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Question Paper Code : 30537

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2024

Fifth Semester

Electronics and Communication Engineering

EC 8553 – DISCRETE-TIME SIGNAL PROCESSING

(Common to : Biomedical Engineering/Computer and Communication Engineering/Electronics and Telecommunication Engineering/Medical Electronics)

(Regulations 2017)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the relationship between the Discrete Fourier Transform (DFT) and the Discrete-Time Fourier Transform (DTFT) and how can DFT be obtained from DTFT?

2. Find the inverse DFT of the sequence X (k) = {0, 10-j10, –4, 10+j10}.

3. Show the mapping of poles from s-plane to z-plane in Impulse Invariant Transformation technique.

4. Define warping effect.

5. Recall the magnitude of side lobe level of Hanning FIR window.

6. A system with transfer function H(z) has impulse response h(n) defined as h(2) = 1, h(3) = –1 and h(n) = 0 otherwise. Show that H(z) is a FIR high pass filter.

7. The filter coefficient –0.673 is represented by sign magnitude fixed point arithmetic. Find the quantization error due to truncation if the word length is 6 bits.

8. Find the minimum scaling factor S_0 to avoid overflow $S_0x(n)+h(n)$, where $x(n)$= 0.75 and $h(n)$ = 0.45.

9. Define circular buffering.

10. List the advantages of fixed point architecture.

PART B — (5 × 13 = 65 marks)

11. (a) Compute the 8 point IDFT of the following sequence :

X(k) = {2, 1.7071 + j0.707, 1+j, 0.2929 + j0.7071 0, 0.2929-j0.7071 1-j 1.7071 – j0.7071} using DIF-FFT algorithm. Calculate the number of complex multiplications and additions required to compute DFT using the above algorithm and compare it with direct evaluation of DFT.

Or

(b) Compute the Linear Convolution of the two sequences $x[n]=$ {–1, 2, –1, 0, 1, 3, –2, 1, 3 –2, –1, 0, –2) and $h(n)$ = {1, 0, 1} using overlap save method.

12. (a) Find the analog transfer function (H(s)) of a Butterworth digital low pass filter using impulse invariant technique with T = 1 sec satisfying the following specification :

$0.9 \le |H(e^{jw})| \le 1 \qquad 0 \le \omega \le 0.25\pi$

$|H(e^{j\omega})| \le 0.1 \qquad 0.55\pi \le \omega \le \pi$

Or

(b) Realize the direct form – I, direct form – II, cascade form and parallel form for the following system :

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

13. (a) (i) Model the transfer function of FIR filter with minimum number of multipliers.

(1) $H(z) = 1 + \frac{2}{3}z^{-1} + \frac{15}{8}z^{-2} + \frac{2}{3}z^{-3} + z^{-4}$. (3)

(2) $H(z) = 1 + \frac{3}{4}z^{-1} + \frac{17}{8}z^{-2} + \frac{4}{3}z^{-3} + z^{-4}$ (3)

(ii) Discuss the importance of rectangular window. (7)

Or

(b) Find the filter coefficients of an ideal high pass filter with and without hamming window. Assume order of the filter N = 11.

$$H(e^{j\omega}) = \begin{cases} 0 & -\frac{\pi}{4} \le \omega \le \frac{\pi}{4} \\ 1 & \frac{\pi}{4} \le |\omega| \le \pi \end{cases}$$

14. (a) Examine the effect of quantization on pole locations of the given system function $H(z)=\frac{1}{\left(1-0.35z^{-1}\right)}\cdot\frac{1}{\left(1-0.62z^{-1}\right)}$ in direct form and in cascade form and select the better realization form based on the output quantization noise power.

Or

(b) Determine the limit cycle oscillations and deadband of the following first order IIR filter. Assume the truncated bit b = 3.

Output $y(n)=x(n)-0.95\,y(n-1)$

Input to the system is

$$x(n)=\begin{cases}0.875 & n=0\\ 0 & Otherwise\end{cases}$$

15. (a) Describe the architecture of any floating point processor with suitable block diagram.

Or

(b) Describe the DSP functionalities and circular buffering in detail.

PART C — (1 × 15 = 15 marks)

16. (a) Design a Chebyshev Type I low pass filter with T = 1 sec satisfying the following constraints using Impulse Invariant Method.

$0.8\le\left|H\left(e^{j\omega}\right)\right|\le 1$ for $0\le\omega\le 0.2\pi$

$\left|H\left(e^{j\omega}\right)\right|\le 0.2$ for $0.6\ \pi\le\omega\le\pi$

Realize the filter using cascade structure.

Or

(b) Design a Butterworth Low pass filter with $\omega_p = 0.23\pi$, $\omega_s = 0.43\ \pi$, $\alpha_p = 2$ dB, $\alpha_s = 11$ dB and T = 1 sec using Bilinear transformation.

Realize the filter using Direct form II structure.

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