CBCS SCHEME

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18EE63

Sixth Semester B.E. Degree Examination, June/July 2023
Digital Signal Processing

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Find the DFT of the sequence x(n) = {1, 1, 1, 1} for N = 8. Plot magnitude and phase spectrum of x(k). **(10 Marks)**

b. State and prove the following properties of DFT
i) Linearity ii) Periodicity property iii) Parseval's theorem. **(10 Marks)**

OR

2 a. The first values of an 8-point DFT of real value sequence is {4, 1–j2.414, 0, 1–j0.414, 0}. Find the remaining values of the DFT. **(04 Marks)**

b. Obtain the circular convolution of x(n) = {1, 2, 3, 4} with h(n) = {1, 1, 2, 2}. **(06 Marks)**

c. A long sequence x[n] is filtered through a filter with impulse response h[n] to yield y[n]. If x(n) = {1, 4, 3, 0, 7, 4, –7, –7, –1, 3, 4, 3} h[n] = {1, 2}. Compute y[n] using overlap-add technique. Use only 5 point circular convolution. **(10 Marks)**

Module-2

3 a. Tabulate the comparison of complex addition and multiplications for direct computation of DFT verses the FFT algorithm for N = 16, 32 and 128. **(10 Marks)**

b. Develop an 8-point DIT.FFT algorithm. Draw the complete signal flow graph. **(10 Marks)**

OR

4 a. Given the sequences $x_1[n]$ and $x_2[n]$ below. Compute the circular convolution $x_1[n] \circledast_N x_2[n]$ for N = 4. Use DIT-FFT algorithm.
$x_1[n] = \{2, 1, 1, 2\}$ $x_2[n] = \{1, -1, -1, 1\}$ **(10 Marks)**

b. First 5 samples of the 8-point DFT of a real valued sequence is given by
x(0) = 0, x(1) = 2 + j2, x(2) = –j4, x(3) = 2 – j2, x(4) = 0. Determine the remaining points, hence find the original sequence x[n] using DIF – FFT algorithm. **(10 Marks)**

Module-3

5 a. Transform $H(s) = \dfrac{s+1}{s^2+5s+6}$ into digital filter using impulse invariant transformation with T = 0.1 sec. **(08 Marks)**

b. Explain bilinear transformation method of converting analog filter into digital filter; Show the mapping from S- plane to Z-plane. Also obtain the relation between ω and Ω. **(12 Marks)**

OR

6 a. Design a unit bandwidth 3dB digital Butterworth filter and order ONE by using bilinear transformation. **(08 Marks)**

b. A digital low pass filter is required to meet the following specifications

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

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

The filter must have a maximally flat frequency response. Find H(z) to meet the above specifications using impulse invariant transformation. Assume T = 1sec. **(12 Marks)**

Module-4

7 a. Bring out a comparison between Butterworth filter and Chebyshev filter. **(06 Marks)**

b. Design a digital filter using Bilinear transformation to is for the following specifications :
i) Monotonic pass and stop bands ii) – 3.01dB cutoff frequency of 0.5π iii) Magnitude down at least 15dB at 0.75π. Assume T = 1 Sec. **(14 Marks)**

OR

8 a. Realize the transfer function of the system defined by the differential equation using direct form I and direct form II

$$y[n]-\frac{3}{4}y[n-1]+\frac{1}{8}y[n-2]=x[n]+\frac{1}{3}x[n-1]$$ **(10 Marks)**

b. Obtain the parallel form for the given transfer function

$$H(z)=\frac{8z^3-4z^2+4z-2}{\left(z-\frac{1}{4}\right)\left(z^2-z+\frac{1}{2}\right)}$$ **(10 Marks)**

Module-5

9 a. A lowpass filter is to be designed with the following desired frequency response

$$H_d(e^{jw})=H_d(w)=\begin{cases} e^{-j2w} & |w|<\frac{\pi}{4} \\ 0 & \frac{\pi}{4}<|w|<\pi \end{cases}$$

Determine the filter coefficients $h_d(n)$ and h(n) if w(n) is a rectangular window defined as follow

$$W_R(n)=\begin{cases} 1 & 0\le n\le 4 \\ 0 & \text{otherwise} \end{cases}$$

b. Also find the frequency response, H(w) of the resulting FIR filter. **(10 Marks)**
The desired response of a low pass filter is

$$H_d(e^{jw})=e^{-j2w} \quad -\frac{\pi}{4}\le w\le\frac{\pi}{4}$$
$$=0 \quad \frac{\pi}{4}<|w|\le\pi$$

Determine $H(e^{jw})$/FIR using the Hamming window. **(10 Marks)**

OR

10 a. Determine the filter coefficient h(n) obtained by sampling

$$H_d(e^{jw})=\begin{cases} e^{\frac{-j(M-1)w}{2}} & 0\le|w|\le\frac{\pi}{2} \\ 0 & \frac{\pi}{2}\le|w|\le\pi \end{cases}$$

For M = 7. **(10 Marks)**

b. Given $H(z)=(1+z^{-1})\left(\frac{1}{2}-\frac{1}{4}z^{-1}+\frac{1}{2}z^{-2}\right)$ for an FIR system obtain the realization in

i) Direct Form ii) Cascade form iii) Linear phase. **(10 Marks)**

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