Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.Tech (ECE)/SEM-1/ECM-104/2009-10

2009

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 any *five* questions. 5 × 14 = 70

1. a) Determine 8-point DFT for a continuous time signal $x(t) = \sin(2 * pi * f * t)$ with f = 50 Hz. 8

   b) Obtain the linear convolution of two sequences $x(n) = u(n) - u(n-3)$ and $h(n) = u(n-1) + u(n-2) - u(n-4) - u(n-5)$ using circular convolution. 6

2. a) What are the various methods used for the design of IIR filters ? Discuss impulse invariant method. What is the main disadvantage of designing IIR filter using impulse invariant method ? How can it be overcome ?

   2 + 3 + 2 + 2

b) Realize the 2nd order digital filter $y(n)=2r\cos(w_0)y(n-1)-r^2y(n-2)+x(n)-r\cos(w_0)x(n-1)$ by direct form-I & direct form-II. 5

3. a) A low-pass filter is to be designed with the following desired frequency response

$$H_d\left(e^{jw}\right)=e^{-2jw}, \qquad -\Pi/4 \le |w| \le \Pi/4$$

$$=0, \qquad \Pi/4 < |w| \le \Pi$$

Determine the filter co-efficients $h_d(n)$ if the window function is rectangular. Also determine the frequency response $H\left(e^{jw}\right)$ of the designed filter. 8

b) A low-pass fitler should have the frequency response given below. Find the filter co-efficients $h_d(n)$. Also determine τ so that $h_d(n)=h_d(-n)$.

$$H_d\left(e^{jw}\right)=e^{-jw\tau}, \qquad -w_c \le w \le wc$$

$$=0, \qquad wc \le |w| \le \Pi. \qquad 6$$

4. a) Write a short note on Zero padding. 4

b) Derive the algorithm for 16-point DIF-FFT. 10

5. a) What is the need for anti-aliasing filter prior to down sampling ? 5

b) What is the need for anti-imaging filter after up sampling ? 5

c) A multi-rate system is shown in the following figure. Find the relation between $x(n)$ & $y(n)$. 4

6. a) A DSP system is described by the linear difference equation $y(n) = 0{\cdot}2\,x(n) - 0{\cdot}5\,x(n-2) + 0{\cdot}4\,x(n-3)$. Given that the digital input sequence $\{-1, 1, 0, -1\}$ is applied to this DSP system. Determine the corresponding digital output sequence. 5

b) What do you mean by ROC ? 2

c) Find $x(n)$ if

$$X(Z) = 1/\left[1-(3/2)2^{-1}+(1/2)Z^{-2}\right]$$

For ROC : $|Z| > 1$ and $|Z| < 1/2$. 7

7. a) A discrete time signal $x(n)$ is applied to a DTLTI system with unit impulse response $h(n)$. Find the output response if given that

$$x(n) = 2^n.u(-n) \text{ and}$$

$$h(n) = u(n).$$ 7

b) Write a short note on FIR filter design using Window method. What is Gibb's phenomenon ? 7

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

b) Compute the DFT of the sequence $x(n)=(-1)^n$ for N = 4. 4

9. a) Find the magnitude and phase responses for the system characterized by the differential equation

$$y(n)=(1/6)\,x(n)+(1/3)\,x(n-1)+(1/6)\,x(n-2).$$ 8

b) Determine the impulse response h (n) for the system described by the difference equation

$$y(n)-3y(n-1)\,4y(n-2)=x(n)+2x(n-1).$$ 6