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10MT74

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

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Compute the DFT of the following sequences
   i) $x(n) = \delta(n - n_0)$
   ii) $x(n) = a^n = u(n), \quad 0 \le n \le N - 1$
   iii) $x(n) = 4 + \text{Cos}^2 \dfrac{4\pi n}{N}, \quad 0 \le n \le N - 1$ **(12 Marks)**

b. Let x(n) be a finite length sequence an $x(n) = \left\{ \underset{\uparrow}{1}, 1, 0, 1, 0 \right\}$. Find the 5 – point DFT of the sequence x(n) and also find y(n) if $y(k) = x^2(k)$. **(08 Marks)**

2 a. State and prove circular convolution property of DFT. **(08 Marks)**
b. Using real and even property obtain the DFT of {0, 0, 5, 1, 0.5, 0} **(08 Marks)**
c. If x(n) = {1, 2, 0, 3, – 2, 4, 7, 5 } evaluate the following :
   i) x(4)
   ii) $\sum_{k=0}^{7} |x(k)|^2$ **(04 Marks)**

3 a. A long sequence x(n) is filtered through a filter with impulse response h(n) to yield the output y(n). If
x(n) = {1, 1, 1, 1, 1, 3, 1, 1, 4, 2, 1, 1, 3, 1}
h(n) = {1, -1}, compute y(n) using overlap save technique. Use only 5-point circular convolution. **(10 Marks)**
b. Develop the Radix – 2 D.I.F-FFT algorithm for N-8. Draw the signal flow graph. **(10 Marks)**

4 a. Develop the DIF – FFT algorithm to compute DFT for N = 8. Write all intermediate signal How graphs? **(12 Marks)**
b. Consider a finite length sequence $x(n) \left\{ \underset{\uparrow}{5}, 3 - j2, -3, 3 + j2 \right\}$, find x(2) using Goertzel algorithm. Assume that initial conditions are zero. **(08 Marks)**

PART – B

5 a. Derive the order of the Butterworth filter. **(06 Marks)**
b. Distinguish between Butterworth and Chebyshev filter. **(04 Marks)**
c. Design a Chebyshev analog low pass filter has –3dB cut off frequency of 100 rad/sec and a stop band attenuation of 25dB or greater for all radian frequencies past 250 rad/sec. **(10 Marks)**

6 a. Realize an FIR linear phase filter for 'N' to be even. **(08 Marks)**

b. A low pass filter is to be designed with the following desired frequency response:

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

Determine the filter coefficients $h_d(n)$ and $h(n)$ if $\omega(n)$ is rectangular window defined as,

$$\omega_R(n) = \begin{cases} 1 & 0 \le n \le 4 \\ 0 & \text{Otherwise} \end{cases}$$ **(12 Marks)**

7 a. Design a Digital Butterworth Low pass filter to meet the following specifications

$$0.8 \le |H(e^{jw})| \le 1 \quad \text{for} \quad 0 \le w \le \frac{\pi}{4}$$

$$|H(e^{jw})| \le 0.18 \quad \text{for} \quad 0.75\pi \le w < \pi$$

Use Bilinear transformation method. **(14 Marks)**

b. Determine system transfer function H(z) using impulse invariance technique for the analog system is

$$H(s) = \frac{s+4}{(s+1)(s+3)}$$. Assume T = 1 Sec. **(06 Marks)**

8 a. Obtain H(z) using impulse invariance method for following analog filter

$$H_a(s) = \frac{1}{(s+0.5)(s^2+0.5s+2)}$$ **(10 Marks)**

b. Obtain the digital filter equivalent of the analog filter shown in Fig. Q8(b) using

i) Impulse invariant transformation

ii) Bilinear transformation.

Assuming the sampling frequency $F_s = 8F_c$, where F_c is the cutoff frequency of filter.

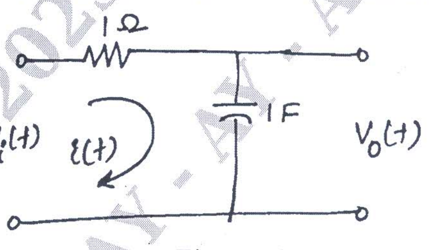

Fig. Q8(b) **(10 Marks)**

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