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

Fifth Semester B.E. Degree Examination, December 2011
Digital Signal Processing

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting atleast TWO questions each from Part – A and Part - B.***
2. ***Use of normalized Butterworth and Chebyshev table is not permitted.***

1 a. Let $x_p(n)$ be a periodic sequence with fundamental period N. Consider the following DFTs
$x_p(n) \xleftrightarrow[N]{DFT} X_1(k)$
$x_p(n) \xleftrightarrow[3N]{DFT} X_3(k)$. What is the relationship between $x_1(k)$ and $x_3(k)$? **(10 Marks)**

b. Compute the N – point DFT of the sequence $x(n) = an, 0 \le n \le N\text{-}1$. **(10 Marks)**

2 a. Given the 8 – point sequence

$$X(n) = \begin{cases} 1, & 0 \le n \le 3 \\ 0, & 4 \le n \le 7 \end{cases}$$

Compute the DFT of the sequence $x_1(n)$ using properties of DFT.

$$X_1(n) = \begin{cases} 1, & n = 0 \\ 0, & 1 \le n \le 4 \\ 1, & 5 \le n \le 7 \end{cases}$$ **(08 Marks)**

b. What are the methods used to perform fast convolution? Explain any one method giving all the steps involved to perform fast convolution. **(07 Marks)**

c. Given the sequences $x(n) = \cos\frac{\pi n}{2}$ and $h(n) = 2^n$. Compute the 4 – point circular convolution. **(05 Marks)**

3 a. How many multiplications and additions are needed for a 64-point sequence using FFT algorithm and DFT using Direct computation? Find i) speed improvement factor ii) number of real and complex registers needed. **(06 Marks)**

b. Prove the symmetry and periodicity property of a twiddle factor. **(06 Marks)**

c. A designer has a number of eight point FFT chips. Show explicity how he should interconnect four such chips in order to compute a 32 – point DFT. **(08 Marks)**

4 a. Describe Goertzel algorithm. Also Obtain direct form – II realization of two pole resonator for computing the DFT. **(10 Marks)**

b. What is chirp signal? What are the applications of chirp – Z transform? **(04 Marks)**

c. Let x(n) be the following 8 – point sequence.

$$x(n) = \left\{\underset{\uparrow}{\frac{1}{\sqrt{2}}}, 1, \frac{1}{\sqrt{2}}, 0, -\frac{1}{\sqrt{2}}, -1, \frac{-1}{\sqrt{2}}, 0\right\}$$. Use DIT FFT algorithm to compute DFT of the above sequence. Also show all intermediate values. **(06 Marks)**

5 a. Define Chebyshev polynomial and list all its properties. **(05 Marks)**

b. Design a Chebyshev analog filter with ripple of 0.5dB in band $| \Omega | \leq 1$ and at $\Omega = 3$, amplitude if down by 3dB. **(10 Marks)**

c. A prototype low pass filter has the system response $H(s) = \frac{1}{s^2 + 2s + 1}$. Obtain a band pass filter with $\Omega_0 = 2$ rad/sec and $B_0 = 10$ rad/sec. **(05 Marks)**

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

$$H_d(e^{j\omega}) = \begin{cases} e^{-j2w}, & -\pi/4 \leq \omega \leq \pi/4 \\ 0, & \pi/4 < |\omega| \leq \pi \end{cases}$$

Determine the filter coefficients $h_d(n)$ if the window functions is defined as

$$\omega(n) = \begin{cases} 1, & 0 \leq n \leq 4 \\ 0, & \text{otherwise} \end{cases}$$ **(10 Marks)**

b. Determine the filter coefficients h(n) obtained by sampling $H_d(\omega)$ given by,

$$H_d(\omega) = \begin{cases} e^{-j3\omega}, & 0 < \omega < \frac{\pi}{2} \\ 0, & \frac{\pi}{2} < \omega < \pi \end{cases}$$

Also, obtain the frequency response $H(\omega)$. Take N = 7. **(10 Marks)**

7 a. Convert the analog filter into a digital filter whose system function is

$H(s) = \frac{2}{(s+1)(s+3)}$ using bilinear transformation with T = 0.1 sec. **(06 Marks)**

b. Explain how an analog filter is mapped on to a digital filter using backward difference method. Using this technique convert the analog filter with system function $H(s) = \frac{1}{s+2}$ into a digital filter. **(14 Marks)**

8 a. Obtain the parallel form realization of a system function :

$$H(z) = \frac{(z-1)(z+1)(z-2)z}{\left(z - \frac{1}{2} + j\frac{1}{2}\right)\left(z - \frac{1}{2} - j\frac{1}{2}\right)\left(z - \frac{j}{4}\right)\left(z + \frac{j}{4}\right)}$$ **(08 Marks)**

b. Obtain the cascade realization for the system function given by

$$H(z) = \frac{\left(1 + \frac{1}{4}z^{-1}\right)}{\left(1 + \frac{1}{2}z^{-1}\right)\left(1 + \frac{1}{2}z^{-1} + \frac{1}{4}z^{-2}\right)}$$ **(06 Marks)**

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

$$h(n) = \delta(n) + \frac{1}{4}\delta(n-1) - \frac{1}{8}\delta(n-2) + \frac{1}{4}\delta(n-3) + \delta(n-4)$$ **(06 Marks)**

*****