DU – 094

V Semester B.E. (Electrical and Electronics) Degree Examination, December 2017/January 2018
(2K11 Scheme)
EE 505 : DIGITAL SIGNAL PROCESSING

Time : 3 Hours Max. Marks : 100

Instructions : *i) Normalized Filter Tables are **permitted** to use.*
*ii) Answer **any five full** questions choosing atleast **two** questions from Part **A** and Part **B**.*

PART – A

1. a) State and prove the following DFT properties : **10**
   i) Time reversal of a sequence
   ii) Circular time shift of a sequence
   iii) Parseval's Theorem.

   b) Compute the 4-point circular convolution of the sequences given by $x(n) = \{2, 1, 3, -2\}$ and $h(n) = \{2, 9, 2, 9\}$ using DFT and IDFT method. **6**

   c) Compute the N-point DFT of the sequence

   $x(n) = \cos(n W_0)$, where $W_0 = \frac{2\pi}{N} K_0, 0 < n < N-1$. **4**

2. a) Find the DFT of the sequence $x(n) = \{1, 2, -1, 2, 3, 4, 1, 2\}$ using Radix-2 DIT-FFT algorithm. **10**

   b) Derive the Radix-2 DIF-FFT algorithm to compute DFT of an N = 8 point sequence and draw the complete signal flow graph. **10**

3. a) Write a short note on Goertzel Algorithm. **4**

   b) Let x(n) be a finite length sequence with $x(k) = \{0, 1 + j, 1, 1 - j\}$. Find DFT's of the following sequences :

   i) $x_1(n) = e^{j\pi/2 n} x(n)$ iii) $x_3(n) = x((n-1))_4$

   ii) $x_2(n) = \cos\left(\frac{\pi}{2} n\right) x(n)$ iv) $x_4(n) = (0, 0, 1, 0) \otimes_4 x(n)$. **8**

P.T.O.

c) Let x(t) be an analog signal with bandwidth B = 3 KHz. N = 2^m – point DFT is used to compute the spectrum of the signal with a resolution less than or equal to 50 Hz. Determine

i) the minimum sampling rate

ii) the minimum number of required samples

iii) the minimum length of the analog signal record. **8**

4. a) Consider a second order LTI system described by the difference equation

$y(n) = \frac{1}{16} y(n-2) + x(n)$. Determine the direct form – I, direct form – II, parallel – form and cascade – form realizations of the system. **10**

b) Realise an FIR filter with impulse response h(n) given by

$h(n) = \left(\frac{1}{2}\right)^n [u(n) - u(n-4)]$ using direct form – I. **4**

c) Realize the linear-phase FIR filter having the following impulse response.

$h(n) = \delta(n) - \frac{1}{6}\delta(n-1) + \frac{1}{8}\delta(n-2) + \frac{1}{16}\delta(n-3) - \delta(n-4)$. **6**

PART – B

5. a) Distinguish between Butterworth and Chebyshev Type I filter. **4**

b) Design a Chebyshev I filter to meet the following specifications :

i) Passband ripple : $\leq$ 2dB

ii) Passband edge : 1 rad/sec

iii) Stopband attenuation : $\geq$ 20 dB

iv) Stopband edge : 1.3 rad/sec

Assume the use of lowpass Chebyshev I filter. **8**

c) Design a Butterworth Analog highpass filter that will meet the following specifications :

i) Maximum passband attenuation = 2dB

ii) Passband edge freq. = 200 rad/sec

iii) Minimum Stopband attenuation = 20 dB

iv) Stopband edge freq. = 100 rad/sec. **8**

6. a) Derive the necessary mathematical modeling for Bilinear transformation of designing IIR filters. Show the mapping of S-plane to z-plane. **10**

   b) A digital lowpass filter is required to meet the following specifications. **10**

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

   $20 \log | H(W) |_{w = 0.6\pi} \leq -13.9794$ dB. The filter must have a maximally flat frequency response. Find H(z) to meet above specifications using IIT (Impulse Invariance Transformation).

7. a) Design a digital filter H(z) that when used in an A/D – H(z) – D/A structure gives an equivalent filter with the specifications **10**

   Passband ripple : $\leq$ 3.01 dB

   Passband edge : 500 Hz

   Stopband attenuation : $\geq$ 20 dB

   Stopband edge : 750 Hz

   Sample rate : 4KHz

   Use bilinear transformation and Butterworth prototype.

   b) Explain the design of FIR digital filter using frequency sampling technique. Derive the mathematical equations and also draw the frequency sampling structure. **10**

8. a) Distinguish between IIR and FIR digital filters. **4**

   b) Obtain the coefficients of an FIR filter to meet the following specifications :

   Passband edge freq. 1.5 KHz

   Stopband edge freq. : 2 KHz

   Minimum stopband Attenuation : 50 dB

   Sampling frequency : 8 KHz **10**

   c) What are the advantages and disadvantages of window technique ? Also explain the design of FIR differentiators. **6**

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