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Name:	<b>A</b>
Roll No. :	As Aganga (Y Kanadada Stad Espectad
Invigilator's Signature :	

# 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) If  $x_1(n)$  and  $x_2(n)$  are finite length sequences of sizes L and M respectively, their linear convolution has the length
    - a) L + M 2
- b) L + M 1

c) L + M

- d) none of these.
- ii) The digital systems in  $y(n) = x(n^2)$  is
  - a) linear and causal
  - b) non-linear and causal
  - c) linear and non-causal
  - d) non-linear and non-causal.

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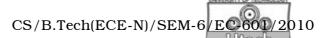
- iii) Zero padding of a signal
  - a) reduces aliasing
  - b) increases frequency
  - c) increases time resolution
  - d) has no effect.
- iv) In a system y(-n) = x(n-1)
  - a) the system is causal for all
  - b) the system is linear and causal for all
  - c) the system is stable, linear and causal for all
  - d) none of these.
- v) If  $x [n] = \{1, 0, 0, 1\}$ , the DFT value X(0) is
  - a) 2

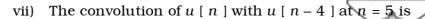
b) 1 + j

c) 0

- d) 1 j.
- vi) The Fourier transform of an aperiodic discrete time sequence is
  - a) discrete and periodic function of frequency
  - b) discrete and aperiodic function of frequency
  - c) continuous and periodic function of frequency
  - d) continuous and aperiodic function of frequency.

6004





a) 5

b) 2

c) 1

d) 0.

# viii) A digital filter is said to be IIR

- a) if present output depends on previous output only
- b) if system function H ( z ) has one or more non-zero denominator co-efficients
- c) if all the poles lie outside the unit circle
- d) if system function has only zeros.
- ix) FIR filter is
  - a) recursive and linear
  - b) non-recursive and linear
  - c) recursive and non-linear
  - d) none of these.
- x) System function of digital filter expressed as  $H(z) = b_k z^{-k}$  represents
  - a) IIR filter
- b) FIR filter
- c) Butterworth filter
- d) Chebyshev filter.
- xi) Stability criteria for a discrete time LTI system is
  - a) h(n) > 1
- b) h(n) < 1
- c) h(n) = 1
- d) h(n) = 0.

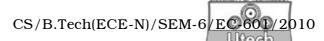


- xii) A digital filter has  $h(n) = \{-3, -2, 0, 2, 3\}$  then it has
  - a) no linear phase
  - b) symmetric linear phase
  - c) anti-symmetric linear phase
  - d) none of these.

xiii) 
$$\left(\frac{1}{2}\right)^n u(n)$$
 is

- a) energy signal
- b) power signal
- c) both (a) and (b)
- d) none of these.
- xiv) The system y(n) = x(n) + nx(n+1) is
  - a) linear time invariant
  - b) non-linear time invariant
  - c) linear time variant
  - d) none of these.
- xv) 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.

6004



# **GROUP - B**

# (Short Answer Type Questions)

Answer any three of the following.



2. Given the following transfer function T ( z ) of a DSP system, write the difference equation :

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

- 3, If Fourier transform of x (n) is X ( $j\omega$ ), then prove that
  - a)  $x(-t) \times X(-i\omega)$ ,
  - b)  $x(at) \times \frac{1}{|a|} X(\frac{j\omega}{a})$ .
- 4. State the properties of convergence for the *Z*-transform.
- 5. Apply bilinear transformation to  $H(s) = \frac{2}{(s+1)(s+3)}$  with T = 0.1 s.
- 6. Define phase delay and group delay.

The length of an FIR filter is 13. If the filter has a linear phase, show that

$$\sum_{n=0}^{\frac{M-1}{2}} h(n) \sin \omega (\tau - n) = 0.$$

# **GROUP – C**( **Long Answer Type Questions** ) Answer any *three* of the following.



- 7. a) What is ROC? State its properties.
  - b) Find the system function and 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

$$X(z) = z(z^2 - 4z + 5) / (z - 3)(z - 2)(z - 1); 2 < z < 3$$

- d) Prove that an LTI system is BIBO stable if the ROC of system function includes the unit circle. 2 + 5 + 5 + 3
- 8. a) Sketch the magnitude response of Butterworth LPF filter and derive an expression for order of such a filter.
  - b) Design a digital Butterworth filter using the following specifications using Impulse Invariant method

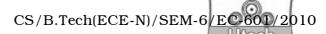
$$0.9 < H(j\omega) < 1$$
 for  $0 < \omega < 0.2$  pi

$$H\left(\,j\omega\,\right)<0{\cdot}2$$
 for 0·4 pi <  $\omega<$  pi

- c) What are the advantages and disadvantages of bilinear transformation? 5 + 5 + 5
- 9. a) Compute 8-point DFT of the sequence

 $x(n) = \{0.5, 0.5, 0.5, 0.5, 0, 0, 0, 0\}$  using any FFT algorithm.

6004



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) Compute the circular convolution of two sequences

$$x(n) = \{1, 2, 0, 1\}$$
  
 $x(n) = \{2, 2, 1, 1\}$ 

6 + 5 + 4

- 10. a) Obtain the mapping formula for the approximation of derivatives method using backward difference :
  - b) Determine H ( z ) for a Butterworth filter satisfying the following constraints :

$$\begin{split} \sqrt{0.5} & \leq \left| H\left(e^{j\omega}\right) \right| \leq 1, \, 0 \leq \omega \leq \pi/2 \\ & \left| H\left(e^{j\omega}\right) \right| \leq 0.2, \, 3 \, \pi/4 \leq \omega \leq \pi \end{split}$$

with T=1s. Apply impulse invariant transformation.

6 + 9

- 11. Write short notes on any *three* of the following :
- $3 \times 5$

- a) Gibbs phenomenon
- b) CCS6713 architecture
- c) IIR and FIR filters
- d) Periodic and aperiodic signals.