Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech(ECE)/SEM-6/EC-601/2012

2012

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

a) linear time-invariant

b) non-linear time-invariant

c) linear time-variant

d) none of these.

ii) $x(n) = \left(\frac{1}{3}\right)^n u(n)$ is

a) energy signal b) power signal

c) both of these d) none of these.

iii) The value of the twiddle factor W_8^4 is given by

a) 1 b) $-j$

c) $\frac{1}{\sqrt{2}} - \frac{j}{\sqrt{2}}$ d) -1.

iv) If F_s is the minimum sampling rate, F_{max} is the highest frequency available in the analog signal, then at Nyquist rate

a) $F_s = 2\,F_{max}$ b) $F_s = 0.5\,F_{max}$

c) $F_s = F_{max}$ d) $F_s < F_{max}$.

v) Overlap save method is used to find

a) circular convolution b) linear convolution

c) z-transform d) DFT.

vi) A system having impulse response $h(t)$ will be BIBO stable if

a) $\int_{-\infty}^{\infty} |h(t)|\,dt < \infty$

b) $\int_{-\infty}^{\infty} h(t)\,dt < \infty$

c) $\int_{-\infty}^{\infty} |h(t)|\,dt > \infty$

d) $\int_{-\infty}^{\infty} |h(t)|\,dt = 0$

vii) Why 16 point DFT is preferable than 4 point DFT ?

a) Resolution of spectrum is poor for 4 point DFT than 16 point DFT

b) Resolution of spectrum is high but not reliable in 4 point DFT

c) Calculation of 4 point DFT is more complex

d) None of these.

viii) The mapping from analog to digital domain in impulse invariant method is

a) one to many b) many to one

c) one to one d) none of these.

ix) If $x[n] = \{1, 0, 0, 1\}$, the DFT value $x(0)$ is

a) 2 b) $1 + j$

c) 0 d) $1 - j$.

x) IIR filter is

a) recursive and linear

b) non-recursive and linear

c) recursive and non-linear

d) none of these.

xi) Zero padding of a signal

a) reduces aliasing

b) increases frequency

c) increases time resolution

d) has no effect.

xii) The digital system in $y(n) = x(n^2)$ is

a) non-linear and causal

b) linear and causal

c) linear and non-causal

d) non-linear and non-causal.

GROUP – B

(Short Answer Type Questions)

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

2. Determine the z-transform of the following sequence and find its ROC.

$$x(n) = (n + 0.5)\left(\frac{1}{3}\right)^n u(n).$$

3. Determine the Fourier transform of the signal :

$$x(n) = 2^n u(-n) - 2^{-n} u(n).$$

4. Determine the DFT of the sequence $x(n) = \{0, 2, 4, 6\}$.

5. For the analog filter having transfer function

$(s) = \frac{2}{(s+1)(s+2)}$, determine $H(z)$ using impulse invariance method. Assume $T = 1$ sec.

6. Determine the direct form of realization of a linear phase FIR filter specified by the impulse response

$h(n) = \{2, 4, 6, 6, 4, 2\}$.

GROUP – C
(Long Answer Type Questions)

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

7. a) Determine the direct form of realization of a linear phase FIR filter specified by the impulse response $h(n) \{1, 2, 3, 3, 3, 2, 1\}$.

b) Draw : (i) direct form I (ii) direct form II (iii) cascade (iv) parallel structures for the system described by the difference equation

$$y(n) = \frac{3}{4} y(n-1) - \frac{1}{8} y(n-2) + x(n) + \frac{1}{3} x(n-1)$$

5 + 10

8. 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 $|z| = 1$.

b) Find the inverse z-transform of

$$x(z) = \frac{1}{\left(1 - 2z^{-1}\right)\left(1 - z^{-1}\right)^2} \text{ for ROC : } |z| > 2.$$

c) Determine the z-transform of the following signal :

$$x(n) = (-1)^n \cos\left(\frac{\pi}{3} n\right) u(n) \qquad 5 + 5 + 5$$

9. a) Determine the sectional convolution whose impulse response is $h(n) = \{1, 1, 1\}$ and input signal is

$X(n) = \{3, -1, 0, 1, 3, 2, 0, 1, 2, 1\}$ using overlap-save method.

b) Describe IIR - low-pass filter design using bilinear transformation mode. 7 + 8

10. 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 are the difference and similarities between DIT and DIF algorithms ? 10 + 2 + 3

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

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

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

$$H(z) = \frac{2}{(s+1)(s+2)}.$$ 9 + 6

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

a) Causal and non-causal system

b) Overlap-add and overlap-save method

c) Butterworth filter

d) Utility of FFT and DFT

e) Bilinear transformation.