USN | | | | | | | | | | | **10EC52**

Fifth Semester B.E. Degree Examination, May 2017

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 normalized filter tables not permitted.***

PART – A

1 a. Define DFT. Derive the relationship of DFT to the z-transform. **(04 Marks)**

b. 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 y(n) that has a DFT $Y(K)=e^{\frac{-j6\pi K}{10}}X(K)$ 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 $w(n)=u(n)-u(n-6)$. **(12 Marks)**

c. Find the z-transform of the sequence $x(n)=\{\underset{\uparrow}{0.5}, 0, 0.5, 0\}$ using z transform, find its DFT. **(04 Marks)**

2 a. State and prove the (i) Circular convolution and (ii) Circular frequency shift properties of DFT. **(08 Marks)**

b. Let $x(n)=\{1, 2, 0, 3, -2, 4, 7, 5\}$. Evaluate the following with out explicity computing the DFT or IDFT:

(i) X(0) (ii) X(4) (iii) $\sum_{K=0}^{7} X(K)$ (iv) $\sum_{K=0}^{7} |X(K)|^2$ **(08 Marks)**

c. Compute the circular autocorrelation of the sequence $x(n)=\{1, 1, 2, 1\}$. **(04 Marks)**

3 a. Using overlap save method. Compute y(n) of a FIR filter with impulse response $h(n)=\{3, 2, 1\}$ and input $x(n)=\{2, 1, -1, -2, -3, 5, 6, -1, 2, 0, 2, 1\}$ use only 8 point circular convolution in your approach. **(12 Marks)**

b. Suppose that we are given 10 seconds of speech that has been sampled at a rate of 8 kHz and that we would like to filter it with an FIR filter h(n) of length M = 64. Using the overlap save method with 1024 point DFTs, how many DFTs and IDFTs are necessary to perform the convolution? **(04 Marks)**

c. State and prove the symmetry and periodicity properties of the DFT. **(04 Marks)**

4 a. Find the sequence x(n) corresponding to the 8 point DFT ,

$X(K)=\{\underset{\uparrow}{4}, 1-j2.414, 0, 1-j0.414, 0, 1+j2.414\}$ by using any of the Radix 2 FFT algorithms to compute the IDFT. Draw the final signal flow graph and show the outputs for each stage. **(12 Marks)**

b. Explain the Goertzel algorithm using a suitable diagram. Given $x(n)=\{1, 0, 1, 0\}$ find x(2) using the Goertzel algorithm. **(08 Marks)**

PART – B

5 a. Given that $\left|H(e^{j\Omega})\right|^2 = \dfrac{1}{1+64\Omega^6}$, determine the analog Butterworth low pass filter transfer function. **(06 Marks)**

b. Design an analog Chebyshev filter with a maximum passband attenuation of 2.5 dB at $\Omega_P = 20$ rad/sec and the stop band attenuation of 30 dB at $\Omega_s = 50$ rad/sec. **(10 Marks)**

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

6 a. Design a linear phase high pass filter using the Hamming window for the following desired frequency response $H_d(\omega) = \begin{cases} e^{-j3\omega}; & \dfrac{\pi}{6} \le |\omega| \le \pi \\ 0; & |\omega| < \dfrac{\pi}{6} \end{cases}$, $\omega(n) = 0.54 - 0.46\cos\left(\dfrac{2\pi n}{N-1}\right)$; where N is the length of the Hamming window. **(10 Marks)**

b. Design a linear phase low pass FIR filter with 7 taps and a cut off frequency of $\omega_C = 0.3\pi$ rad using the frequency sampling method. **(10 Marks)**

7 a. Design a digital low pass Butter worth filter using Bilinear transformation method to meet the following specifications. Take $T = 2$ sec, Pass band ripple $\le$ 1.25 dB, Pass band edge = 200 Hz, Stop band attenuation ≥ 15 dB, Stop band edge = 400 Hz, Sampling frequency = 2 KHz. **(12 Marks)**

b. An analog filter is characterized with the transfer function $H(s) = \dfrac{s+0.1}{(s+0.1)^2+9}$. Derive the corresponding digital filter by using the impulse invariance technique. **(08 Marks)**

8 a. Obtain the direct form II and cascade realization of, $H(z) = \dfrac{(z-1)(z^2+5z+6)(z-3)}{(z^2+6z+5)(z^2-6z+8)}$. The cascade section should consist of two biquadratic sections. **(10 Marks)**

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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