

**2011**

**SIGNALS AND SYSTEM**

*Time Allotted : 3 Hours*

*Full Marks : 70*

*The figures in the margin indicate full marks.*

*Candidates are required to give their answers in their own words  
as far as practicable.*

**GROUP – A**

**( Multiple Choice Type Questions )**

1. Choose the correct alternatives for any *ten* of the following :

$10 \times 1 = 10$

i) Which of the following signals is power signal ?

a)  $x(n) = \left(\frac{1}{3}\right)^n u(n)$       b)  $x(n) = e^{j\pi n}$

c)  $x(n) = e^{2n} u(n)$       d)  $x(n) = e^{2n} u(n+1)$ .

ii) Determine the following discrete time systems are time invariant or not ?

1)  $y(n) = \cos [x(n)]$

2)  $y(n) = x(n) + x(n-1)$

3)  $y(n) = x(-n)$

a) 1 and 2 are time variant, 3 is time invariant

b) 1 and 3 are time variant, 2 is time invariant

c) 3 and 2 are time variant, 1 is time invariant

d) all are time variant system.

iii) Determine if the systems described by the following input-output equations are linear or non-linear.

1)  $y(n) = x^2(n)$

2)  $y(n) = nx(n)$

- a) 1 is linear, 2 is nonlinear
- b) 2 is linear, 1 is nonlinear
- c) 1 and 2 both are linear
- d) 1 and 2 both are nonlinear.

iv) Determine if the systems described by the following input-output equations are causal or non-causal.

1)  $y(n) = x(n^2)$

2)  $y(n) = \sum_{n=0}^{N-1} x(n)$

- a) 1 is causal but 2 is non-causal
- b) 2 is causal but 1 is non-causal
- c) 1 and 2 both are causal
- d) 1 and 2 both are non-causal.

v) The fundamental period of the sequence,  $x(n) = \cos(2n\pi/3)$  is

- a) 1
- b) 2
- c) 3
- d) 6.

vi) The Fourier coefficient  $a_n$  can be evaluated as

a)  $2/T \int_{-\infty}^{\infty} x(t) \cos n\omega t dt$

b)  $2/T \int_0^T x(t) \cos n\omega t dt$

c)  $2/T \int_{-T/2}^{T/2} x(t) \sin n\omega t dt$

d)  $2/T \int_0^{\infty} x(t) \cos n\omega t dt.$

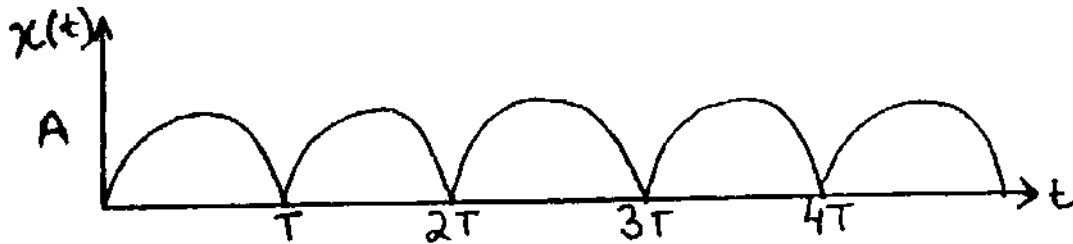
- vii) The step response of an LTI system when the impulse response  $h(n)$  is unit step  $u(n)$  is
- a)  $n+1$                                       b)  $n$
- c)  $n-1$                                       d)  $n^2$ .
- viii) If the signal  $x(t)$  has odd and half wave symmetry, then the Fourier series will have only
- a) odd harmonics of sine terms
- b) constant term and odd harmonics of cosine terms
- c) even harmonics of sine terms
- d) odd harmonics of cosine terms.
- ix) An LTI system is stable, if the impulse response is
- a)  $\sum_{n=-\infty}^{\infty} |h(n)| < \infty$                       b)  $\sum_{n=-\infty}^{\infty} |h(n)| < 0$
- c)  $\sum_{n=-\infty}^{\infty} |h(n)| \neq 0$                   d) either (a) or (b).
- x) The z-transform of a signal is given by  
 $(1 - 2 \cdot 3z^{-1}) / (0.5 - 0.2z^{-1})(1 - z^{-1})$   
The steady state value of the signal is
- a)  $\infty$     b) 0
- c) 1.0    d) 2.0.
- xi) Power signals are the signal with
- a)  $0 < E < \infty, P = 0$                       b)  $0 < E < \infty, P = \infty$
- c)  $0 < P < \infty, E = \infty$                       d)  $0 < P < \infty, E = 0$ .
- xii) Even part of the unit step signal is
- a) 0.5    b) 1
- c)  $0.5 \operatorname{sgn}(t)$                                       d) 0.

**GROUP - B**

**( Short Answer Type Questions )**

Answer any *three* of the following  $3 \times 5 = 15$

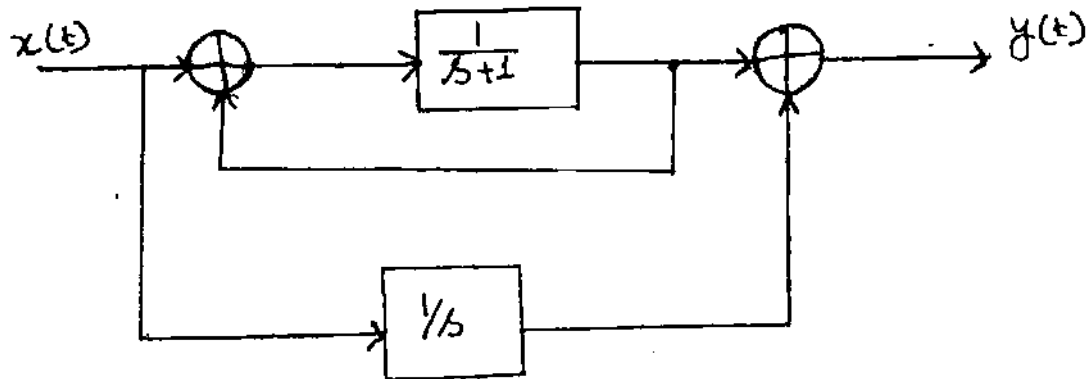
2. The waveform of a full wave rectifier output is shown below :



Show that its Laplace transform  $X(s)$  is given by

$$X(s) = (A\omega) / (s^2 + \omega^2) \coth(sT/4).$$

3. A casual LTI system has the following block diagram :

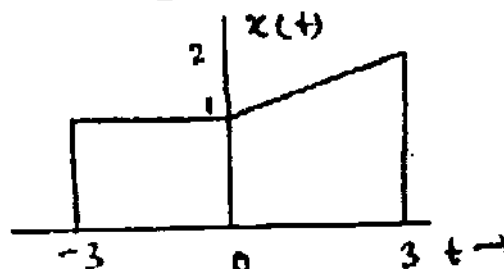


Determine a differential equation relating the output  $y(t)$  with its input  $x(t)$ .

4. Determine the inverse  $z$ -transform of the following using contour integration method.

$$X(z) = 1 / (1 - 1.5z^{-1} + 0.5z^{-2}), \quad z > 1$$

5. a) What do you mean by even signal and odd signal ?  
 b) Consider the signal shown below. Draw the even and odd parts of the signal.  $1 + 4$



6. Define autocorrelation function. What are the properties of autocorrelation function ?
7. Determine whether following systems are linear :  $2\frac{1}{2} + 2\frac{1}{2}$

a)  $5 \frac{dy}{dt} + 3y(t) = 4 \frac{d^2x}{dt^2} + x(t)$

b)  $\frac{dy}{dt} + 2y(t) = 3x(t).$

### GROUP - C

#### ( Long Answer Type Questions )

Answer any *three* of the following.  $3 \times 15 = 45$

8. a) Calculate the coefficient to Trigonometric Fourier series. Write down the Dirichlet conditions.
- b) Find out the Trigonometric Fourier series for the periodic signal, which is defined as

$$x(t) = e^{-t/2} \quad 0 < t < \pi$$

Fundamental frequency  $= \omega_0 = 2 \text{ rad/sec.}$   $(5 + 2) + 8$

9. a) Find the direct form II realization of the following :

$$H(z) = \frac{1 - \frac{7}{4}z^{-1} - \frac{1}{2}z^{-2}}{1 + \frac{1}{4}z^{-1} - \frac{1}{8}z^{-2}}$$

- b) If  $H(z) = \frac{1}{(1 - \frac{1}{4}z^{-2})}$  and  $h(n) = A_1\alpha_1u(n) + A_2\alpha_2u(n).$

Determine the values of  $A_1, \alpha_1, A_2, \alpha_2.$

- c) Use convolution to find  $x(n)$  if  $X(z)$  is given by

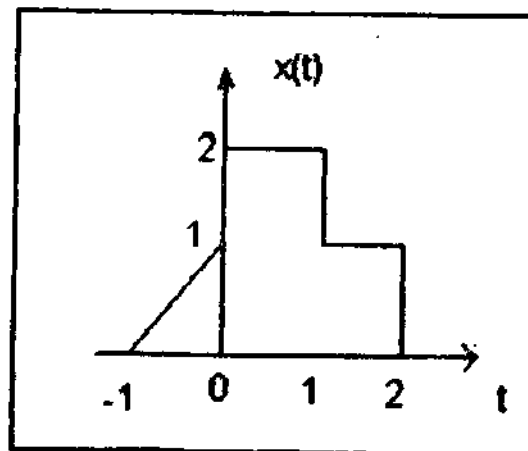
$$X(z) = \frac{1}{(1 - \frac{1}{2}z^{-1}) \cdot (1 + \frac{1}{4}z^{-1})}$$

$5 + 5 + 5$

10. a) What do you mean by S-plane ?  
 b) Find the Laplace transform and ROC of the following signal :

$$e^{-at}u(t)$$

- c) State and prove the time scaling property of Laplace transform.  
 3 + 6 + ( 2 + 4 )
11. a) For the signal  $x(t)$  shown in following figure, find the signals :



- i)  $x(t - 2)$   
 ii)  $x(2t + 3)$   
 iii)  $x(3/2)t$ .
- b) State and explain the non-linearity property of a system.  
 c) Determine whether the system described by the following input-output equation is linear or non-linear.

$$y(n) = x(n) + 1/x(n-1) \quad (3 \times 3) + 3 + 3$$

12. a) State and prove the time shifting property of Z-transform.  
 b) Determine the z-transform of

$$X(n) = (1/2)^n u(n) + 2^n u(n-1)$$

Determine the region of convergence and the location of poles and zeros.

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- c) A casual discrete time LTI system is described by  $y(n) - 3/4y(n-1) + 1/8y(n-2) = x(n)$ . Determine the system function  $H(z)$  and the step response of the system.

13. a) Define discrete probability distribution, cumulative probability distribution function, joint probability function, marginal probability function and conditional density function.

- b) A continuous random variable has the density function

$$f(x) = 2/9(x-1) \quad 1 < x < 4$$

$$0 \quad \text{otherwise}$$

Determine the distribution function of the random variable.

- c) The joint density function of two continuous random variables  $x$  and  $y$  is given by

$$f(x, y) = 2 \quad \text{for } 0 < x < 1, 0 < y < x$$

$$0 \quad \text{otherwise}$$

Determine the conditional density functions.

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