



Name :
Roll No. :
Invigilator's Signature :

CS/B.TECH/ICE (NEW)/SEM-6/IC-605 A/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 × 1 = 10

- i) The output of a causal system
 - a) does not depend on the inputs
 - b) does not depend on the past inputs
 - c) does not depend on the future inputs
 - d) depends on the present inputs only.
- ii) The system $y(n) = -x(-n)$ is
 - a) Causal and static
 - b) Causal and dynamic
 - c) Non-causal and static
 - d) Non-causal and dynamic.



- iii) The system $y(n) = 2x(2n) + 3$ is
- a) Linear time invariant
 - b) Linear time variant
 - c) Nonlinear time invariant
 - d) Nonlinear time variant.
- iv) The system $y(n) = x(n) + nx(n-1)$ is
- a) non-causal and time-invariant
 - b) causal and time-variant
 - c) causal and time-invariant
 - d) non-causal and time-variant.
- v) Which of the following is defined as N-point DFT of a sequence $x(n)$?
- a) $X(k) = \sum_{k=0}^{N-1} x(n)e^{-j2\pi kn/N} \quad k = 0, 1, 2, \dots, N-1$
 - b) $X(k) = \sum_{k=0}^{N-1} x(n)e^{-j2\pi kn/N} \quad k = 0, 1, 2, \dots, N-1$
 - c) $X(k) = \sum_{k=0}^{N-1} x(n)e^{j2\pi kn/N} \quad k = 0, 1, 2, \dots, N-1$
 - d) $X(k) = \sum_{k=0}^{N-1} x(n)e^{j2\pi kn/N} \quad k = 0, 1, 2, \dots, N-1.$



vi) If a signal $x(n) = \{2, -3, 5, -5, 6, 1, -4\}$ then $x(2-n)$ will be

a) $x(n) = \{-4, 1, 6, -5, 5, -3, 2\}$

b) $x(n) = \{-4, 1, 6, -5, 5, -3, 2\}$

c) $x(n) = \{-4, 1, 6, -5, 5, -3, 2\}$

d) none of these.

vii) An FIR filter with impulse response $h(n)$ and length N will have linear phase if

a) $h(n) = \pm h(N-1-n)$

b) $h(n) = h(N-1-n)$

c) $h(n) = -h(N-1-n)$

d) $h(n) = -h(N-n)$.

viii) The Fourier transform of a discrete and periodic sequence is

a) discrete and periodic

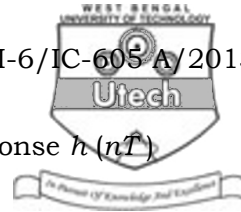
b) continuous and periodic

c) continuous and aperiodic

d) discrete and aperiodic.



- ix) Which of the following error(s) arise(s) due to quantization of numbers ?
- a) Input quantization error
 - b) Product quantization error
 - c) Coefficient quantization error
 - d) All of these.
- x) Which of the following is NOT a power signal ?
- a) Unit step sequence
 - b) $e^{j\omega_0 n}$
 - c) A periodic sequence
 - d) Unit ramp sequence.
- xi) Consider an analog signal $x_a(t) = 3 \cos 100 \pi t$. The minimum sampling rate required to avoid aliasing is
- a) 100Hz
 - b) 200Hz
 - c) 50Hz
 - d) 75Hz.
- 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) An infinite length causal signal has a Z transform ROC
- a) within a circle
 - b) outside a circle
 - c) on a circle
 - d) throughout the plane.



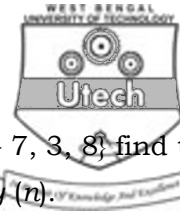
- xiv) For a stable system, the impulse response $h(nT)$
- is infinite in length
 - decays to zero
 - is absolutely summable
 - none of these.
- xv) FIR filter is of
- non-recursive and non-linear type
 - non-recursive and linear type
 - recursive and non-linear type
 - recursive and linear type.
- xvi) If $x_1(n)$ and $x_2(n)$ are definite duration sequences then their circular convolution is denoted as
- $x_1(n) * x_2(n)$
 - $x_1(n) \oplus x_2(n)$
 - $x_1(n) \otimes x_2(n)$
 - $x_1(n) \square x_2(n)$.

GROUP - B

(Short Answer Type Questions)

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

2. Consider the transfer function of an analog filter is $H(s) = \frac{s+3}{s^2+4s+13}$. Now design the digital filter using bilinear transformation method. Consider the sampling interval $T = 0.1s$.



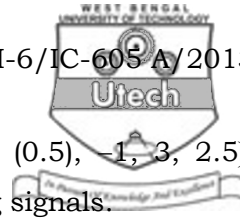
3. If $x(n) = \{5, -4, 6\}$ and $y(n) = \{1, 2\}$, $h(n) = \{-7, 3, 8\}$ find the linear convolution $y(n) = x(n) \otimes h(n)$ $x(n) * y(n)$. 3
4. a) Show that if the unit sample response is zero for $n < 0$, the system is necessarily causal. 3
- b) A system has unit impulse response $h(n)$ is given by $h(n) = -0.25\delta(n+1) - 0.5\delta(n) - 0.25\delta(n-1)$. Is the system causal? 2
5. Determine the Z-transform of the following signal and indicate the ROC along with pole zero plots.
 $x(n) = a^n u(n) - b^n u(-n-1)$; $|a| < |b|$
6. Find the inverse Z-transform of $X(z) = \frac{z(z^2 - 4z + 5)}{(z-3)(z-1)(z-2)}$ for ROC (i) $2 < |z| < 3$ and (ii) $|z| < 1$.
7. Consider a causal LTI system which is characterized by the difference equation
 $y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = 2x(n)$
 Find out the impulse response.

GROUP - C

(Long Answer Type Questions)

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

8. a) Examine the periodicity of the signals $x_1(t) = 5 \sin(5t)$;
 $x_2(t) = 5 \cos(0.1\pi t + 0.01\pi)$;



b) A discrete-time signal $x[n] = \{ 2, 0, (0.5)^n, -1, -3, 2.5 \}$. Sketch and label each of the following signals.

- i) $x(2-n)$, ii) Odd part of $x[n-1]$.
- c) Find out the linear convolution $y_L[n] = x[n] * h[n]$ and circular convolution $y_C[n] = x[n] \textcircled{4} h[n]$ and cross correlation, where $x[n] = \{1, -2, 4, 1.5\}$, $h[n] = \{3, 0, -2, 5\}$
- d) Define the DFT and evaluate $X[k]$, the DFT of the sequence $x[n] = \{ 5, -2, 0, 1, -3, 2 \}$

$$2 + (2 \times 2) + (2 \times 3) + 3$$

9. a) What are the conditions for the impulse response of FIR filter to satisfy for constant group delay and constant phase delay ?

b) Determine the magnitude response and phase function of symmetric sequence with odd length FIR filter (M=9).

c) What are the desirable and undesirable features of FIR filters ? 3 + 8 + 4

10. a) Why are FFT techniques so important in digital signal processing ?

b) Draw the 8 point FFT structure in DIT signal flow graph.

c) Find the DFT of $x(n) = \{3, -4, 2, 5\}$. 3 + 7 + 5

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

- a) Impulse invariant method
 - b) Overlap-add method
 - c) Design of FIR filter using window method
 - d) Warping effect and pre-warping.
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