	Utech
Name :	
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Invigilator's Signature :	

CS/B.Tech (EE-N)/SEM-6/EC-611/2011 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

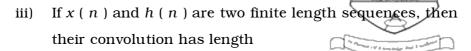
(Multiple Choice Type Questions)

- 1. Choose the correct alternatives for any ten of the following: $10 \times 1 = 10$
 - The system described by y(n) = x(n) + 2x(n-2) + 3x(n-3)i)
 - causal and stable a)
 - b) causal and unstable
 - c) noncausal and stable
 - noncausal and unstable.
 - If $x(n) = \{2, 1, 3, 0, 1, 2, 4\}$, then x (-n + 2) is ii) given by
 - $\{2, 1, 3, 0, 1, 2, 4\}$

 - b) $\{2, 1, 3, 0, 1, 2, 4\}$ c) $\{4, 2, 1, 0, 3, 1, 2\}$
 - d) $\{4, 2, 1, 0, 3, \frac{1}{1}, 2\}.$

6406 [Turn over

CS/B.Tech (EE-N)/SEM-6/EC-611/2011



a) 8

10 b)

c) 11 d) 9.

The overall impulse response of a cascade connection of iv) two systems with impulse responses $h_1(n)$ and $h_2(n)$ is

- $h_1(n) + h_2(n)$ a)
- b) $h_1(n)h_2(n)$
- $h_1(n) * h_2(n)$ c)
- d) $h_1(n) h_2(n)$.

v) A discrete-time LTI system is causal if

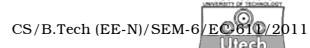
- impulse response h(n) > 0, n > 0a)
- impulse response h(n) < 0, n > 0b)
- impulse response h(n) = 0, n > 0c)
- d) impulse response h(n) = 0, n < 0.

The ROC of an infinite causal sequence is the vi)

- a) interior of a circle
- exterior of a circle b)
- entire z-plane except z = 0c)
- entire z-plane except $z = \infty$. d)

vii) The *Z*-transform of u[n-1] is

- a) $1/(1-Z^{-1})$
- a) $1/(1-Z^{-1})$ b) $Z/(1-Z^{-1})$ c) $1/[Z(1-Z^{-1})]$ d) $(1+Z^{-1}).$



viii) If x (K) represents the 8 point DFT of x (n) = (1, 1, 1

1, 1, 1, 0, 0} then x(0) is

a) 3

b) 6

c) 1

d) 0.

ix) 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.

x) Overlap save method is used to find

- a) circular convolution
- b) linear convolution

c) DFT

d) Z-transform.

xi) Number of multiplications is FFT algorithm is

- a) $n \log (n)$
- b) (n/2) * log(n)
- c) $(n/2) * \log(n/2)$
- d) $n \log (n/2)$.

xii) FIR filter is

- a) recursive and linear
- b) non-recursive linear
- c) recursive and non-linear
- d) none of these.

GROUP - B



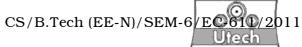
(Short Answer Type Questions)

Answer any three of the following.

- 2. The impulse response of an LTI system is $h(n) = \{1, 2, 1, -1\}$. Determine the response of the system to the input signal $x (n = \{1, 2, 3, 1\})$.
- 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. Explain the relationship between S-plane and Z-plane.
- 5. a) Find the DTFT of the sequence $x(n) = \{1, -1, 1, -1\}$.
 - b) Find the IDTFT of $X(e^{i\omega}) = e^{-j\omega} \left(\frac{1}{2} + \frac{1}{2} \cos \omega\right)$. 2 + 3
- 6. Determine the convolution of the two following sequences using overlap add method :

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

6406



GROUP - C

(Long Answer Type Questions)

Answer any three of the following.

 $3 \times 15 = 45$

7. a) Justify whether the system is LTI or not.

$$y(n) = y(n-1) + \sum_{k=0}^{2} x(n-k).$$

b) Compute the circular convolution of the two sequences given below.

$$x(n) = \{2 -1 \ 0 \ 1 -2 \ 3 \ 0 \ 1\}.$$

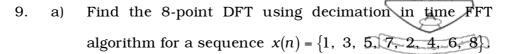
$$h(n) = \{1 \ 2 \ -1 \ 1\}.$$

- c) Determine the linear convolution of the above sequences using over-lap save method.
- 8. a) What is ROC? State its properties.
 - b) Find the system function & impulse response of the system described by y(n) = x(n) + 2x(n-1) 4x(n-2) + x(n-3)
 - c) Find the Inverse Z-transform of

$$X(Z) = Z(Z^2 - 4Z + 5)/(Z - 3)(Z - 2)(Z - 1)$$

d) Prove that an LTI system is BIBO stable if the ROC system function includes the unit circle. 2 + 5 + 5 + 3

CS/B.Tech (EE-N)/SEM-6/EC-611/2011



- b) What do you mean by zero padding?
- c) Using linear convolution find y(n) = x(n) * h(n) for the sequence $x(n) = \{1, 2, -1, -2, 0, 1, 3, -1\}$. Compare the result by solving the problem using
 - i) overlap save method
 - ii) overlap add method.

5 + 2 + 8

10. Following specifications are given for a filter function:

$$\alpha_{\rm pass}$$
 = 4 dB, $\alpha_{\rm stop}$ = 48 dB, $f_{\rm stop}$ = 7 kHz, $f_{\rm pass}$ = 2 kHz, $f_{\rm sampling}$ = 20 kHz

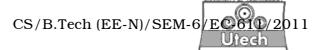
Determine an IIR filter using Butterworth approximation and impulse invariant method.

11. a) Design a digital Butteworth IIR filter for the given frequency response :

$$0 \cdot 85 \le \left| H(e^{j\omega}) \right| \le 1,$$
 for $0 \le \omega \le 0.2 \pi$

$$\left| H(e^{j\omega}) \right| \le 0.02,$$
 for $0.45 \pi \le \omega \le \pi$

Use impulse invariant method.



b) Convert the analog filter with system function $G(s) = \frac{s + 0 \cdot 1}{(s + 0 \cdot 1)^2 + 16}$ into a digital filter using bilinear

transformation. The digital filter should have a resonant frequency of $\omega_r = \frac{\pi}{4}$ radian. 8+7

- 12. Write short notes on any *three* of the following: 3×5
 - a) Causal and non-causal system
 - b) Circular convolution and linear convolution
 - c) DIT-FFT algorithm
 - d) Difference between DTFT and DFT
 - e) Bilinear transformation.