Bengal Engineering and Science University
Final-Sem Examination 2013-November
3rd Sem E&T.C.
Subject: Signal and System (ET 301)
Time: 3 Hours   F.M. 70

Answer question 1 and any five from the rest.
Besides question 1, all questions carry equal marks.

1. Answer all questions. Answer of the each question must be justified by the necessary explanation and mathematical statement. No credit will be given if only the answer is written and justification is not proper. $2 \times 10 = 20$

   (a) Compute, $x(t-1) * \delta(t-3)$, '*' indicates convolution.

   (b) Discrete time Fourier transform of a sequence is $X(e^{jw})$. If

   $$X(e^{jw}) = \sum_{k=-\infty}^{+\infty} 2\pi\delta(w + 2\pi k) \quad \text{then compute x(n).}$$

   (c) A Gaussian random voltage X has a mean of $m_x = 0$ and variance of $\sigma_x^2 = 9$. The voltage is applied to a square law diode detector with transfer characteristic $Y = 5X^2$. Find the mean value of the output voltage Y ?

   (d) Consider the continuous random process $X(t) = B \cos(2\pi t)$, where B is a random variable that has a uniform density range $[-1, +1]$. Compute mean of $X(t)$.

   (e) If $\delta(t)$ is defined as an impulse function, then compute

   $$\int_{-\infty}^{+\infty} \delta(t)\cos(2t + \pi)dt$$

   (f) Express the signal shown in the figure below as a composite form (i.e., unit step and/or impulse etc.).
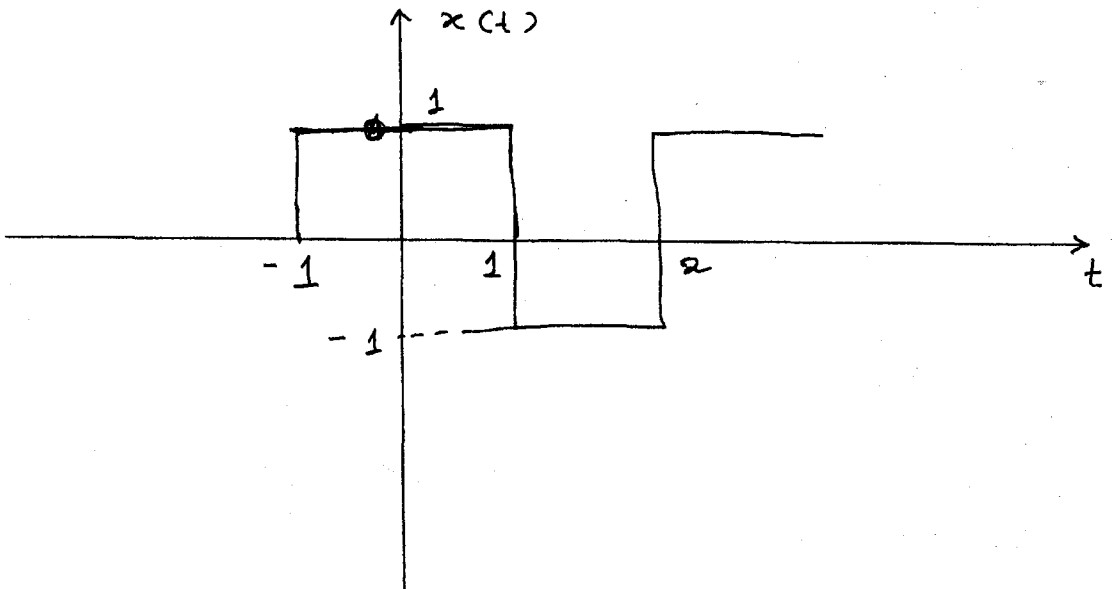
(g) Compute the energy of the signal $x(t) = e^{-3t}u(t)$.

(h) A continuous time signal x(t) = 5 cos 200 πt is sampled by a signal y(t) (with frequency f_s). The signal is sampled at nyquist rate, then determine the characteristic of time period of the signal y(t).

(i) A signal $x(t) = 10e^{-j5t-3}$, then determine the periodicity and frequency of the signal.

(j) A discrete time system has the input-output relationship

$$y(n) = x(n) \ , \ n >= 1 \ (\text{i.e., greater than equal to 1})$$
$$= 0 \ , \ n = 0$$
$$= (n-1) \ \ n <= -1 \ (\text{i.e., less than equal to -1})$$

x(n) is the input, y(n) is the output. Determine the characteristic of the system (i.e., linearity, non linearity ... etc.)

2. a) Determine the response y(n), n >= 0 of the system described by the second order difference equation, y(n) - 3 y(n-1) –4 y(n-2) = x(n) + 2 x(n-1) when the input sequence is $x(n) = 4^n u(n-1)$.

b) Determine homogeneous solution of the system described by the first order difference equation $y(n) + a_1 y(n-1) = x(n)$.
For both the cases consider initial conditions are zero.

c) Explain how linearity and causality of a continuous system is determined.

3. a) Determine the cross correlation function sequence r_{xy} (xy)(l) of the sequences
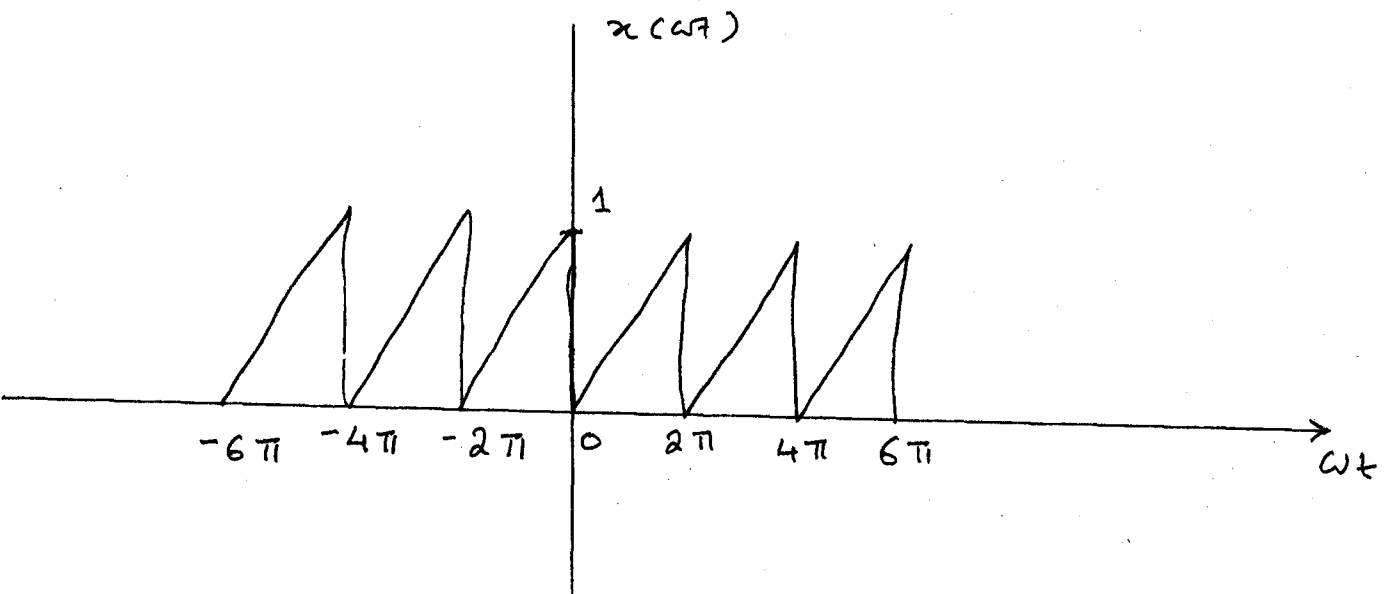
x(n) = { ....0, 0, 2, -1,3,7, 1, 2, -3, 0, 0, ...}
↑
↓

y(n) = { ....0, 0, 1, -1, , -2, 4, 1, -2, 5, 0, 0, ...}

b) Compute auto correlation of the signal
x(n) = a^n u(n),   0 <a <1, . Also, draw the rough diagram of the computed result.

c) Discuss the difference between correlation and convolution.

4. a) Find the trigonometric Fourier series for the continuous time saw-tooth waveform shown in the figure below.

(b) Find the trigonometric Fourier series representation for the rectified sine wave shown in the figure below.
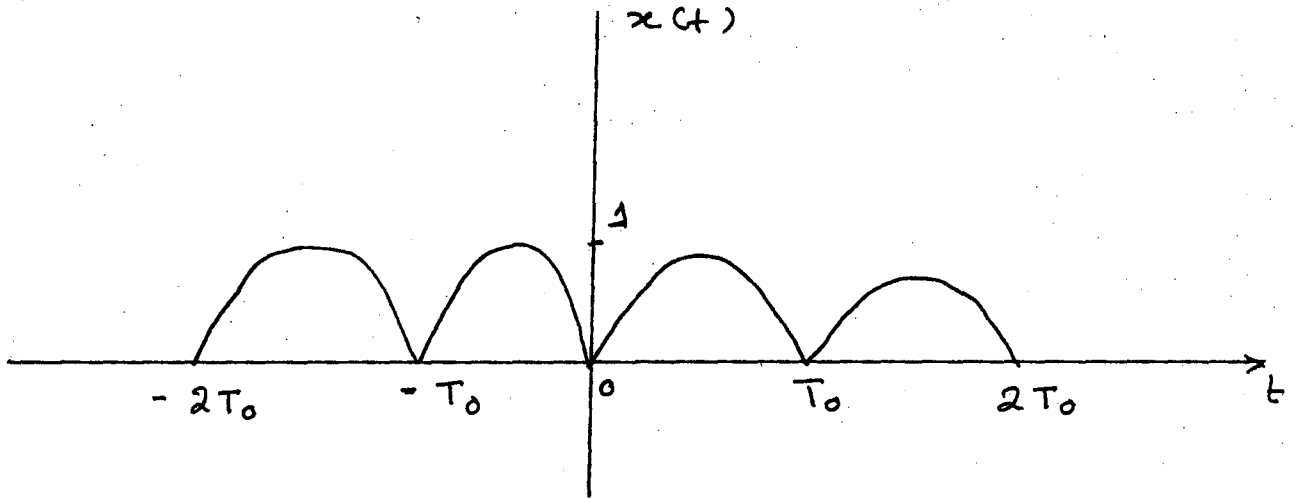
5. a) Determine the Fourier series coefficients and power spectral density spectrum of the periodic signal shown in the figure below.
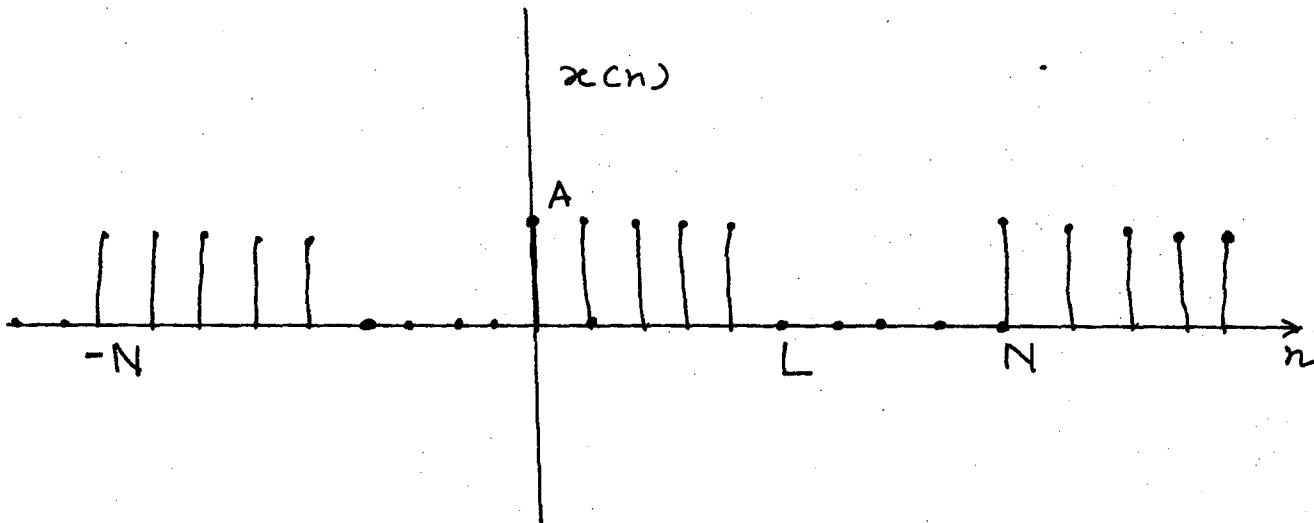
b) Determine the Fourier transform and energy density spectrum of the sequence,

$$x(n) = A \qquad 0 <= n <= L\text{-}1$$
$$= 0 \qquad \text{otherwise.}$$

which is expressed in the figure below.

c) Explain the differences between Fourier series and Fourier transform.

6. a) What do you mean by symmetry properties of the Fourier transform of the discrete time signal? Discuss the symmetru properties and its implication of the properties in the frequency domain for real signals.
   b) Write the properties and theorem of Fourier transform.

7. a) Determine the unit impulse response h(t) for a system specified by the equation, $(D^2 + 4D + 3) y(t) = D f(t)$, operational notation D represents d/dt.
   b) Discuss the differences between time average and ensemble average.
   c) What do you men by the term orthogonality? Discuss the orthogonality of a vector and signal.

8. a) Suppose that the low pass filter illustrated in the figure below is excited by a stochastic process x(t) having a power density spectrum

$$\Phi_{xx}(f) = \frac{N_0}{2} \quad \text{for all } f.$$

Determine the power density spectrum of the output process.
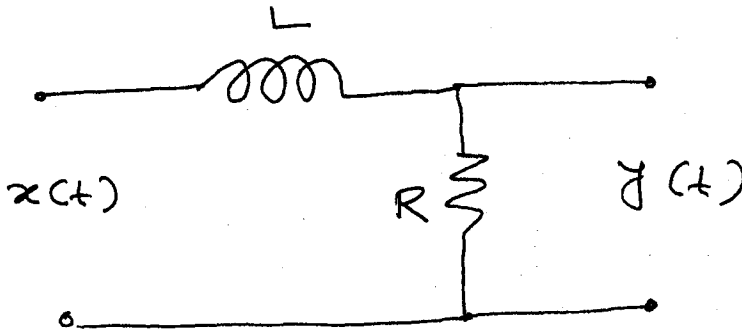
b) State and explain the differences between stationary and ergodic process.
c) What do you mean by Gaussian process.

9. Write short notes on:
   a) White noise.

b) Hilbert transform.
c) Thermal noise.
d) Zero input response and zero state response.