Name : ....

Roll No. : ....

Invigilator's Signature : ....

CS/B.TECH (ECE-N)/SEM-6/EC-601/2011

2011
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 fundamental period of the sequence

$x(n) = \cos\left(\dfrac{2n\pi}{3}\right)$ is

a)   1   b)   2

c)   3   d)   6.

ii) A signal is a power signal if

a)   E<∞, P=0   b)   P<∞, E = 0

c)   P<∞, E = ∞   d)   P = ∞, E = 0

iii) The Z-transform of δ (n) is

a)   0   b) Z^{-1}

c) $1/(1 - Z^{-1})$ d)   1.

6004   [Turn over

iv) The system described by $y[n] = nx[n]$ is

    a)   Linear, time varying and stable

    b)   Non-linear, time invariant and unstable.

    c)   Non-linear, time varying and stable.

    d)   Linear, time varying and unstable.

v) For an analog signal $x(t) = 3\cos(50\pi t) + 10\sin(300\pi t)$.
The Nyquist sampling rate is

    a)   150 Hz.

    b)   300 Hz.

    c)   25 Hz.

    d)   50 Hz.

vi) Z-transform of $u[n-1]$ is

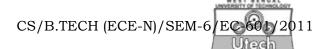   a) $\dfrac{1}{1-z^{-1}}$.   b) $\dfrac{1}{1+z^{-1}}$.

    c) $\dfrac{1}{z(1-z^{-1})}$.   d) $1 + z^{-1}$.

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

    a) $h(n) = 0,\ n < 0$ b) $h(n) = 0,\ n > 0$

    c) $h(n)$ is positive, $n < 0$ d) none of these.

viii) If $h(n) = \{1, 0, 1\}$ and $y(n) = x(n)*h(n) = \{1, -2, 4, -2, 3\}$, then $x(n)$ is

    a) $x(n) = \{1, -2, 1\}$ b) $x(n) = \{1, -1, 3\}$

    c) $x(n) = \{1, -2, 3\}$ d) $x(n) = \{1, -2, -3\}$.

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) Overlap save method is used to find

    a)   circular convolution

    b)   linear convolution

    c)   DFT

    d) Z transform.

xi) The direct evaluation of DFT requires

    a) N^2 multiplications and N^2 additions.

    b) N^2 multiplications and $N(N-1)$ additions.

    c) $N(N-1)$ multiplications and N^2 additions.

    d) $N(N-1)$ multiplications and $N(N-1)$ additions.

xii) The poles of the Chebyshev filter lie

    a)   on an ellipse   b)   on a circle

    c)   on a parabola   d)   on a rectangle.

GROUP – B

(Short Answer Type Questions)

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

2. Define energy and power signal.

Calculate the power of signal sequence given by

$$x[n] = \left(\frac{1}{3}\right)^n u[n].$$ 2 + 3

3. a) What is convolution sum ?

   b) Find the convolution sum of the signals :

   $x\,(n) = 1$, $n = -2,\ 0,\ 1$

   $= 2$, $n = -1$

   $= 0$, elsewhere

   $h\,(n) = \delta\,(n) - \delta\,(n-1) + \delta\,(n-2) - \delta\,(n-3)$.

4. Find the inverse Z transform of

   $X\,(z) = z^2/(\,z^2 - 3z + 2\,)$; ROC : $|Z| > 2$

5. For the sequence $x\,(n) = \{\,1,\ 1,\ 0,\ 0,\ -1,\ -1,\ 0,\ 0\,\}$, determine the 8-point DFT.

6. How do you take care of warping effect for designing an IIR filter using bilinear transformation ?
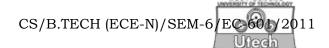
GROUP – C

(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

   $Y\,(n) = X\,(n) + 2X\,(n-1) - 4\,X\,(n-2) + X\,(n-3)$

b) Find the linear convolution using circular convolution for the two sequences :

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

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

c) What are the properties of ROC ? Find the Z transform and the ROC of the signal $X(n) = -b^n U(-n-1)$

5 + 5 + 5

8. a) Find the Z-transform of the discrete time signal

$$x[n] = \left(\frac{1}{3}\right)^{n-1} u[n-1]$$

b) Find the inverse Z-transform of

$$X(z) = \frac{z(z^2-4z+5)}{(z-3)(z-1)(z-2)}$$

for ROC

i) $2 < |z| < 3$

ii) $|z| > 3$

iii) $|z| < 1$.

9. a) What is the need for FFT ? Explain the decimation in time FFT algorithm.

b) Evaluate 8-point for the sequence using DIT-FFT algorithm :

$x(n) = 1, -3 \le n \le 3$

$= 0,$ elsewhere.

c) What is bit reversal ?

d) Differentiate between overlap-save method and overlap-add method.   1 + 5 + 6 + 1 + 2

10. a) Differentiate between FIR and IIR filters.

b) What is windowing ?

c) Find the order and cut-off frequency of a digital filter with the following specifications :

$0.89 \leq |H(e^{jw})| \leq 1, \quad 0 \leq w \leq 0.4\pi$

$|H(e^{jw})| \leq 0.18, \qquad 0.6\pi \leq w \leq \pi.$

Use impulse invariance method.

d) Write down the advantages of bilinear transformation over impulse invariance.   3 + 2 + 8 + 2

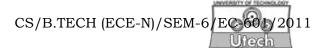11. a) Obtain the structures of cascade and parallel realization of the following transfer function :

$H(z) = (1 - z^{-1})^3 / (1 - \frac{1}{8} z^{-1})(1 - \frac{1}{2} z^{-1})$

b) What is the difference between linear and circular convolutions ?

c) Compute the circular convolution of the following two sequences :

$x_1(n) = \{ 2, 1, 2, 1 \}$
          ↑
$x_2(n) = \{ 1, 2, 3, 4 \}$
          ↑

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

    a)   Radix-2 DIF algorithm

    b)   Chebyshev filter

    c)   Causal & non-causal systems

    d)   Bilinear transformation

    e)   TMS 32OC 6713 architecture.