Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.Tech(ECE-VLSI)/SEM-2/MVLSI-202/2011

2011

DIGITAL SIGNAL PROCESSING AND APPLICATIONS

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.

Answer Question 1 and any *four* from the rest.

5 × 14 = 70

1. Answer any *seven* of the following : 7 × 2

State *True* / *False* and justify.

i) Given a system with $h(n) = a^n u(n)$, a is constant, then system is IIR.

ii) The mapping from analog to digital domain in impulse invariant method is one to many.

iii) FIR filter is recursive and linear.

iv) System function of digital filter is expressed as $H(z) = b_k z^{-K}$ represents FIR filter.

v) Stability criteria for a discrete time LTI system is $\Sigma h(n) | < \alpha$.

vi) A digital filter has $h(n) = \{ -3, -2, 0, 2, 3 \}$ has symmetric linear phase.

vii) A DTLTI system has an impulse response

$h(n) = \{ 1, 2, 1, 1, -1 \}$. Its output is

$y(n) = \{ 1, 5, 6, 4, 3, 2, 9, 3, 2 \}$ for an excitation of $x(n)$. The length of $x(n)$ is 13.

viii) A discrete time system is represent by $y(n) = x(n^2)$ is linear and causal.

2. a) State and prove the convolution property of Z-transform. State and prove stability theorem of Z-transform.

b) Discuss the stability and find $h(n)$.

$H(z) = 1/[1 - (1/2)z^{-1}][1 + (1/2)z^{-1}][1 - (1/4)z^{-1}]$

3 + 4 + 7

3. a) Find the total response of the system described by difference equation

$y(n) + 2y(n-1) + y(n-2) = x(n) + x(n-1)$ for I/P $x(n) = (1/2)^n u(n)$ with initial condition $y(-1) = y(-2) = 1$.

b) A discrete LTI system has $h(n) = a^n u(n)$. Is it causal ? Under what condition will it be BIBO stable ? Also find $y(n)$ if $x(n) = u(n)$. 7 + 7

4. a) The frequency response of an input sequence $x(n)$ is shown. If the signal is passed through a downsampler ($M = 2$), find the frequency response of O/P. Under what condition will the output be free from aliasing ?

   b) Show that upsampler and downsampler are time variant systems. 7 + 7

5. a) Design a digital Butterworth filter using the following specification using Bilinear transformation.

   $0{\cdot}8 < H(e^{jw}) < 1$ for $0 < w < 0{\cdot}2\ pi$

   $H(e^{jw}) < 0{\cdot}2$ for $0{\cdot}6\ pi < w < pi$

   b) Discuss the disadvantages of impulse invariant method and Bilinear transformation.

   c) Realize the system with difference equation in cascade form :

   $$y(n) = (3/4)\,y(n-1) - (1/8)\,y(n-2) + x(n) + (1/3)\,x(n-1)$$

   5 + 4 + 5

6. a) Compare Fixed point & Floating point representations.

   b) Explain effect on Finite Word Length on Direct Form-I and Direct Form-II structures. 7 + 7

7. a) Find the IDFT using DIF method of the sequence $X(k) = \{10, -(-2-2j), 2, (-2+2j)\}$.

   b) Determine the section convolution whose impulse response is $h(n) = \{1, 1, 1\}$ and input signal is $X(n) = \{3, -1, 0, 1, 3, 2, 0, 1, 2, 1\}$ using Overlap-Save method. 5 + 9

8. Design an ideal LPF whose desire frequency response

$$H_d(e^{jw}) = \begin{cases} 1, & \pi/3 \geq w \geq -\pi/3 \\ 0 & \text{otherwise} \end{cases}$$

Using Hanning window

a) determine the impulse response for $N = 9$

b) determine $H(Z)$. 14