Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH (EEE)/SEM-7/EEE-703/2011-12

2011

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* the following : $10 \times 1 = 10$

i) Laplace transform of $\delta(n)$ is equal to

a) 0 b) ∞

c) 1 d) cannot be determined.

ii) $X(n) = e^{2n}\ u(n)$, the signal is

a) energy signal

b) power signal

c) energy signal but not power signal

d) neither energy nor power signal.

iii) Advantage of digital signal processing over analog signal processing is

a) greater accuracy

b) flexibility in configuration

c) digital realization is cheaper

d) all of these.

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

a) non-causal and time-invariant

b) causal and time-variant

c) causal and time-invariant

d) non-causal and time invariant.

v) The Z-transform of $u(-n)$ is

a) $1/(1-Z^{-1})$ b) $N/(1-Z)$

c) $1/(1-Z)$ d) $1/(Z-1)$.

vi) $X(n) = 2^n\ u(n) - 3^n\ u(-n-1)$, ROC of $X(z)$ is

a) $|z| < 2$ b) $|z| < 3$

c) $2 < |z| < 3$ d) $2 > |z| > 3$.

vii) $X(z) = 3z / (z - 1)(z + 1)$, $x(\alpha)$ equals to

a) 0 b) 3/2

c) 1 d) cannot be determined.

viii) A discrete-time signal is periodic if its frequency is

a) irrational number b) prime number

c) rational number d) complex number.

ix) The ROC of the Z-transform of a causal sequence is

a) the interior of a circle

b) the exterior of a circle

c) a rectangle

d) an annular region.

x) For rectangular window used for designing FIR filters, the peak amplitude of side lobe is

a) – 41 dB b) – 3 dB

c) 0 dB d) – 13 dB.

xi) A digital filter is said to be IIR

a) if present output depends on previous output only

b) if system function $H(z)$ has one more non-zero denominator coefficients

c) if all the poles lie outsdide the unit circle

d) if system function has only zeros.

xii) Digital IIR filters designed using bilinear transformation are free from

a) zero-input limit cycles due to round-off errors in multiplication

b) limit cycles due to overflow errors addition

c) aliasing of characteristic

d) dead-band effect.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. If a discrete-time LTI system is BIBO stable, show that the ROC of its system function $H(z)$ must contain the unit circle, *i.e.*, $|z| = 1$.

3. a) What are the two basic differences between the Fourier transform of a discrete-time signal with Fourier transform of continuous time signal ?

b) Find the Fourier transform of a sequence

$x(n) = 1$ for $-2 \le n \le 2$

$= 0$, otherwise. 2 + 3

4. a) Define energy signal and power signal with example.

   b) Give an example of a Periodic signal. 4 + 1

5. a) Explain the time shifting property of the *z*-transform.

   b) What are the properties of Region of convergence ?

   1 + 4

6. a) Define discrete Fourier series.

   b) Distinguish between linear and circular convolution of two sequences. 1 + 4

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

7. a) Find the circular convolution of two finite duration sequences

   $X_1(n) = \{3, -2, -1, 3, -4\}$ and $X_2(n) = \{1, 3, 4\}$ using

   i) graphical method and

   ii) matrix method.

   b) If $x(n) = \{1, 3, 2\}$ and $y(n) = \{1, 2\}$, find the linear convolution $x(n) * y(n)$ using DFT based approach.

   9 + 6

8. a) Find the output $y(n)$ of a filter whose impulse response is $h(n) = \{1, 1, 1\}$ and the input signal $x(n) = \{3, -1, 0, 1, 3, 2, 0, 1, 2, 1\}$ using

   i) overlap-save method

   ii) overlap-add method.

   b) Determine the 8-point DFT of the sequence

   $x(n) = \{1, 1, 1, 1, 1, 1, 0, 0\}$.

   c) Compute DFT of a sequence $(-1)^n$ for $N = 4$.

   d) State and prove time shifting property of DFT.

6 + 4 + 2 + 3

9. a) What is signal flow graph ?

   b) What do you mean by the transposition theorem and transposed structure ?

   c) Determine the direct form II and transposed direct form II for the given system :

   $Y(n) = \frac{1}{2}\, y(n-1) - \frac{1}{4}\, y(n-2) + x(n) + x(n-1)$.

3 + 4 + 8

10. a) Design a Butterworth filter using the bilinear transformation for the specifications :

$$0{\cdot}8 \le |H(e^{j\omega})| \le 1, \qquad 0 \le \omega \le 0{\cdot}2\,\pi$$

$$\le |H(e^{j\omega})| \le 0{\cdot}2, \qquad 0 \le \omega \le 0{\cdot}2\,\pi$$

   b) Consider the transfer function of an analog filter is

   $H(s) = \dfrac{s+2}{s^2 + 13s + 42}$. Now design the digital filter using impulse invariance method. Consider the sampling interval $T = 0{,}1s$. 8 + 7

11. a) Explain the scaling property of the Z-transform.

b) $X(n) = 2^n u(n-2)$. Determine its Z-transform and ROC.

c) Use partial fraction method to find the inverse Z-transform of the following transfer function :

$$H(z) = \frac{(z^2 + z)}{(z-1)(z-3)}$$

ROC : $|z| > 3$. 4 + 4 + 7