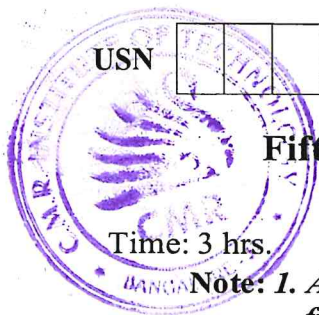


Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg. 42+8 = 50, will be treated as malpractice.



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10TE52

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021
Digital Signal Processing

Time: 3 hrs.

Max. Marks: 100

Note: 1. Answer any FIVE full questions, selecting at least TWO full questions from each part.

2. Use of normalized Chebyshev and Butterworth prototype tables are not allowed.

PART - A

- 1 a. Find the DFT of a sequence $x(n) = \begin{cases} 1 & \text{for } 0 \leq n \leq 2 \\ 0 & \text{otherwise} \end{cases}$ for $N = 4$. Plot magnitude of the DFT $X(k)$. (06 Marks)
- b. What is the relationship between DFT and DFS? (02 Marks)
- c. If DFT $\{x(n)\} = X(k)$, then show that
- i) DFT $\{x((-n))_N\} = X((-k))_N$ ii) DFT $\{W_N^{-\ell n} x(n)\} = X((k - \ell))_N$ (12 Marks)
- 2 a. Determine the response of an LTI system with $h(n) = \{1, -1, 2\}$ for an input $x(n) = \{1, 0, 1, -2, 1, 2, 3, -1, 0, 2\}$. Use overlap add method with block length $N = 4$. (12 Marks)
- b. Consider the sequence $x(n) = \{8, 3, 4, 1, -5, -4, -20, 2, -1, 7, 4\}$. Evaluate the following without explicitly computing $X(k)$:
- i) $\sum_{k=0}^{10} X(k)$ ii) $\sum_{k=0}^{10} |X(k)|^2$ (08 Marks)
- 3 a. Derive DIT-FFT algorithm for $N = 8$ and draw the complete signal flow graph. (12 Marks)
- b. What is in-place computation? What is the total number of complex additions and multiplications required for $N = 512$ point, if DFT is computed directly and if FFT is used? (04 Marks)
- c. Compute the 4-point DFT of the sequence $x(n) = \{1, 0, 1, 0\}$ using DIF FFT radix-2-Algorithm. (04 Marks)
- 4 a. Given $x(n) = n + 1$ and $N = 8$. Determine $X(k)$ using DIF-FFT algorithm. (12 Marks)
- b. Write a note on chirp z-transform algorithm. (04 Marks)
- c. Given $x(n) = \{1, 0, 1, 0\}$, find $X(2)$ using Goertzel algorithm. (04 Marks)

PART - B

- 5 a. Bring out a comparison between Butterworth filter and Chebyshev filter. (04 Marks)
- b. Design Butterworth filter for following specifications: (10 Marks)
- $$0.8 \leq |H_a(s)| \leq 1 \quad \text{for } 0 \leq f \leq 1000\text{Hz}$$
- $$|H_a(s)| \leq 0.2 \quad \text{for } f \geq 5000\text{Hz}$$
- c. Derive an expression for order of the Chebyshev filter. (06 Marks)
- 6 a. Design a FIR low pass filter with a desired frequency response (10 Marks)
- $$H_d(w) = \begin{cases} e^{-j3w} & -\frac{3\pi}{4} \leq w \leq \frac{3\pi}{4} \\ 0 & \frac{3\pi}{4} \leq |w| \leq \pi \end{cases}$$
- Use Hamming window with $M = 7$. (10 Marks)
- b. Design a lowpass FIR filter using frequency sampling technique having cut off frequency of $\frac{\pi}{2}$ rad/sample. The filter should have linear phase and length of 17. (10 Marks)



10TE52

- 7 a. Let $H_a(S) = \frac{S+a}{(S+a)^2 + b^2}$ be a causal second order analog transfer function. Show that the casual second-order digital function $H(z)$ is obtained from $H_a(S)$ through impulse invariance method is given by

$$H(z) = \frac{1 - e^{-aT} \cos bTz^{-1}}{1 - 2 \cos bT e^{-aT} z^{-1} + e^{-2aT} z^{-2}} \quad (08 \text{ Marks})$$

- b. What are the limitations of Impulse invariance method? (02 Marks)
c. Design a digital butterworth filter satisfying the following constraints using bilinear transform. Assume $T = 1$ sec.

$$\begin{aligned} 0.9 \leq |H(e^{jw})| \leq 1 \quad 0 \leq w \leq \frac{\pi}{2}; \\ |H(e^{jw})| \leq 0.2 \quad \frac{3\pi}{4} \leq w \leq \pi \end{aligned} \quad (10 \text{ Marks})$$

- 8 a. If $H_a(S) = \frac{1}{(S+2)(S+1)}$; find the corresponding $H(z)$ using Impulse invariance method for sampling frequency of 5 samples/sec. (05 Marks)

- b. Obtain the cascade realization of system function

$$H(z) = 1 + \frac{5}{z} z^{-1} + 2z^{-2} + 2z^{-3} \quad (05 \text{ Marks})$$

- c. Consider the system function

$$H(z) = \frac{1 + \frac{1}{5} z^{-1}}{\left(1 - \frac{1}{2} z^{-1} + \frac{1}{3} z^{-2}\right) \left(1 + \frac{1}{4} z^{-1}\right)}$$

- i) Realize the system in direct form – I
ii) Realize the system in parallel form using first and second order direct form II sections. (10 Marks)
