Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH/ICE (NEW)/SEM-6/IC-605 A/2013

2013

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 output of a causal system

      a) does not depend on the inputs

      b) does not depend on the past inputs

      c) does not depend on the future inputs

      d) depends on the present inputs only.

   ii) The system $y(n) = -x(-n)$ is

      a) Causal and static

      b) Causal and dynamic

      c) Non-causal and static

      d) Non-causal and dynamic.

iii) The system $y(n) = 2x(2n) + 3$ is

a) Linear time invariant

b) Linear time variant

c) Nonlinear time invariant

d) Nonlinear time variant.

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

a) non-causal and time-invariant

b) causal and time-variant

c) causal and time-invariant

d) non-causal and time-variant.

v) Which of the following is defined as N-point DFT of a sequence $x(n)$?

a) $X(k) = \sum_{k=0}^{N-1} x(n)e^{-j2\pi knN}$ $k = 0, 1, 2, \ldots\ldots\ldots N-1$

b) $X(k) = \sum_{k=0}^{N-1} x(n)e^{-j2\pi kn/N}$ $k = 0, 1, 2, \ldots\ldots\ldots N-1$

c) $X(k) = \sum_{k=0}^{N-1} x(n)e^{j2\pi kn/N}$ $k = 0, 1, 2, \ldots\ldots\ldots N-1$

d) $X(k) = \sum_{k=0}^{N-1} x(n)e^{j2\pi knN}$ $k = 0, 1, 2, \ldots\ldots\ldots N-1.$

vi) If a signal $x(n) = \{2, -3, 5, \underset{\uparrow}{-5}, 6, 1, -4\}$ then $x(2-n)$ will be

a) $x(n) = \{-4, 1, 6, \underset{\uparrow}{-5}, 5, -3, 2\}$

b) $x(n) = \{-4, 1, 6, \underset{\uparrow}{-5}, 5, -3, 2\}$

c) $x(n) = \{-4, 1, 6, \underset{\uparrow}{-5}, 5, -3, 2\}$

d) none of these.

vii) An FIR filter with impulse response $h(n)$ and length N will have linear phase if

a) $h(n) = \pm h(N-1-n)$

b) $h(n) = h(N-1-n)$

c) $h(n) = -h(N-1-n)$

d) $h(n) = -h(N-n)$.

viii) The Fourier transform of a discrete and periodic sequence is

a) discrete and periodic

b) continuous and periodic

c) continuous and aperiodic

d) discrete and aperiodic.

ix) Which of the following error(s) arise(s) due to quantization of numbers ?

a) Input quantization error

b) Product quantization error

c) Coefficient quantization error

d) All of these.

x) Which of the following is NOT a power signal ?

a) Unit step sequence

b) $e^{j\omega_0 n}$

c) A periodic sequence

d) Unit ramp sequence.

xi) Consider an analog signal $xa\ (t\ )$ = 3 cos 100 πt. The minimum sampling rate required to avoid aliasing is

a) 100Hz b) 200Hz

c) 50Hz d) 75Hz.

xii) Zero padding indicates

a) zero appearing in $x\ (k)$ sequence

b) value of $x\ (k)$ is zero

c) dummy samples added with zero value in $x\ (k\ )$

d) none of these.

xiii) An infinite length causal signal has a Z transform ROC

a) within a circle b) outside a circle

c) on a circle d) throughout the plane.

xiv) For a stable system, the impulse response $h(nT)$

a) is infinite in length

b) decays to zero

c) is abosolutely summable

d) none of these.

xv) FIR filter is of

a) non-recursive and non-linear type

b) non-recursive and linear type

c) recursive and non-linear type

d) recursive and linear type.

xvi) If $x_1(n)$ and $x_2(n)$ are definite duration sequences then their circular convolution is denoted as

a) $x_1(n) * x_2(n)$ b) $x_1(n) \oplus x_2(n)$

c) $x_1(n) \otimes x_2(n)$ d) $x_1(n) \square x_2(n)$.

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 is $H(s) = \frac{s+3}{s^2+4s+13}$. Now design the digital filter using bilinear transformation method. Consider the sampling interval T = 0.1s.

3. If $x(n) = \{5, -4, 6\}$ and $y(n) = \{1, 2\}$, $h(n) = \{-7, 3, 8\}$ find the linear convolution $y(n) = x(n) \circledast h(n)\ x(n) * y(n)$.

4. a) Show that if the unit sample response is zero for $n < 0$, the system is necessarily causal. 3

   b) A system has unit impulse response $h(n)$ is given by

   $h(n) = -0.25\delta(n+1) - 0.5\delta(n) - 0.25\delta(n-1)$. Is the system causal ? 2

5. Determine the Z-transform of the following signal and indicate the ROC along with pole zero plots.

   $x(n) = a^n u(n) - b^n u(-n-1)$; $|a| < |b|$

6. Find the inverse Z-transform of $X(z) = \dfrac{z(z^2 - 4z + 5)}{(z-3)(z-1)(z-2)}$ for ROC (i) $2 < |z| < 3$ and (ii) $|z| < 1$.

7. Consider a causal LTI system which is characterized by the difference equation

$$y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = 2x(n)$$

   Find out the impulse response.

GROUP – C

(Long Answer Type Questions)

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

8. a) Examine the periodicity of the signals $x_1(t)$ = 5*sin (5t);

   $x_2(t)$ = 5*cos(0.1*pi*t+ 0.01*pi);

b) A discrete-time signal $x[n]$ = { 2, 0, (0.5), –1, 3, 2.5}. Sketch and label each of the following signals.

i) $x(2-n)$, ii) Odd part of $x[n-1]$.

c) Find out the linear convolution $y_L[n] = x[n] \circledast h[n]$ and circular convolution $y_c[n] = x[n]$ (4) $h[n]$ and cross correlation, where $x[n]$ = {1, –2, 4, 1.5}, $h[n]$ = {3, 0, – 2, 5}

d) Define the DFT and evaluate $X[k]$, the DFT of the sequence $x[n]$ = { 5, –2, 0, 1, –3, 2}

2 + (2 × 2) + (2 × 3) + 3

9. a) What are the conditions for the impulse response of FIR filter to satisfy for constant group delay and constant phase delay ?

b) Determine the magnitude response and phase function of symmetric sequence with odd length FIR filter (M=9).

c) What are the desirable and undesirable features of FIR filters ? 3 + 8 + 4

10. a) Why are FFT techniques so important in digital signal processing ?

b) Draw the 8 point FFT structure in DIT signal flow graph.

c) Find the DFT of $x(n)$ = {3, – 4, 2, 5}. 3 + 7 + 5

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

a) Impulse invariant method

b) Overlap-add method

c) Design of FIR filter using window method

d) Warping effect and pre-warping.