

Code No: X0423 **R07** SET - 2

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1. a) Check whether the following signals are orthogonal or not

   $X_1(n) = e^{jk(\pi/8)n}$ and $X_2(n) = e^{jm(2\pi+\pi/8)n}$

   b) Define mean square error and derive the expression for evaluating mean square error.

2. a) Consider the periodic impulse train $\delta_{T0}(t)$ which is defined $\delta_{T0}(t) = \sum_{K=-\infty}^{\infty} \delta(t - KT_0)$

   Determine the complex exponential Fourier series.

   b) Explain the trigonometric Fourier series with necessary mathematical expressions

3. a) Find the Fourier transform of the signal $X(t) = \dfrac{\sin at}{\pi t}$

   b) Briefly explain the following terms:

   i) Hilbert transforms ii) Modulation theorem

4. a) What is an LTI system? Explain its properties.

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

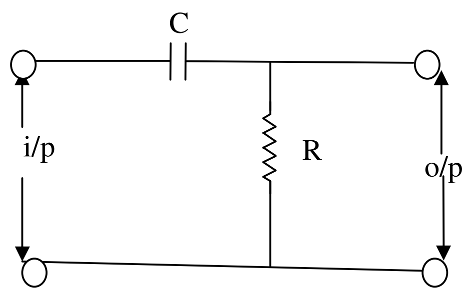

Figure 1
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5. a) *If* $y(t) = x(t) * h(t)$ then show that $x(t-t_1) * h(t-t_2) = y(t-t_1-t_2)$

   b) Derive an expression that relates energy spectral density and autocorrelation function.

6. a) A continuous time signal is given below: x(t) = 8 cos 200πt

   i) Minimum sampling rate

   ii) If f_s=400Hz, what is the continuous signal obtained after sampling

   iii) What is the frequency $0 < f < f_s/2$ of sinusoidal that yields samples identical to those obtained in part (ii)

   b) State and explain Sampling theorem for continuous signals.

7. a) Discuss various properties of ROC's for Laplace transform.

   b) Determine the inverse Laplace transform of the following:

   i) $\dfrac{s^3+1}{s(s+1)(s+2)}$ ii) $\dfrac{s-1}{(s+1)(s^2+2s+5)}$

8. a) Using long division, determine the inverse Z-transform of

$$X(z) = \frac{1}{1-\left(\frac{3}{2}\right)z^{-1}+\left(\frac{1}{2}\right)z^{-2}}$$

   b) State and prove the following properties

   i) Convolution property ii) Correlation property

   iii) Time shifting property iv) Time reversal property

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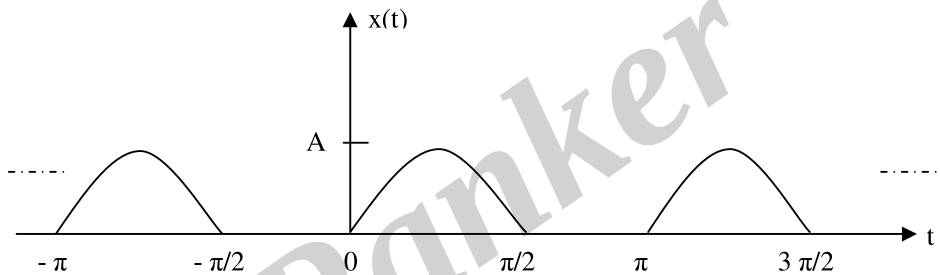
1. a) Prove the following signals are periodic and their fundamental period is $2\pi/\omega_0$

   i) $x(t) = e^{j\omega_0 t}$ ii) $x(t) = \cos(\omega_0 t + \theta)$

   b) Explain the concepts of impulse function, unit step function and signum function.

2. a) Find the Fourier series expansion of the half wave rectified sine wave shown below.



   b) Discuss the Drichlet conditions.

3. a) Show that $x(t)\cos\omega_0 t \leftrightarrow \frac{1}{2}X(\omega-\omega_0)+\frac{1}{2}X(\omega+\omega_0)$ and

$$X(t)\sin\omega_0 t \leftrightarrow -j\left[\frac{1}{2}X(\omega-\omega_0)-\frac{1}{2}X(\omega+\omega_0)\right]$$

   b) Find the fourier transform of the following signal.

$$Sgn(t) = \begin{cases} 1 & for\ t > 0 \\ -1 & for\ t < 0 \end{cases}$$
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4. a) What is Paley-Winer criterion? Explain its significance
b) Determine the maximum bandwidth of signals that can be transmitted through low pass RC filter as shown in the Figure 1 given below, if over this bandwidth the gain variation is to be within 10% and the phase variation is to be within 7% of the ideal characteristics.

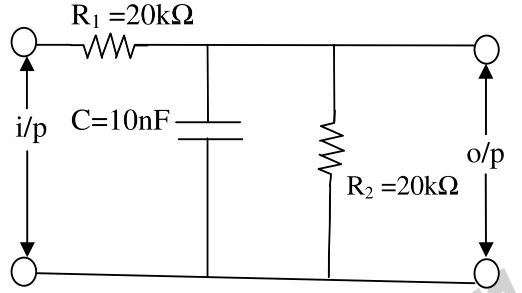

Figure 1

5. a) Discuss cross correlation and its properties.
b) Find the power, rms value and sketch the PSD for the following signal.
x(t) = (A+sin 100t) cos 200t

6. a) Determine the Nyquist rate for a continuous time signal
x(t) = 6 cos50πt+20 sin 300πt+10 cos 100πt
b) Explain the following terms:
i) Natural sampling ii) Importance of sampling theorem

7. a) State and prove initial and final value theorem wrt Laplace transform
b) Determine the Laplace transform of the following:
i) x(t) = sin (at) cos (bt) ii) $x(t) = \text{Cos}^3\, 3t$ iii) x(t) = t sin at

8. a) 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 ROC's are
i) $|Z| > 3$ ii) $|Z| < 1/2$ iii) $\frac{1}{2} < |Z| < 3$
b) Explain the differentiation property of Z-transform.

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1. a) Discuss how an unknown function f(t) can be expressed using infinite mutually orthogonal function. Show the representation of a waveform f(t) using trigonometric Fourier series.
   b) Determine whether the following signals are energy signals, power signals or neither.
   i) $x(t) = A\cos(\omega_0 t + \theta)$ ii) $x(t) = e^{-at}u(t), a > 0$ iii) $x(t) = t\,u(t)$

2. a) 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) $x(t) = \sin^2 t$
   b) Write short notes on "Complex Fourier Spectrum".

3. a) Prove the frequency convolution theorem that is $x_1(t)x_2(t) \leftrightarrow \frac{1}{2\pi} X_1(\omega) * X_2(\omega)$
   b) Find the inverse Fourier transform of the following:
   i) $X(\omega) = \frac{1}{(a + j\omega)^2}$ ii) $X(\omega) = \frac{1}{a - j\omega}$

4. a) Obtain the conditions for the distortion less transmission through a system. What do you understand by the term signal bandwidth & system bandwidth?
   b) Check whether the following systems are linear time invariant systems or not.
   i) y(t) = sin x(t) ii) y(t) = t x(t) iii) y(t) = x(t) cos 200 π iv) y(t) = t e^{-2t}
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5. a) Discuss the relation between convolution & correlation and briefly explain autocorrelation and its properties.

   b) For the signal $x(t) = e^{-at}\,u(t)$, find out the total energy contained in the frequency band $|f| \le W \text{ where } W = a/2\pi$

6. a) Discuss different sampling techniques.

   b) Explain the effect of under sampling-aliasing.

7. a) Define Laplace transform. Distinguish between Laplace transform and continuous time Fourier transforms.

   b) Find the output response y(t) of the RC low pass network as shown in the Figure 1 given below due to the input $x(t) = t\,e^{-t/RC}$ by convolution.

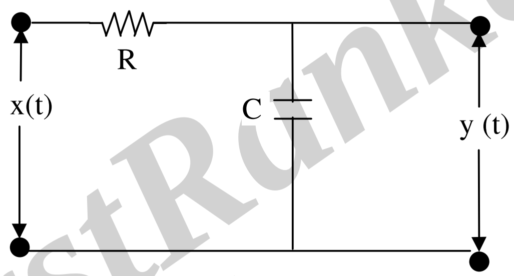

Figure 1

8. a) Determine the final value of the signal corresponding to the Z-transform

$$X(Z) = \frac{2Z^{-1}}{1-1.8Z^{-1}+0.8Z^{-2}}$$

   b) Explain different properties of ROC of Z-transform.