Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (EIE)/SEM-5/EC-512(EI)/2010-11

2010-11

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 energy of constant amplitude complex-valued exponential function $x[n] = A \exp[j n\omega]$, where A and ω are constant, is given by

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

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

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

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

   b) $|x(n)|^2 = x(n).x^*(n)$

   c) $|x(n)| = x(n).x^*(n)$

   d) none of these.

iii) Z transform of $u(n-1)$ is

a) $\frac{1}{1-z^{-1}}$

b) $\frac{z}{1+z^{-1}}$

c) $\frac{1}{z(1-z^{-1})}$

d) $1+z^{-1}$.

iv) For an analog signal = 3 cos 50 πt + 10 sin 300 πt, the Nyquist sampling rate is

a) 150 Hz b) 300 Hz

c) 25 Hz d) 50 Hz.

v) 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).

vi) Find the correct alternative :

a) $x(t) * \delta(t-t_0) = x(t-t_0)$

b) $x(t) * \delta(t-t_0) = 1$

c) $x(t) * \delta(t-t_0) = x(t_0)$

d) $x(t) * \delta(t-t_0) = x(t)$.

vii) If $x(n) = \{j, -j\}$ then

a) $X(k) = \{2j, 0\}$

b) $X(k) = \{0, 0\}$

c) $X(k) = \{0, 2j\}$

d) $X(k) = \{-j, j\}$.

viii) The digital system in $y[n] = x[n^2]$ is

a) linear and causal

b) linear and non-causal

c) non-linear and causal

d) non-linear and non-causal.

ix) Chebyshev type I filter

a) is all pole filter

b) is all zero filter

c) contains both poles and zeros

d) contains either poles or zeros.

x) $e^{2n}u(n)$ is

a) energy signal

b) power signal

c) both (a) and (b)

d) none of these.

xd) Poles of Butterworth filter lie on

a) circle

b) ellipse

c) circle and ellipse

d) none of these.

xii) A discrete-time LTI system is known as causal system if its

a) impulse response $h(n)$ is zero for $n < 0$

b) impulse response $h(n)$ is zero for $n > 0$

c) impulse response $h(n)$ is positive for $n < 0$

d) none of these.

GROUP – B

(Short Answer Type Questions)

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

2. When a system is said to be stable ?

   Find whether the system with impulse response $h(n) = 2e^{-2|n|}$ is stable or not.

3. Define energy and power signal.

   Calculate the power of signal sequence given by

   $x(n) = 2(-1)^n$ for $n \geq 0$

   $= 0$ for $n < 0$.

4. An LTI system has the following input relationship :

   $$y(n) - 3y(n-1) + 2y(n-2) = x(n) - x(n-1)$$

   Find impulse response $h(n)$ of the system.

5. a) Compute the DFT of a sequence

$$x(n) = \begin{cases} \frac{1}{5}, & \text{for } -1 \leq n \leq 1 \\ 0, & \text{otherwise} \end{cases}$$

   b) State and prove time shifting property of DFT. 3 + 2

6. Define convolution. Perform the convolution of

   $x(n) = \{4, 3, 2, 1\}$ $h(n) = \{1, 2, 3, 4\}$

GROUP – C

(Long Answer Type Questions)

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

7. a) Find the Z-transform of the discrete-time signal $x(n) = \cos \omega_0 n$ for $n \geq 0$.

   b) Find the causal signal $x(n)$ which is having the Z-transform as

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

8 + 7

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

   b) Show how linear filtering is possible with DFT.

   c) Compute DFT of the sequence $x(n) = \{1, 1, 0, 0\}$.

7 + 5 + 3

9. a) Compute the 8-point DFT of the following sequence :

$$x(n) = \left\{\frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2}, 0, 0, 0, 0\right\}.$$

   Use in-place radix-2 decimation in time FFT algorithm.

   b) What is a butterfly regarding FFT ?

   c) What is in-place computation to reduce memory size ?

10 + 2 + 3

10. a) Design the symmetric FIR lowpass filter using rectangular window for which desired frequency response is expressed as

$$H_d(\omega) = \begin{cases} e^{-j\omega\tau} & \text{for } |\omega| \leq \omega_c \\ 0 & \text{elsewhere} \end{cases}$$

   b) Determine $H(z)$ using impulse invariant method at 5 Hz sampling frequency from

$$H(z) = \frac{2}{(s+1)(s+2)}$$

9 + 6

11. a) What is the difference between IIR and FIR filters ?

b) Define window technique in digital filter design.

c) Desing a Butterworth filter, the bilinear transformation for the specifications

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

$$\le |H(e^{j\omega})| \le 0{\cdot}2, \quad 0{\cdot}6\pi \le \omega \le \pi \qquad 4 + 3 + 8$$

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

a) Causal & non-causal system

b) Overlap-add and overlap-save method

c) Butterworth filter

d) Utility of FFT over DFT

e) Bilinear transformation.