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B. Tech.

(SEM V) THEORY EXAMINATION 2021-22

DIGITAL SIGNAL PROCESSING

Time: 3 Hours

Total Marks: 100

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt all questions in brief.

2 x 10 = 20

- Define the Recursive and Non-Recursive systems.
- Enlist the Condition for Linear Phase FIR digital filter with 5 Number of samples.
- Differentiate Butterworth Low Pass Filter with Chebyshev LPF in terms of Filter Order.
- Evaluate the value of $C_3(x)$, Chebyshev Polynomial.
- Demonstrate the term Gibb's Phenomenon with schematic diagram.
- Explain the terms Truncation Error & Round off Error with suitable examples.
- Evaluate the DFT for the sequence [1, 2, 7, 3].
- Find out the total no of Complex additions and Complex multiplications required for calculating 8-point Conventional DFT & by using butterfly structure DIT-FFT.
- Explain the term Decimation with suitable example.
- Find the output of the sequence [1 2 3] after up sampling by a factor $N=3$.

SECTION B

2. Attempt any three of the following:

10 x 3 = 30

- Realize the given $H(z)$ for using ladder structure.

$$H(z) = \frac{2 + 8z^{-1} + 6z^{-2}}{1 + 8z^{-1} + 12z^{-2}}$$

- Design Digital Butterworth filter to satisfy the following constraints using bilinear transformation method, the sampling Interval is 2 second: assume missing data if required:

$$0.52 \leq \left| \frac{H(e^{j\omega})}{H(e^{j\omega})} \right| \leq 1, \quad 0 \leq \omega \leq \pi/2$$

$$\left| \frac{H(e^{j\omega})}{H(e^{j\omega})} \right| \leq 0.1, \quad 3\pi/4 \leq \omega \leq \pi$$

- Explain the concept of the Limit Cycle Oscillations & dead band effect with suitable example.
- Calculate the circular convolution using graphical method for $x(n) = [1, 2, 3, 4]$ and $h(n) = [4, 3, 2, 1]$.
- Summarize QMF & Explain analytical and synthesis filter bank with aliasing free filter bank.

SECTION C

3. Attempt any one part of the following:

10 x 1 = 10

- Describe the linear phase FIR systems, & For $h(n) = [1/2, 1/3, 1/5, 1/3, 1/2]$ Realize $H(z)$ of the Linear Phase FIR system for the given impulse response.
- Find out the direct form-I & direct form-II realization of a discrete-time system represented by the transfer function



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$$y(n) = -\frac{13}{12}y(n-1) - \frac{9}{24}y(n-2) - \frac{1}{24}y(n-3) + x(n) + 4x(n-1) + 3x(n-2)$$

4. Attempt any one part of the following: 10 x 1 = 10

- (a) Design Chebyshev Digital LPF filter to satisfy the following constraints using Impulse Invariant method.

$$0.9 \leq |H(e^{jw})| \leq 1, 0 \leq w \leq 0.25\pi$$

$$|H(e^{jw})| \leq 0.24, 0.5\pi \leq w \leq \pi$$

- (b) Design Chebyshev Digital LPF filter to satisfy the following constraints using Bilinear Transformation method, assume that the sampling time is one second.

$$0.707 \leq |H(e^{jw})| \leq 1, 0 \leq w \leq 0.2\pi$$

$$|H(e^{jw})| \leq 0.1, 0.5\pi \leq w \leq \pi$$

5. Attempt any one part of the following: 10 x 1 = 10

- (a) A low Pass filter is to be designed with the following specifications:

$$H_d(e^{jw}) = \begin{cases} e^{-2jw} & , -\pi/4 \leq w \leq \pi/4 \\ 0 & , \text{otherwise} \end{cases}$$

Using Rectangular window function, Find the Filter coefficients & Frequency spectrum of the designed filter.

- (b) Design a Filter with

$$H_d(e^{jw}) = \begin{cases} e^{-3jw} & , -\pi/4 \leq w \leq \pi/4 \\ 0 & , \pi/4 \leq w \leq \pi \end{cases}$$

Using Hamming window with M= 7.

6. Attempt any one part of the following: 10 x 1 = 10

- (a) Using DIF FFT find X (k), for x (n) = 2ⁿ⁺¹, for N=8.
- (b) Derive & solve the DIT FFT algorithm for 8 numbers of samples.

7. Attempt any one part of the following: 10 x 1 = 10

- (a) Explain the block diagrammatic presentation of DSP processor, with its architecture, addressing formats and its commercial usages.
- (b) Write a short note on LMS Algorithm.