Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH (EI)/SEM-5/EC-512 (EI)/2009-10

2009

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) A system described by the input-output relation $y(n) \sum_{k=0} x(n-k)$ is

a) a system with finite memory
b) a system with infinite memory
c) a dynamic system without memory
d) a static system without memory.

ii) The output $y(n)$ of IIR filter

a) is a function of past outputs only
b) is a function of only past and present inputs
c) is a function of past outputs, past and present inputs
d) all of these.

iii) Find the correct meaning of $x((n+k))_N$ from the following :

a) Sequence $x(n)$ shifted clockwise by k sample

b) Sequence $x(n)$ shifted anti-clockwise by k samples

c) Partly clockwise and partly anti-clockwise

d) Sequence $x(n)$ is not shifted.

iv) The transfer function of a digital integrator is given by

a) $\frac{T_S}{2}\left(\frac{z+1}{z-1}\right)$ b) $\frac{T_S}{2}\left(\frac{z-1}{z+1}\right)$

c) $\frac{2}{T_S}z$ d) $\frac{T_S}{2}\left(\frac{1}{z+1}\right)$.

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

a) is defined for $n \geq 0$

b) contains impulses

c) decays to zero

d) is infinite in length.

vi) A control system has a Z Transform ROC

a) within a circle b) outside a circle

c) on a circle d) through the plane.

vii) A DTLTI sysem has an impulse response

$h(n) = \{1, 2, 1, 1, -1\}$. Its output is

$y(n) = \{1, 5, 6, 4, 3, 2, 9, 3, 2\}$ for an excitation $x(n)$. The length of $x(n)$ is

a) 6 b) 7

c) 3 d) 5.

viii) For a rectangular window function, main lobe width is equal to

a) $\frac{2w_s}{5}$ b) $\frac{2w_s}{N}$

c) $\frac{2w_s}{N^2}$ d) $\frac{2w_s}{NV_2}$.

ix) A signal $x(n)$ is called an energy signed, if its energy E and power P satisfy which of the following ?

a) Both E and P are infinite

b) $E = \infty$ but $P < \infty$

c) $E < \infty$ and $P = 0$

d) $E < \infty$ and $P = \infty$.

x) If $X(K)$ represents the 8 point DFT of $x(n) = \{1, 1, 1, 1, 1, 1, 0, 0\}$, then $X(0)$ is

a) 3 b) 6

c) 1 d) 0.

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

a) 100 Hz b) 200 Hz

c) 50 Hz d) 75 Hz.

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.

GROUP – B

(Short Answer Type Questions)

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

2. Find the circular convolution of the two sequences
$x_1(n) = \{1, 2, 2, 1\}$ and $x_2(n) = \{1, 2, 3, 1\}$. 5

3. What is warping effect ? What is Gibbs phenomenon ? 2 + 3

4. What are the different methods available to find out inverse Z Transform of a sequence ?

Determine the inverse Z Transform of

$$X(Z) = \frac{1}{1 - 1{\cdot}5\,Z^{-1} + 0{\cdot}5\,Z^{-2}}.$$ 5

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

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

$h(n) = -0{\cdot}25\,\delta(n+1) - 0{\cdot}5\,\delta(n) - 0{\cdot}25\,\delta(n-1)$.
Is the system is causal ? 2

6. A differentiator is a continuous time LTI system with the system function $H_c(s) = s$. A discrete time LTI system is constructed by replacing s in $H_c(s)$ by the following transformation known as the bilinear transformation :

$$s = 2\left(1 - z^{-1}\right) / T_s\left(1 + z^{-1}\right)$$

to simulate the differentiator. Again T_s is a positive number to be chosen as part of the design procedure.

a) Draw a diagram for the discrete time system.

b) Find the frequency response $H_d(\Omega)$ of the discrete time system. 3 + 2

GROUP – C

(Long Answer Type Questions)

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

7. a) Find the system function and impulse response of the system described by the difference equation

$$y(n) = x(n) + 2x(n-1) - 4x(n-2) + x(n-3).$$

b) Find the inverse z-transform of

$$X(Z) = (z + 0{\cdot}2) / (z + 0{\cdot}5)(z - 1), \; |z| > 1.$$

c) What are the properties of Region of Convergence ? Find the z-transform and ROC of the signal

$$x(n) = -b^n u(-n-1).$$ 5 + 5 + 5

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

b) What is the basic butterfly structure in DIT signal flow graph ?

c) Find the DTFT of $x(n) = (3)^n u(n)$. Plot the magnitude and phase as function of frequency.

d) Find the DFT of $x(n) = \{2, 1, 2, 1\}$. 3 + 2 + 5 + 5

9. a) Determine the z-domain transform function $H(z)$ of the discrete time system described by the difference equation

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

where $0 < \alpha < 1$. Show the pole-zero sketch of $H(z)$, indicating the unit circle clearly.

b) From $H(z)$ found in (a), find the unit impulse response $x(n)$ in closed form.

c) Find $|H(e^{j\omega})|$ in the simplest form.

d) Show that $\angle H(e^{j\omega}) = -\omega + 2\tan^{-1}\frac{\sin\omega}{1+\cos\omega}$. Sketch the variation of $\angle H(e^{j\omega})$ with ω in the range $0 \le \omega \le \pi$. 5 + 3 + 2 + 5

10. a) Discuss about design method of Low-pass filter.

b) What do you mean by Windowing ?

c) What is rectangular window ?

d) How are rectangular windows used to design FIR filter ?

e) Differentiate between FIR and IIR filter.

4 + 2 + 2 + 4 + 3

11. a) The frequency response of a system is given by $H(e^{jw}) = \frac{e^{jw} - a}{e^{jw} - b^{l}}$ where a and b are real with $a \neq b$. Show that $|H(e^{jw})|^2$ is constant if $ab = 1$ and determine its value. Also, find the phase response and time delay.

b) An FIR LTI system has an impulse response $h[n]$, which is real valued, even and has finite duration of $(2N + 1)$. Show that if $z_1 = re^{jw_0}$ is a zero of the system, and then $z_1 = \left(\frac{1}{r}\right)e^{jw_0}$ is also a zero.

(4 + 3 + 2) + 6

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

a) Effect of finite register length on digital system

b) Circular convolution

c) Warping effect & prewarping

d) Chevshev filter

e) Properties of discrete time sinusoid.