

Reg. No. :

Question Paper Code : 53236

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2019.

Fifth/Sixth Semester

Information Technology

IT 6502 — DIGITAL SIGNAL PROCESSING

(Common to Computer Science and Engineering/Mechatronics Engineering)

(Regulation 2013)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. For the discrete time signal $x(n]$ shown in the Fig. 1 below, sketch the signal $x(n-3]$ and $x(n+2]$.

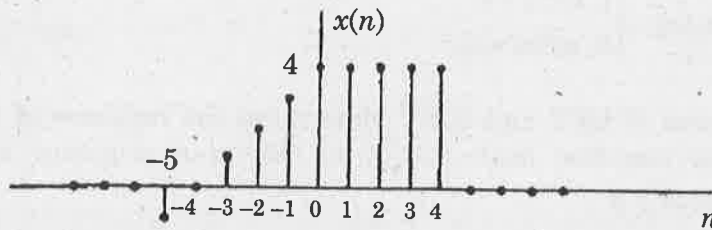


Fig. 1

- Define correlation of two different signals.
- Mention the number of computations involved in direct computation of DFT.
- State the circular frequency shift property of DFT.
- Mention the characteristics of the Butterworth and Chebychev analog filters.
- Mention two advantages and disadvantages of IIR filters.
- Define the Hamming and Hanning window functions.
- Sketch the direct form structure for the FIR filter with the difference equation:

$$y(n) = x(n) + \frac{1}{2}x(n-1) + \frac{1}{4}x(n-2) + \frac{1}{8}x(n-3).$$

9. Mention the three ways of representing negative numbers. Express $-7/8$ in the three forms.
10. What is the advantage of scaling compared to saturation arithmetic?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Consider the periodic sampling of a continuous time signal, establish the relation between analog and digital signal frequencies. (7)
- (ii) Consider the analog signal $x_a(t) = 3\cos 100\pi t$.
- (1) Determine the minimum sampling rate required to avoid aliasing. (2)
- (2) Suppose that the signal is sampled at the rate $F_s = 300$ Hz and 75 Hz. What is the discrete time signal obtained after sampling? (4)

Or

- (b) (i) Determine the power and energy of the unit step signal. (3)
- (ii) Determine the Z-transform of the signal $x(n) = -a^n u(-n-1)$. Sketch its ROC. (5)
- (iii) Compute the convolution of the two signals $x_1(n) = \{1, -2, 1\}$ and $x_2(n) = \begin{cases} 1, & 0 \leq n \leq 5 \\ 0, & \text{otherwise} \end{cases}$. (5)
12. (a) By means of DFT and IDFT, determine the response of the filter with impulse response $h(n) = \{1, 2, 3\}$ to the input sequence $x(n) = \{1, 2, 2, 1\}$. Assume $N = 8$. (13)

Or

- (b) (i) Sketch the flow graphs of the basic butterfly computation and the 8 point Decimation in time FFT. (6)
- (ii) Using the flow graph, determine the 8 point DFT of the sequence $x(n) = \{1, 2, 2, 2, 1, 0, 0, 0\}$. (7)
13. (a) A digital IIR low pass filter is required to meet the following frequency domain specifications :
- 3 dB ripple (maximum) in the passband $0 \leq \omega \leq 0.3\pi$ rad.
- At least 20 dB (minimum) attenuation in the stopband $0.6\pi \leq \omega \leq \pi$
- The digital filter is to be designed by applying bilinear transformation. (13)

Or

- (b) A digital low pass filter is to be designed to have a maximally flat frequency response with the following specifications.

$$20 \log |H(\omega)|_{\omega=0.2\pi} \geq -1.9328 \text{ dB}$$

$$20 \log |H(\omega)|_{\omega=0.6\pi} \leq -13.9794 \text{ dB}$$

Find the transfer function of the filter to meet the above specifications using impulse invariant transformation method. (13)

14. (a) The desired frequency response of a low pass filter is given by

$$H_d(\omega) = \begin{cases} e^{-j3\omega}, & |\omega| < \frac{3\pi}{4} \\ 0, & \frac{3\pi}{4} < |\omega| < \pi \end{cases}$$

Determine the frequency response of the FIR filter if Hamming window is used with $N = 7$. (13)

Or

- (b) Design a 17 tap linear phase FIR low pass filter with cut off frequency $\omega_c = \frac{\pi}{2}$. The design is to be done using frequency sampling technique. (13)

15. (a) Consider the recursive filter shown in the Fig. 2 below. The input $x(n]$ has a range of values $\pm 100 \text{ V}$, represented by 8 bits. Compute the variance of the output of the A/D conversion process. (13)

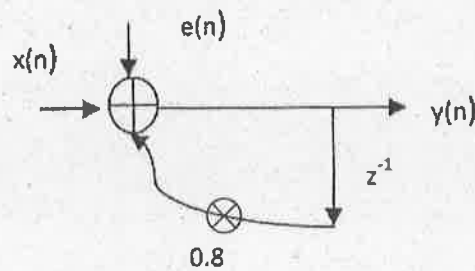


Fig. 2

Or

- (b) Find the effect of coefficient quantization on pole locations of the given second order IIR system, when it is realized in direct form I and in cascade form. Assume a word length of 4 bits through truncation.

$$H(z) = \frac{1}{1 - 0.9z^{-1} + 0.2z^{-2}} \quad (13)$$

PART C — (1 × 15 = 15 marks)

16. (a) Compute the characteristics of a limit cycle oscillation with respect to the system described the difference equation $x(n) = 0.95y(n-1) + x(n)$. Determine the dead band of the filter. Assume 4 bit sign magnitude representation including sign bit and the input as
- $$x(n) = \begin{cases} 0.875, & \text{for } n=0 \\ 0, & \text{otherwise} \end{cases} \quad (15)$$

Or

- (b) (i) Perform Circular convolution of the two sequences: (7)
 $x_1(n) = \{2, 1, 2, 1\}$ $x_2(n) = \{1, 2, 3, 4\}$
- (ii) Find the 4 point DFT of the sequence $x(n) = \cos\left(\frac{\pi}{4}n\right)$ using Decimation in Frequency algorithm. (8)