Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (EE(O)/EIE (O))/SEM-6/EC-611/2010

2010

DIGITAL SIGNAL PROCESSING

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) The fundamental period of the signal

$x(n) = 3 \cos(\pi n/4 + \pi/3) - \sin(\pi n/8) + \cos(\pi n/20)$ is

a) 8 b) 16

c) 4 d) 20.

ii) The energy & power of unit step sequence are

a) ∞, 2 b) 0, 2

c) ∞, 1/2 d) 0, 1.

iii) The system $y(n) = x(n) + nx(n + 1)$ is

a) Non-causal & time variant

b) Causal & time variant

c) Causal & time invariant

d) Non-causal & time invariant.

iv) Consider a system of transfer function $X(z) = 1/(1-az^{-1})$. The ROC of the system is

a) $|z| > |1/a|$ b) $|z| > |a|$

c) $|z| < |1/a|$ d) $|z| < |a|$.

v) The Fourier transform of the sequence $x^*(-n)$ is

a) $X^*(-\omega)$ b) $X^*(\omega)$

c) $X(-\omega)$ d) $X(\omega)$.

vi) The Z transform of the sequence $2u(n)$ is

a) $1/1-2z^{-1}$ b) $4/2-2z^{-1}$

c) $2/1-2z^{-1}$ d) $1/1-4z^{-1}$.

vii) We may use convolution to find the output for the

a) Linear time variant system

b) Causal system

c) Linear time invariant system

d) Non-causal system.

viii) For a rectangular window of M samples, width of the main lobe is

a) $2\pi/m$ b) $6\pi/m$

c) $4\pi/m$ d) π/m.

ix) If $x(n) = \{ 1, 1, 0, 2 \}$, the DFT value $X(0)$ is

a) $1 + j$ b) 0

c) $1 - j$ d) 2.

x) On digital differentiation of unit ramp sequence $U_r(n)$, one obtains

a) unit impulse sequence

b) unit ramp sequence

c) unit step sequence

d) none of these.

xi) If $x_1(n)$ and $x_2(n)$ are finite length sequences of sizes L and M respectively, their linear convolution has the length

a) $L + M - 2$ b) $L + M - 1$

c) $L + M$ d) $\max\{L, M\}$.

xii) If $x^*(n)$ is the complex conjugate of $x(n)$ then

a) $|x(n)|^2 \neq |x^*(n)|^2$ b) $|x(n)| = x(n) \cdot x^*(n)$

c) $|x(n)|^2 = x(n) \cdot x^*(n)$ d) none of these.

xiii) The energy of constant amplitude complex valued exponential function $x(n) = A \exp(jn\omega)$ where A and ω are constants, is given by

a) A^2 b) $\frac{A^2}{2\omega}$

c) $\frac{A^2}{2}$ d) $\frac{A^2}{\omega}$.

xiv) Infinite memory system is also known as

a) FIR system b) IIR system

c) Digital system d) Analog system.

xv) The even & odd parts of a unit step sequence are

a) $[1/2+1/2\delta(n)]$, $[1/2\delta(n)]$

b) $[1/2+\delta(n)]$, $[1/2\delta(n)]$

c) $[1/2+1/2\delta(n)]$, $[1/2\mathrm{sgn}(n)]$

d) $[1+\delta(n)]$, $[1/2\delta(n)]$.

GROUP – B
(Short Answer Type Questions)

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

2. Consider the transfer function of an analog filter as $H(s) = (s+3)/\left(s^2+4s+13\right)$. Now design the digital filter using impulse invariance method. Consider the sampling interval $T=0{\cdot}1s$.

3. Write short note on any one of the following topics :

a) Design of FIR filter using windowing technique.

b) Effect of finite register length on digital system.

4. Compute the circular convolution of the two sequences

$X1(n) = \{ 2, 1, 2, 1 \}$ & $X2(n) = \{ 1, 2, 3, 4 \}$

5. Obtain the cascade form structure for the system characterized by

$y(n) = 3/4y\,(n-1) - 1/8y\,(n-2) + x(n) + 1/3x\,(n-1)$.

6. Design a low-pass digital filter with a 3 dB bandwidth of $0{\cdot}2\pi$. Use Bilinear transformation applied to the analog filter

$H_a(s) = \Omega_c / (S + \Omega_c)$.

GROUP – C
(Long Answer Type Questions)

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

7. a) Find the circular convolution of two sequences $x_1(n) = \{1,\ 1,\ 2,\ 2\}$ and $x_2(n) = \{1,\ 2,\ 3,\ 4\}$.

   b) State and prove the initial value theorem regarding Z-transform.

   c) Determine the DFT of the sequence

   $x_1(n) = \frac{1}{4}$ for $0 \le n \le 2$

   = 0 for otherwise. $7 + 3 + 5$

8. a) Discuss about design method of low-pass filter.

   b) What is rectangular window ?

   c) How is a rectangular window used to design FIR filter ?

   d) Determine the IDFT of $X(k) = \{3,\ (2 + j),\ 1,\ (2 - j)\}$.

   $4 + 2 + 4 + 5$

9. a) Find $x(n)$ by using convolution for

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

b) Find the inverse z-transform of

$$X(z)=\frac{1}{(z-0\cdot25)(z-0\cdot5)},\ \text{ROC}: |z| > 0\cdot5.$$

c) Check whether the following digital system is BIBO stable or not :

$$y(n)=ax^2(n).$$

6 + 5 + 4

10. a) Discuss in brief on the effect of Finite Register Length in Digital Signal Processing.

b) Using Linear Convolution find $y(n)=X(n)^{*}h(n)$ for the sequence $X(n)$ = (1, 2, –1, –2, 0, 1, 3, –1) and $H(n)$ = (1, 2). Compare the result by solving the problem using (i) Overlap Save Method (ii) Overlap Add method.

c) For the difference equations in which $x(n)$ is input and $y(n)$ is output $y(n) = 3y^2(n-1)-nx(n)+4x(n-1)-2x(n-1)$

Determine whether the system is

i) linear

ii) time invariant

iii) causal.

In each case justify the answer. 4 + 7 + 4

11. Write short notes on any *three* of the following : 3 × 5

a) Circular convolution

b) Utility of FFT over DFT

c) BIBO stability in Z domain

d) Architrure of digital Signal processor

e) Mapping of S-plane into Z-plane.