Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.Tech (ECE VLSI)/SEM-2/MVLSI-202/2013

2013

ADVANCED 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.

Answer *five* questions taking at least two questions from each Group.

GROUP – A

1. a) Establish the relationship between input $x(n)$ and output $y(n)$ of an LTI system with impulse response $h(n)$.

   b) Derive the condition on impulse response $h(n)$ for an LTI system to be (i) causal (ii) stable.

   c) The impulse response of relaxed LTI system is $h(n) = u(n)$. Determine the value of the step response of the system. 5 + 5 + 4

2. a) Describe the method of homogeneous solution of linear constant coefficient difference equation.

   b) Determine the response $y(n)$ for $n \geq 0$ of the system described by the 2nd order difference equation $y(n) - 3y(n-1) - 4y(n-2) = x(n) + 2x(n-1)$ with $x(n) = 4^n u(n)$. 7 + 7

3. a) Determine the pole zero plot of the signal $x(n) = \begin{cases} a^n, & 0 \leq n \leq M-1 \\ 0, & else\ where \end{cases}$ where $a > 0$.

   b) Determine the system function and unit sample response of the system $y(n) = 0{\cdot}5\, y(n-1) + 2x(n)$.

   c) Discuss the method of inverse z-transform using contour integration. 4 + 5 + 5

4. a) Show that the circular shift of a N point sequence is equivalent to linear shift of its periodic extension.

   b) How is linear convolution obtained using circular convolution ? Explain.

   c) Find the output $y(n)$ of a filter whose impulse response is $h(n) = \{1, 1, 1\}$ and input $x(n) = \{3, -1, 0, 1, 3, 2, 0, 1, 2, 1\}$ using overlap save method. 3 + 6 + 5

GROUP – B

5. a) Describe the Radix-2 DIT-FFT algorithm.

   b) What is bit reversal ? Compute the complexity of 4 point Radix-2 DIF-FFT algorithm.

   c) Compute the 8-point DFT of the sequence $x(n) = \{0{\cdot}5, 0{\cdot}5, 0{\cdot}5, 0{\cdot}5, 0, 0, 0, 0\}$ using the radix-2 DIF algorithm. 7 + 3 + 4

6. a) For the given specification design an ananalog Butterworth Low Pass Filter :

   $0{\cdot}9 \le |H(j\Omega)| \le 1$ for $0 \le \Omega \le 0{\cdot}2\pi$ and $|H(j\Omega)| \le 0{\cdot}2$ for $0{\cdot}4\,\pi \le \Omega \le \pi$

   b) Discuss the bilinear transformation technique of digital IIR filter design.

   c) A filter is to be designed with the following desired frequency response :

   $$H_d\left(e^{jw}\right) = \begin{cases} e^{-j2w}, & -\pi/4 \le w \le \pi/4 \\ 0, & \text{elsewhere} \end{cases}$$

   Determine the filter coefficient $h_d(n)$ if the window function is defined as

   $$w(n) = \begin{cases} 1, & 0 \le n \le 4 \\ 0, & \text{elsewhere} \end{cases}$$

   4 + 4 + 6

7. a) Discuss the minimum MSE criterion to develop an adaptive FIR filter.

   b) Explain with block diagram the general polyphase framework for decimators and interpolators.

   c) What are the characteristics of a comb filter ? 6 + 6 + 2

8. a) Discuss briefly the finite word length effects in IIR digital filters.

   b) An 8 bit ADC feeds a DSP system characterized by following transfer function H (z) = 1/(z + 0·5). Estimate the steady state quantization noise power at the output of the system.

   c) Explain the application of DSP in adaptive echo cancellation. 6 + 3 + 5