Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(EE-N)/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) If a discrete time signal is anticausal then ROC will include

a) $z = 0$ b) $z = 0$ and $z = \bullet$

c) $z = \bullet$ d) none of these.

ii) Poles of butterworth filter lie on

a) circle b) ellipse

c) circle and ellipse d) none of these.

iii) Given a system with $h(n) = a^n u(n)$, a is constant, then the system is

a) IIR system

b) FIR system

c) IIR system and FIR system

d) none of these.

iv) Overlap save method is used to find

a) circular convolution b) linear convolution

c) DFT d) Z-transform.

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

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

c) $\frac{1}{(1-z)}$ d) $\frac{1}{(z-1)}$.

vi) The transfer function of a system with impulse response $h(n) = u(n) - u(n-1)$ is

a) 2 b) $z/(z-1)$

c) 1 d) $z/[(z-1)(z+1)]$

vii) $y(n) = \cos[x(n)]$ is

a) linear time invariant system

b) linear time variant system

c) nonlinear time invariant system

d) nonlinear time variant system.

viii) 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 or more non-zero denominator coefficients

c) if all the poles lie outside the unit circle

d) if system function has only zeros.

ix) If $x(n)$ is a complex sequence, then

a) each sample value of $x(n)$ is complex

b) some sample values of $x(n)$ must be complex

c) at least one sample value should be complex

d) no sample value has real component.

x) The Fourier transform of $\delta(n)$ is

a) 1 b) 0

c) $\pi\,\delta(\omega)$ d) $\delta(\omega)$.

x) For a system with output - input relationship as
$y(-n) = x(n-1)$

a) the system is causal for all n

b) the system is linear and causal for all n

c) the system is stable, linear and causal for all n

d) none of these.

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) The convolution of $u(n)$ with $u(n-4)$ at $n = 5$ is

a) 5 b) 2

c) 1 d) 0.

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

a) – 40 dB b) – 3 dB

c) 0 dB d) – 13 dB.

xv) If the fourier transform of $x(n)$ is $X(w)$, then the fourier transform of $nx(n)$ is

a) $-j\,\frac{dx(w)}{dw}$ b) $j\,\frac{dx(w)}{dw}$

c) $\frac{dx(w)}{dw}$ d) none of these.

GROUP – B
(Short Answer Type Questions)

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

2. a) Define convolution sum.

b) Determine whether the following signal is energy, power or neither energy nor power signal :

$x(n) = e^{j(\pi n/4 + \pi/8)}$. 2 + 3

3. a) What is the necessary and sufficient condition for system stability ?

b) Determine whether or not the following system is LTI :

$y(n) = \cos[x(n)]$ 1 + 4

4. a) Define ROC.

   b) Determine the Z-transform and ROC of the following signal.

   $$x(n) = (2/3)^n\, u(n) + (3/4)^n\, u(n).$$ 1 + 4

5. a) State Parseval's energy theorem.

   b) Compute the convolution of the following signals :

   $x(n) = n/2 ;\ 0 \le n \le 5$ $\quad h(n) = n/2 ;\ -3 \le n \le 5$

   $= 0$; othewise $\quad = 0$; othewise

   1 + 4

6. Write down the procedure for designing FIR filter using frequency sampling method.

GROUP – C

(Long Answer Type Questions)

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

7. Let $x(n) = 0,\ 0 < n < N-1$ be a sequence with an N-point DFT $X(k) ;\ 0 \le k \le N-1$:

   a) If $x(n)$ is symmetric sequence satisfying the condition $x(n) = x(N-1-n)$, show that $X(N/2) = 0$, for N even.

   b) If $x(n)$ is symmetric sequence satisfying the condition $x(n) = -x(N-1-n)$, show that $X(0) = 0$, for N even.

   c) If N is even and $x(n) = -x(n+N/2)$, then $X(k) = 0$ for k even. 5 + 5 + 5

8. a) Obtain a cascade realization of the system characterized by the transfer function

$H(z) = 2(z + 2) / \{z(z - 0{\cdot}1)(z + 0{\cdot}5)(z + 0{\cdot}4)\}$

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

$y(n) = 0{\cdot}5y(n - 1) - 0{\cdot}25y(n - 2) + x(n) + x(n - 1)$.

9. a) 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.*, $|z| = 1$.

b) Determine the output sequence of the system with impulse respone $h[n] = \left(\frac{1}{2}\right)^n u[n]$, when the input is the complex exponential sequence

$x[n] = Ae^{j\pi\frac{n}{2}}$; $-\infty < n < \bullet$. 5 + 10

10. a) Convert the following analog filter with $H(s) = (s + 0{\cdot}1) / (s + 0{\cdot}1)^2 + 16$ into a digital IIR filter by means of bilinear transformation. The digital filter is to have a resonant frequency $\omega_r = \pi/2$.

b) Find the relation between analog frequency and digital frequency, due to bilinear transformation.

c) What do you mean by warping and prewarping ?

d) What is the difference between linear convolution and circular convolution ? 5 + 3 + 5 + 2

11. a) Find the DFT of the sequence { 1, 1, 1, 1, 2, 2, 2, 2 } using radix-2. Decimation-in-time FFT. Sketch the magnitude and phase plot.

b) What is the need of FFT ?

c) What is bit-reversal ? 10 + 3 + 2