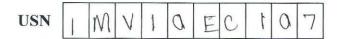
**10EC52** 



Fifth Semester B.E. Degree Examination, December 2012

## Digital Signal Processing

Time: 3 hrs.

1

2

Max. Marks:100

Note: 1. Answer FIVE full questions, selecting at least TWO questions from each part. 2. Use of normalized Chebyshev and Butterworth prototype tables are NOT ALLOWED.

## <u> PART – A</u>

Find the N-point DFT of x(n) if  $x(n) = \begin{cases} \frac{1}{3}; & 0 \le n \le 2\\ 0; & \text{otherwise} \end{cases}$ . a.

(08 Marks)

- Two finite sequences x(n) = [x(0), x(1), x(2), x(3)] and h(n) = [h(0), h(1), h(2), h(3)] have b. DFTs given by  $X(R) = DFT \{x(n)\} = \{1, J, -1, -J\}; H(R) = DFT \{h(n)\} = \{0, 1+J, 1, 1-J\}.$ Use the properties of the DFT and find the following:
  - $X_1(R) = DFT \{h(0), -h(1), h(2), -h(3)\}$ i)
  - $X_2(R) = DFT \{y(n)\}$  where  $y(n) = x(n) \underset{4}{\circledast} h(n)$ ii)

iii) 
$$X_3(R) = DFT\{x(0), h(0), x(1), h(1), x(2), h(2), x(3), h(3)\}$$
 (12 Marks)

- Consider a length 12 sequence defined for a.  $0 \le n \le 11$ ,  $x(n) = \{8, 4, 7, -1, 2, 0, -2, -4, -5, 1, 4, 3\}$ with 12-point DFT given by X(R),  $0 \le R \le 11$ , evaluate the following function without computing DFT,  $\sum_{R=0}^{11} e^{-\frac{J4R}{6}} \times (R)$ (05 Marks)
  - Determine  $x_3(n) = x_1(n) \bigotimes_{8} x_2(n)$  for the sequences,  $x_1(n) = e^{j\pi n}$ ;  $0 \le n \le 7$ ; b.  $x_2(n) = u(n)-u(n-5)$ . Sketch all the sequences. Use time domain approach. (08 Marks)
  - c. Show that:
    - i) Real and even sequence has real DFT.
    - ii) Multiplication of two DFT's in frequency domain corresponds to circular convolution in time domain. (07 Marks)
- 3 Consider a FIR filter with impulse response  $h(n) = \{3, 2, 1, 1\}$  if the input is a.  $\mathbf{x}(\mathbf{n}) = \{1, 2, 3, 3, 2, 1, -1, -2, -3, 5, 6, -1, 2, 0, 2, 1\},\$ 
  - find the output y(n). Use overlap-add method assuming the length of block is 7. (09 Marks) (06 Marks)

Write a note on Chirp z-transform. b.

What is in-place computation? What is the total number of complex additions and c. multiplications required for N = 512 point, if DFT is computed directly and if FFT is used? Also find the number of stages required and its memory requirement. (05 Marks)

- 4 a. Derive DIT-FFT algorithm for N = 8 and draw the complete signal graph. (12 Marks)
  - b. Find the IDFT of  $X(R) = \{0, 2 + 2j, -j4, 2 2j, 0 2+2j, j4, 2 2j\}$  using inverse Radix 2 DIT-FFT algorithm. (08 Marks)

## PART – B

- 5 a. Design a Chebyshev analog low pass filter that has -3dB cut off frequency of 100 rad/sec and a stopband attenuation of 25 dB or greater for all radian frequencies past 250 rad/sec. Verify the design.
  (10 Marks)
  - b. Derive the s to z plane transformation based on finite backward difference method. Also show that the entire left half s-plane poles are mapped inside the smaller circle of radius  $\frac{1}{2}$  centered at  $z = \frac{1}{2}$  inside the unit circle in the z-plane. (10 Marks)
- 6 a. Obtain the direct form II (canonic) and cascade realization of

$$H(z) = \frac{(z-1)(z^2+5z+6)(z-3)}{(z^2+6z+5)(z^2-6z+8)}$$

the cascade system should consist of two biquadratic sections.

Given  $H(z) = (1 + 0.6z^{-1})^5$ 

b.

- i) Realize in direct form
- ii) Realize as a cascade of first order sections only
- iii) As a cascade of  $1^{st}$  and  $2^{nd}$  order sections.
- 7 a. Using rectangular window technique, design a lowpass filter with passband gain of unity, cut off frequency of 1000 Hz and working at a sampling frequency of 5 kHz. The length of impulse response should be 7.
  (10 Marks)
  - b. With necessary mathematical analysis, explain the frequency sampling technique of FIR filter design. (10 Marks)
- 8 a. Design a digital filter H(z) that when used in A/D H(z) D/A structure, gives an equivalent analog filter with the following specifications:
  - PB Ripple  $\leq$  3.01 dB
  - PB Edge : 500 Hz
  - SB attenuation  $\geq 15 \text{ dB}$
  - SB Edge : 750 Hz
  - Sample rate : 2 kHz

The filter is to be designed by performing a bilinear transformation on an analog system function. Use Butterworth prototype. Also obtain the difference equation. (15 Marks)

b. If  $H_a(s) = \frac{1}{(s+2)(s+1)}$ ; find the corresponding H(z) using impulse invariance method for sampling frequency of 5 samples/sec. (05 Marks)

\* \* \* \* \*

(10 Marks)

## (10 Marks)