Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(ECE)(N)/SEM-3/EC-303/2011-12

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) $2/T \int_{-\infty}^{\infty} x(t)\cos nwt\,dt$

b) $2/T \int_{0}^{T} x(t)\cos nwt\,dt$

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

d) $2/T \int_{0}^{\infty} x(t)\cos nwt\,dt$.

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) $\sum_{n=-\infty}^{\infty} Ih(n)I = 0$ b) $\sum_{n=-\infty}^{\infty} Ih(n)I < 0$

c) $\sum_{n=-\infty}^{\infty} Ih(n)I \neq 0$ d) either (a) or (b).

x) The z-transform of a signal is given by

$(1-2\cdot 3z^{-1})/(0\cdot 5-0\cdot 2z^{-1})(1-z^{-1})$

The steady state value of the signal is

a) ∞ 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

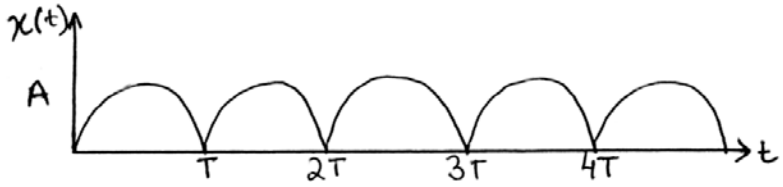
c) 0·5 sgn (t) d) 0.

GROUP – B

(Short Answer Type Questions)

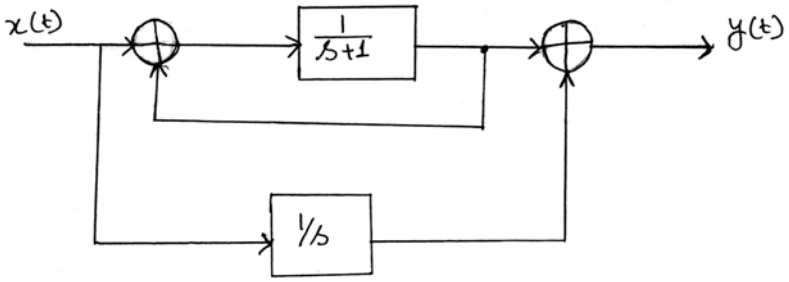
Answer any *three* of the following $3 \times 5 = 15$

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 :



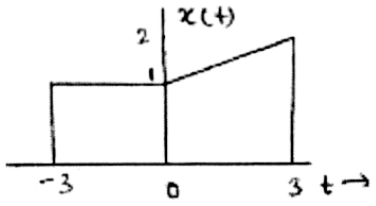
Determine a differential equation relating the output $y(t)$ with its input $x(t)$.

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

$X(z) = 1/(1 - 1.5z^{-1} + 0 \cdot 5z^{-2})$, $z > 1$

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 : 2½ + 2½

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

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

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 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 $= \omega_0 = 2$ rad/sec. (5 + 2) + 8

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

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

   b) If $H(z) = \frac{1}{(1 - \frac{1}{4}\cdot z^{-2})}$ and $h(n) = A_1\alpha_1 u(n) + A_2\alpha_2 u(n)$.

   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

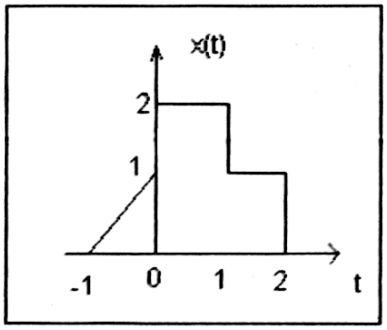
10. a) What do you mean by *S*-plane ?

    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) $x(3/2)\times t$.

    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.

    $y(n)=x(n)+1/x(n-1)$ (3 × 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.

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

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

$0 \qquad$ 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

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

$0 \qquad$ otherwise

Determine the conditional density functions.

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