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15EC52

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022

**Digital Signal Processing**

Time: 3 hrs.

Max. Marks: 80

*Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.  
2. Use of Normalized filter tables not permitted.*

**Module-1**

- 1 a. Describe the process of frequency domain sampling and reconstruction of discrete time signals. (06 Marks)  
b. Compute 8-point DFT of  $x(n) = \{1, 1, 1\}$ , also sketch magnitude and phase plot. (10 Marks)

OR

- 2 a. Derive the Relationship of DFT with Z-transform. (04 Marks)  
b. State and prove circular time shift property of DFT. (04 Marks)  
c. Compute circular convolution of  $x(n) = \{1, 2, 3, 4\}$  and  $h(n) = \{1, 2, 2\}$  using transform domain approach. (08 Marks)

**Module-2**

- 3 a. Find the output  $y(n)$  of a filter whose impulse response  $h(n) = \{1, -2\}$  and input  $x(n) = \{3, -2, 4, 1, 5, 7, 2, -9\}$  using overlap add method. Use 5-point circular convolution in your approach. (08 Marks)  
b. Determine N-point circular correlation of  $x(n) = \cos\left(\frac{2\pi n}{N}\right)$  and  $y(n) = \sin\left(\frac{2\pi n}{N}\right)$  (08 Marks)

OR

- 4 a. State and prove Parseval's theorem of DFT. (04 Marks)  
b. Explain the linear filtering of long data sequence using overlap-save method. (08 Marks)  
c. State and prove properties of twiddle factor. (04 Marks)

**Module-3**

- 5 a. Develop DIT-FFT algorithm to compute DFT of a sequence and obtain the signal flow diagram for  $N = 8$ . (12 Marks)  
b. Compute 4-point IDFT of  $X(K) = \{6, (-1 - j), 0, (-1 + j)\}$  using DIT-FFT algorithm. (04 Marks)

OR

- 6 a. Compute 8-point DFT of  $x(n) = \{1, 2, 3, 4, 5, 6, 7, 8\}$  using DIF-FFT algorithm. (08 Marks)  
b. Explain Goertzel algorithm for computation of DFT. (08 Marks)

**Module-4**

- 7 a. Obtain DF-II and parallel realization of  $H(z) = \frac{1 + z^{-1}}{\left(1 - \frac{1}{4}z^{-1}\right)\left(1 - z^{-1} + \frac{1}{2}z^{-2}\right)}$ . (08 Marks)  
b. Derive the expression for order and cutoff frequency for a lowpass Butterworth filter. (08 Marks)

OR

- 8 a. Design a digital filter  $H(z)$  that when used in A/D –  $H(z)$  – D/A structure gives an equivalent analog filter with the following specifications: passband attenuation of 3 dB at 500 Hz, stopband attenuation of 15 dB at 750 Hz with sampling rate 2 kHz. The filter is to be designed by performing a BLT on an analog system function. Use Butterworth prototype. Also obtain the difference equation. (10 Marks)
- b. Explain how an analog filter is mapped on to a digital filter using impulse invariance method. What are the limitations of the method? (06 Marks)

Module-5

- 9 a. Derive the frequency response of a symmetric FIR low pass filter for  $N = \text{odd}$ . (08 Marks)
- b. A FIR filter is described by  $y(n) = x(n) + \frac{2}{5}x(n-1) + \frac{3}{4}x(n-2) + \frac{1}{3}x(n-3)$ . Draw its Lattice structure. (08 Marks)

OR

- 10 a. Design a LPF with the frequency response

$$H_d(j\omega) = \begin{cases} e^{-j2\omega} & |\omega| < \frac{\pi}{4} \\ 0 & \frac{\pi}{4} < |\omega| < \pi \end{cases}$$

using rectangular window, also find its impulse response, frequency response and difference equation. (12 Marks)

- b. Realize the linear phase FIR filter having the impulse response  $h(n) = \left\{1, \frac{1}{4}, -\frac{1}{8}, \frac{1}{4}, 1\right\}$ . (04 Marks)

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