USN | | | | | | | | | | 06EC52

Fifth Semester B.E. Degree Examination, Dec.2015/Jan.2016
Digital Signal Processing

Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. ***Use of Normalised filter tables not permitted.***

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.

PART - A

1 a. Define DFT. Derive the relationship of DFT to the Z - transform. **(05 Marks)**

b. An analog signal is sampled at 10kHz and the DFT of 512 samples is computed. Determine the frequency spacing between spectral samples of DFT. **(03 Marks)**

c. Consider the finite length sequence $x[n] = \delta[n] + 2\delta[n-5]$. Find i) the 10 point DFT of x[n] ii) the sequence that has a DFT $Y(k) = e^{-j\frac{4\pi}{10}} X(k)$, where X(k) is the 10 point DFT of x[n] iii) the 10 point sequence y[n] that has a DFT Y(k) = X(k) W(k), where X(k) is the 10 point DFT of X[n] and W(k) is the 10 point DFT of u[n] – u[n-7]. **(12 Marks)**

2 a. Determine the circular convolution of the sequences x[n] = {1, 2, 3, 1} and h[n] = {4, 3, 2, 2} using DFT and IDFT equations. **(08 Marks)**

b. Consider the FIR filter with impulse response h[n] = {3, 2, 1, 1}. If the input is x[n] = {1, 2, 3, 3, 2, 1, -1, -2, -3, 5, 6, -1, 2, 0, 2, 1}. Find the output using overlap Add method. Use 7 point circular convolution. **(12 Marks)**

3 a. Assume that a complex multiplication takes 1μsec and that the amount of time to compute a DFT is determined by the amount of time it takes to perform all of the multiplications :
i) How much time does it take to compute a 1024 point DFT directly?
ii) How much time is required if an FFT is used? and
iii) The speed improvement factor. **(04 Marks)**

b. Derive the Radix – 2 decimation in frequency FFT algorithm to compute the DFT of a N = 8 point sequence and draw the final complete signal flow graph. **(10 Marks)**

c. Let x[n] be a finite length sequence with x(k) = {0, 1+j, 1, 1 – j}. Using the properties of DFT, find the DFT's of the following sequences.
i) $x_1[n] = e^{j\frac{\pi}{2}n} x[n]$ ii) $x_2[n] = \cos\{(\frac{\pi}{2})n\}\, x[n]$ iii) $x_3[n] = x((n-1)_4)$. **(06 Marks)**

4 a. Find the sequence x[n] corresponding to the 8 point DFT $x(k) = \{\underset{\uparrow}{4},\ 1-j2.44,\ 0,\ 1-j0.414,\ 0,\ 1+j0.414,\ 0,\ 1+j2.414\}$ by using any of the Radix 2 FFT algorithms to compute the IDFT. Draw the final signal flow graph. Show the outputs for each stage. **(12 Marks)**

b. With the help of suitable diagrams, explain the Chirp Z transform algorithm. **(08 Marks)**

PART - B

5 a. Give that $|Ha(j\Omega)|^2 = \frac{1}{1+64\Omega^6}$, determine the analog low pass filter system function Ha(s). **(08 Marks)**

b. Compare Butterworth and Chebyshev filters. **(04 Marks)**

c. Design a Chebyshev filter with a maximum passband attenuation of 2.5dB at $\Omega p = 20$ rad/sec and the stopband attenuation of 30dB at $\Omega s = 50$rad/sec. **(08 Marks)**

6 a. Design a FIR low pass filter with a desired frequency response

$$H_d(e^{jw}) = \begin{cases} e^{-j3w}; & -\frac{3\pi}{4} \le w \le \frac{3\pi}{4} \\ 0; & \frac{3\pi}{4} < |w| < \pi \end{cases}$$

Use Hamming window with M = 7. Also obtain the frequency response. **(10 Marks)**

b. Using frequency sampling method, design a band pass filter with the following specifications. Determine the filter coefficients for N = 7. Sampling frequency F = 8000Hz, cut off frequencies $f_{c_1} = 1000$ Hz $f_{c_2} = 3000$ Hz. **(10 Marks)**

7 a. Design a digital low pass filter using the bilinear transformation method to satisfy the following characteristics i) Monotonic stop band and pass band ii) -3dB cut off frequency of 0.5π rad iii) Magnitude down at least 15dB at 0.75π rad. **(10 Marks)**

b. Design a Butterworth digital filter using the Impulse invariance method for the following specifications. Assume T = 1 sec

$0.8 \le |H(e^{jw})| \le 1$; $0 \le w \le 0.2\pi$

$|H(e^{jw})| \le 0.2$; $0.6\pi \le w \le \pi$. **(10 Marks)**

8 a. Obtain the Direct form II (Canonic) and Cascade realization of

$$H(Z) = \frac{(z-1)(z^2+5z+6)(z-3)}{(z^2+6z+5)(z^2-6z+8)}.$$ **(10 Marks)**

The cascade section should consist of two biquadratic sections.

b. A FIR filter is given by

$Y[n] = x[n] + \frac{2}{5}x[n-1] + \frac{3}{4}x[n-2] + \frac{1}{3}x[n-3]$. Draw the direct form I and lattice structure. **(10 Marks)**

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