



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 × 1 = 10

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

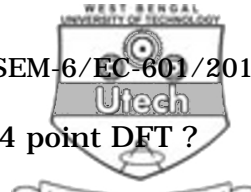
- a) linear time-invariant
- b) non-linear time-invariant
- c) linear time-variant
- d) none of these.

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)

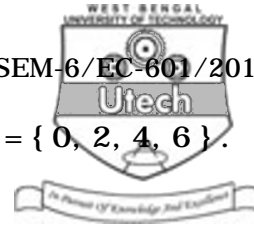
Answer any *three* of the following. $3 \times 5 = 15$

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

$$H(s) = \frac{2}{(s+1)(s+2)}, \text{ determine } H(z) \text{ using}$$

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

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

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

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

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

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

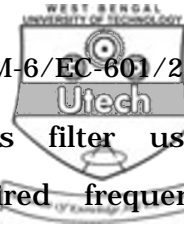
- b) Describe IIR - low-pass filter design using bilinear transformation mode. 7 + 8

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

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

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

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

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.

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