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M. Tech 3rd Semester Examination

Digital Signal Processing

EC-304

Time : 3 Hours **Max. Marks : 100**

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : (i) All questions carry equal marks.

(ii) Attempt any five out of eight.

1. (a) Develop a general expression for the output y(n) of an LTI discrete-time system in terms of its input x(n) and the unit sample response h(n) of the system.

   (b) Draw the butterfly line diagram for 8 - point FFT calculation and briefly explain. Use decimation -in-time algorithm. (10+10=20)

2. (a) An LTI system is described by the equation, y(n) + y(n-1) - 1/4y(n-2) = x(n). Determine the cascade realization structure of the system. Discuss the stability of the system.

   (b) Define Z-Transform. Bring out the relationship between DFT and Z-transform. (10+10=20)

[P.T.O.]

3. (a) Compute Discrete Fourier transform of the following finite length sequence considered to be of length N.

(i) $x(n) = \delta(n + n_0)$ where $0 < n_0 < N$

(ii) $x(n) = \text{In}$ where $0 < I < 1$

(iii) If x(n) denotes a finite length sequence of length N, show that $x((-n))_N = x((N - n))_N$.

(b) What is transposed form structure? Give the Direct form –I and transposed structure for the given difference equation $y(n) = 3x(n)+2x(n-1)+5x(n-3)-3y(n-1)- 7y(n-3)$. (12+8=20)

4. (a) Derive the necessary expressions for computing FFT using DIF Algorithm and hence Compute FFT of the given sequence $x(n) = \{1,2,3,4,4,3,2,1\}$ using Radix-2 DIF FFT Algorithm.

(b) Compare and Contrast Bilinear & Impulse Invariant transformation technique. (12+8=20)

5. (a) Explain the aliasing effect in realization of digital filters using Impulse invariant technique.

(b) Convert the analog filter into a digital filter whose system function is

$H(S) = (S+0.2) / (S+0.2)^2 + 9$ using impulse invariant technique. Assume T =0.5s. (10+10=20)

6. (a) What is a FIR filter? How are FIR filter realized? Discuss various cases of frequency response of FIR filter design.

(b) Apply the overlap-save convolution method to find the output sequence of an FIR digital filter in response to the input sequence, $x(n) = \{1, 3, 2, -3, 0, 2, -1, 0, -2, 3, -2,1)$. The unit impulse response sequence of the filter is, $h(n) = \{1, 0, 1\}$. You can select the size of the DFT/IDFT equal to 8. (10+10=20)

7. (a) Using the bilinear transformation method, design a digital filter that when used in an A/D-Digital filter-D/A structure gives an equivalent low-pass analog filter with:

(a) monotonic passband and stopband.

(b) -3.01 dB cutoff frequency of 500 Hz.

(c) magnitude of frequency response down at least 15 dB at 750 Hz.

(d) sample rate of 2000 samples/sec.

(b) Discuss the process of decimation with a neat block diagram and explain how the aliasing effect can be avoided. (10+10=20)

8. (a) Compare various windowing techniques with respect to side lobes and beam width.

(b) Compare and Contrast Butterworth and Chebyshev approximations. (10+10=20)