53 (EC 603) DSPR

2017

DIGITAL SIGNAL PROCESSING

Paper : EC 603

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

Answer ***any five*** *questions.*

1. *(a)* Find the impulse response $h(n)$ for each of the causal, discrete-time LTI systems satisfying the following difference equations and also indicate whether each system is FIR or IIR system : 15

(i) $y(n)=x(n)-2x(n-2)+x(n-3)$

(ii) $y(n)+2y(n-1)=x(n)+x(n-1)$

(iii) $y(n)-0{\cdot}5y(n-2)=2x(n)-x(n-2)$

Contd.

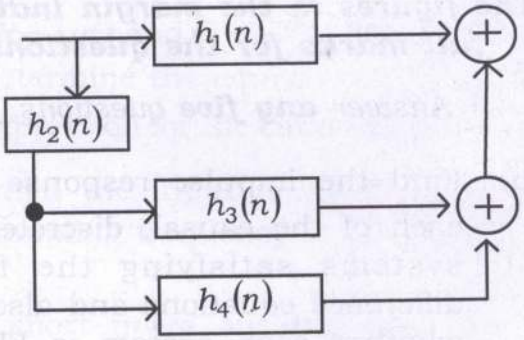
(b) Why folding operation is necessary in convolution operation (linear) ? 5

2. (a) Consider the discrete time LTI system composed of four interconnected simple discrete-time systems with impulse response given by : 15

$$h_1(n)=\delta(n)+0{\cdot}5\,\delta(n-1)$$

$$h_2(n)=0{\cdot}5\delta(n)-0{\cdot}25\,\delta(n-1)$$

$$h_3(n)=2\delta(n);\quad h_4(n)=-2\left(\tfrac{1}{2}\right)^n u(n)$$



Find the overall impulse response of the given system.

(b) Show that if $x(n)$ is real, then its DFT $X(K)$ satisfies the relation $X(N-K)=X^*(K)$; where '*' denotes complex conjugate. 5

3. Discuss and develop the theory behind Decimation-in-time (DIT) radix-2 FFT algorithm. You may choose N=8. 20

4. *(a)* A digital low-pass filter is to be designed with the following desired frequency response : 10+5

$$Hd(e^{jw})=\begin{cases} e^{-j2w}\,; & -\frac{\pi}{4}\le w\le\frac{\pi}{4} \\ 0 \quad ; & \frac{\pi}{4}\le w\le 0 \end{cases}$$

Calculate the filter's coefficients $hd(n)$ if the window function is defined as

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

Also, find the frequency response $H(w)$ of the designed filter.

(b) An ideal discrete-time high-pass filter with cut-off frequency '$w_c=\pi/2$' was designed using the bilinear transformation with $T=1ms$. What was the cut off frequency 'Ωc' for the prototype continuous time ideal high-pass filter ? 5

5. *(a)* Design a single pole low pass digital filter with a 3-dB bandwidth of $0{\cdot}2\Pi$, using the bilinear transformation. The analog filter has a system function given by

$$Ha(S)=\frac{\Omega c}{S+\Omega c}$$; where 'Ωc' is the 3-dB bandwidth of the analog filter. 10

(b) For the given low pass RC network $(R=1\mu\Omega$ and $C=1\mu F)$ shown below, determine the equivalent discrete time expression for the circuit response $y(n)$, when the input is $x(t)=e^{-2t}$ and the sampling frequency is $50Hz$. 10

6. Write short notes on ***any two*** from the following : 10+10

(i) Digital resonator

(ii) Analog and digital frequency

(iii) Sub-band coding of speech signal

(iv) Linear phase FIR filter.
