M.TECH. VLSI AND MICRO ELECTRONICS
(Second year, Second semester)

ADVANCED DIGITAL SIGNAL PROCESSING

Time: Three Hours | Full Marks: 100

Answer ***any five*** questions.

1. a) An IIR filter is described by the following difference equation.

$$\mathbf{y(n) = x(n) + 0.5\ x(n-1) + 0.5\ y(n-1)}$$

Draw the direct form - I structure of the filter and hence obtain the impulse response intuitively. 10

b) An IIR filter is described by the following difference equation.

$$\mathbf{y(n) = b\ x(n) + 0.9\ y(n-1)}$$

Obtain the frequency response and hence determine **b** so that dc gain equals 1. Determine the cutoff frequency of the filter. Is this filter lowpass bandpass or highpass? 10

2. a) An FIR filter is described by the following difference equation.

$$\mathbf{y(n) = \tfrac{1}{3}\ .[x(n) + x(n-1) + x(n-2)]}$$

Compute and sketch its magnitude and phase response. What is the name of this filter? 10

b) A second-order filter has a double pole at $\mathbf{p_{1,2} = 0.5}$ and two zeros at $\mathbf{z_{1,2} = e^{\pm j3\pi/4}}$. Design the filter so that $|H(z)|_{z=1} = \mathbf{1}$. 10

3. a) Obtain expressions for amplitude and phase frequency responses of a Type II (Even-length symmetric) FIR filter. Is this a linear phase filter? What is the advantage of a linear phase FIR filter? Comment on the automatic zero locations of linear phase FIR filters. 10

b) Consider the following system function of a filter.

$$\mathbf{H(z) = 0.5\,(1 - z^{-2})\,/\,(1 + 1.3\,z^{-1} - 0.36\,z^{-2})}$$

Obtain the parallel form realization structure of the filter. 10

4. a) Design the simplest possible first-order FIR lowpass filter through the pole-zero placement method. Find the frequency response of the filter, plot the magnitude response, and calculate the 3-dB cutoff frequency. What is the limitation of the filter thus designed? Suggest a suitable method to overcome this limitation. 10

b) Which signals are blocked by the following FIR filter?

$$\mathbf{H(z) = 1 - 2\,z^{-1} + 2\,z^{-2} - z^{-3}}$$ 10

5. a) Design a filter to generate a digital tone of 1 KHz and also show the realization structure of the same. Assume a sampling rate of 8 KHz. How to use the designed filter to generate the said tone? 10

b) Draw the transversal structure of a 3-tap FIR filter and hence obtain its transposed structure. Show that both the transversal and its transposed form have the same system function. 10

6. a) Block diagram of a filter is shown in Fig.1; Determine its system function, and the difference equation. 10

b) Draw the magnitude response of the frequency response of an 8-point running sum filter and hence justify that the filter can be termed a Comb filter. 10

7. a) Design a 4-tap linear phase FIR filter for which the amplitude frequency response at $\omega = 0$ *and* $\omega = \frac{\pi}{2}$ are given by 1 and $\frac{1}{2}$ respectively. 10

b) For the FIR filter with coefficients $b_k = \{1, 2, 1\}$, find the response when the input is $x(n) = 5 + 6\cos\left(\frac{\pi}{3}.n + \frac{\pi}{2}\right), \quad -\infty < n < \infty$ 10

8. Discuss in detail any application of Digital Signal Processing. 20

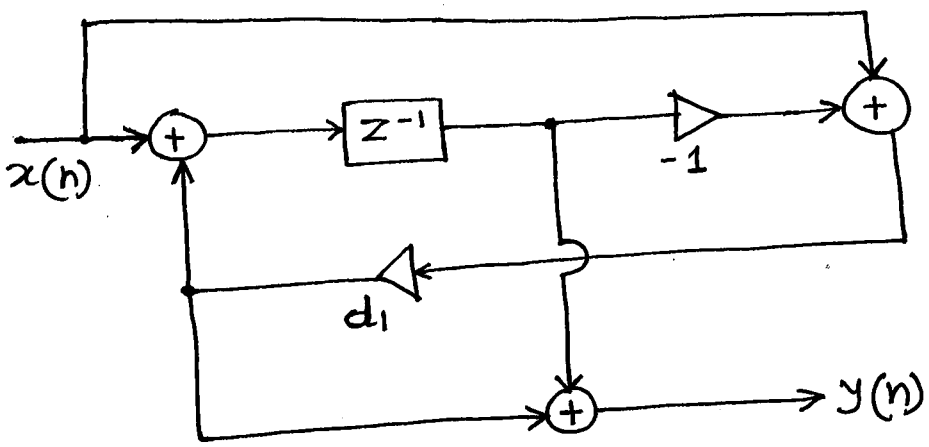

Fig. 1