Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.Tech/(EIE-NEW)/SEM-6/EI-605A/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 digital system described by $y(n) = ax(n) + b$ is a

a) linear system b) non-linear system

c) non-causal system d) dynamic system.

ii) 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.

iii) An analog signal is expressed by the equation

$x(t) = 3\cos 50\pi t + 10\sin 300\pi t - \cos 100\pi t$.

The Nyquist rate of the signal is

a) 150 Hz b) 300 Hz

c) 25 Hz d) 50 Hz.

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

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

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

v) 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.

vi) If a discrete time signal is anti-causal then ROC will include

a) z = 0 b) z = ∞

c) z = 0 and z = ∞ d) none of these.

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

a) linear and time invariant system

b) linear and time variant system

c) non-linear and time invariant system

d) non-linear time invariant system.

viii) Fourier transform of $x(n)$ is $X(w)$, then the Fourier transform of $n\,x(n)$ is

a) $-j\dfrac{\mathrm{d}x(w)}{\mathrm{d}w}$ b) $\dfrac{\mathrm{d}x(w)}{\mathrm{d}w}$

c) $j\dfrac{\mathrm{d}x(w)}{\mathrm{d}w}$ d) none of these.

ix) The sequence $x(n) = (-1)^n$ is periodic with a period of

a) 6 samples b) 2 samples

c) 0 samples d) none of these.

x) Poles of Butterworth filter lie on

a) Circle b) Circle and Ellipse

c) Ellipse d) none of these.

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

a) 5 b) 1

c) 2 d) 0 .

xii) The equation for hamming window is

a) $\omega_H(n) = 0 \cdot 46 + 0 \cdot 54 \cos \; (2\pi n / N - 1)$

for $-(N-1)/2 \leq n \leq (N-1)/2$

b) $\omega_H(n) = 0 \cdot 54 + 0 \cdot 46 \cos \; (2\pi n / N - 1)$

for $-(N-1)/2 \leq n \leq (N-1)/2$

c) $\omega_H(n) = 0 \cdot 46 + 0 \cdot 54 \; \sin \; (2\pi n / N - 1)$

for $-(N-1)/2 \leq n \leq (N-1)/2$

d) $\omega_H(n) = 0 \cdot 54 + 0 \cdot 46 \; \sin \; (2\pi n / N - 1)$

for $-(N-1)/2 \leq n \leq (N-1)/2$

GROUP – B

(Short Answer Type Questions)

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

2. Show that the product of two even signals or of two odd signals is an even signal and that the product of an even and an odd signal is an odd signal.

3. 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.*, $|z| = 1$.

4. Use one sided Z transform to find out the solution of difference equation given by, $Y(n) = \frac{1}{2} y(n-1) + x(n); \; n > 0$ Given that, $y(-1) = 1$ and $x(n) = (1/3)^n$.

5. 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 :

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

6. Determine whether the following signals are energy signals, power signals or none of them :

   a) $x(n) = (-0 \cdot 5)^n u(n)$

   b) $x(n) = 2 \exp(j3n)$.

GROUP – C

(Long Answer Type Questions)

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

7. a) Using linear convolution find $y(n) = x(n) * h(n)$ for the sequences $x(n) = \{1, 2, -1, 2, 3, -2, -3, -1, 1, 1, 2, -1\}$ and $h(n) = \{1, 2\}$ using Overlap Add Method.

b) Determine the output response $y(n)$ if $h(n) = \{1, 1, 1\}$; $x(n) = \{1, 2, 3, 1\}$ by using (i) linear convolution, (ii) circular convolution and (iii) linear convolution from circular convolution. 9 + 6

8. a) Find the DFT of a sequence $x(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$ using DIT-FFT algorithm.

b) What are the properties of ROC ? Find the Z transform and the ROC of the signal $x(n) = -b^n u(-n-1)$. 10 + 5

9. a) Write down the advantages of bilinear transformation over impulse invariance.

b) Design an analog low pass Butterworth filter with pass band and stop band cut-off frequencies 800 rad/sec and 1800 rad/sec. The pass band attenuation is –3dB and stop band attenuation is – 10 dB. 5 + 10

10. Design an Ideal LPF whose desired frequency response $H_d(e^{jw}) = 1, \quad \pi/3 \geq w \geq -\pi/3$

$$= 0, \quad \pi \geq |w| \geq \pi/3$$

using Hamming window. Determine the impulse response for N = 9 and $H(z)$.

Describe IIR LPF design using bilinear transform mode.

10 + 5

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

a) Butterworth filter

b) Impulse invariance

c) Radix 2 DIF algorithm

d) Windows technique.