Name : .....

Roll No. : .....

Invigilator's Signature : .....

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

2013

DIGITAL SIGNAL PROCESSING & 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 any *five* questions taking at least *one* from each Group.

GROUP – A

1. Consider the system described by the following difference equation :

$$y(n) - y(n-1) + 0{\cdot}25\, y(n-2) = x(n) - 0{\cdot}25\, x(n-1)$$

a) Realize the system using adder, subtractor and delay units. If the adder/subtractor and multiplier units need t_a and t_m units respectively then find out the minimum sampling period. 4 + 2

b) Find out the unit sample response of the system. 4

c) Find out the response of the system to $x(n) = (0{\cdot}25)^n\, U(n)$. 4

2. Consider the CT signal $x(t) = \cos(20\pi t) + \cos(100\pi t)$:

   a) What are the corresponding "digital" frequencies ω1 and ω2 (in radians/sample) ? What should be the minimum sampling frequency ? 3 + 3

   b) Write expression for the equivalent digital signal $x(n)$. 2

   c) Find out the Z-transform of

      i) $\cos\left(w_0 n\right) U(n)$

      ii) $U(n)$. 6

3. a) Determine whether or not the signals below are periodic or not. For each signal that is periodic, find out the fundamental period.

      i) $x(n) = \cos(\cdot 125\,\pi n)$

      ii) $x(n) = \sin(\pi + 0{\cdot}02\,n)$. 2 × 2

   b) Express the signal $x(n)$ as a sum of scaled and shifted unit steps : 4

      $x(n) = \{ 1 \text{ for } n = 0,\ 2 \text{ for } n = 1,\ 3 \text{ for } n = 2,\ 0 \text{ else} \}$

   c) Consider a signal which is pulse having sample on and off periods, time period (T) is 20 msec and the peak value is 5 unit. Find out the *d.c.* value and 3rd harmonics of the signal. 3 × 2

GROUP – B

4. a) A system is characterized by the difference equation
$y(n) = y(n-1) - y(n-2) + 0{\cdot}5\,x(n) + 0{\cdot}5\,x(n-1)$

Find the response of the system to the input $x(n) = (0{\cdot}5)^n \; u(n)$ with initial condition $y(-1) = 0{\cdot}75$ and $y(-2) = 0{\cdot}25$. 6

b) Consider a discrete sequence
$x(n) = \{4, 2, 4, 4, 2, 4, 4, 2\}$ for $n = 0, 1, 2, \ldots\ldots$. Find out the Fourier transform $X(k)$ for $k = 3$. 4

c) Find out the Z-transform of the above sequence. 4

5. a) Realize the equivalent digital (using adder, multiplier, delay etc.) for the LSI system described by the difference equation

$y(n) = y(n-1) - y(n-2) + 0{\cdot}5\,x(n) + 0{\cdot}5\,x(n-1)$ 5

b) What is bi-linear transformation ? Prove the relation between S and Z. 1 + 4

c) Transfer function of a continuous time system is given by $H(S) = 1/S^2$. Derive the equivalent digital circuit. 4

6. A normalized Butterworth filter needs to be designed with the following specifications :

Passband edge = 0·7 rad/sec, stopband edge = 0·2 rad/sec, maximum passband loss = 0·5 dB, Minimum stop band loss = 30 dB

a) Find out the minimum filter order. 6

b) Find out the transfer function $H(S)$ of the filter. 6

c) Find out $H(Z)$ of the filter. 2

GROUP – C

7. a) What are the typical features of a typical DSP Processor ? 2

   b) Explain clearly the following :

      i) Circular addressing scheme

      ii) Zero overhead loop

      iii) Single cycle execution

      iv) Harvard architecture. 6

   c) Give the block diagram of ADSP2181 and indicate the salient features. 6

8. a) What are the possible different platforms to implement DSP algorithms and discuss their advantages and drawbacks. 3 + 3

   b) What is Look Up Table (LUT) ? How a Boolean expression can be implemented using LUT ? Explain with an example. 2 + 2

   c) With a block diagram explain the operation of FPGA. 4

9. a) Derive the mathematical expression to arrive at the FFT algorithm for the Discrete Fourier Transform (DFT). Give the structure of a 8-point FFT computation. 3 + 3

   b) What is the drawback of Fourier Transform ? Explain with an example. What do you mean by "Short term Fourier Transform" ? 1 + 1

   c) Explain clearly the principle of "Wavelet transform" and discuss its advantage over the "Short term Fourier Transform". 6