Q. CODE:106437

B.E./B.TECH. DEGREE EXAMINATION, DECEMBER 2020

Fifth Semester

EC16502- PRINCIPLES OF DIGITAL SIGNAL PROCESSING

(Regulation 2016)

Time: Three hours | Maximum : 80 Marks

Answer **ALL** questions

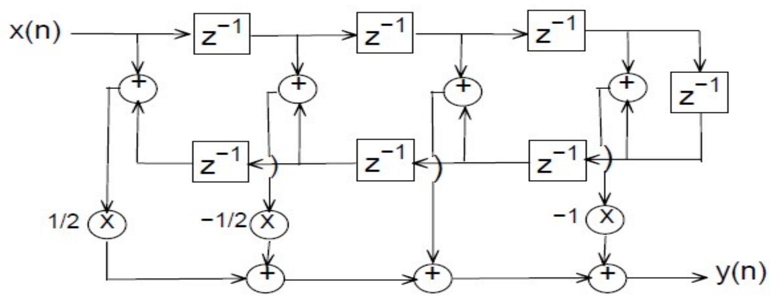
PART A - (8 X 2 = 16 marks)

1. Discrete Fourier Transform of a sequence x(n) is given by X(k) = {4, (1+2j), j, (1-3j)}, hence Discrete Fourier Transform of x*(n) is:

(a) {4, (1+3j), -j, (1-2j)} (b) {4, (1-2j), j, (1+3j)}

(c) {4, (1-3j), j, (1+2j)} (d) {4, (1+2j), -j, (1-3j)}

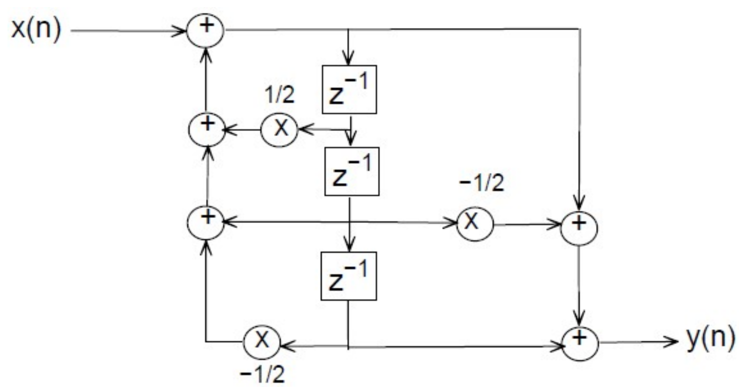
2. Determine the filter coefficients for the given Linear phase realization structure



(a) 1 -1 2 -2 -2 2 -1 1 (b) ½, -½, 1, -1

(c) ½, -½, 1, -1, -1, 1, -½, ½ (d) 0,0,0,0, -½, ½, 1, -1

3. For the IIR filter shown below, what is the input-output relation?



$$(a)\ y(n) - \frac{1}{2}y(n-1) - y(n-2) + \frac{1}{2}y(n-3) = x(n) - \frac{1}{2}x(n-2) + x(n-3)$$

$$(b)\ y(n) + \frac{1}{2}y(n-1) + y(n-2) - \frac{1}{2}y(n-3) = x(n-1) + \frac{1}{2}x(n-2) - x(n-3)$$

$$(c)\ y(n) + \frac{1}{2}y(n-1) - y(n-2) + \frac{1}{2}y(n-3) = x(n) - \frac{1}{2}x(n-2) + x(n-3)$$

$$(d)\ y(n) - \frac{1}{2}y(n-1) + y(n-2) + \frac{1}{2}y(n-3) = x(n) + \frac{1}{2}x(n-2) + x(n-3)$$

4. The error in the filter output that results from rounding or truncating calculations within the filter is called

(a) Coefficient quantization error (b) Adder overflow limit cycle

(c) Round off noise (d) Limit cycles

5. Give the significance of anti-imaging filter in sampling rate conversion.

6. Realize the following system using minimum number of multipliers:
$H(z) = 1 + (3/4)z^{-1} + (17/8)z^{-2} + (3/4)z^{-3} + z^{-4}$

7. Given the specification $\alpha_p = 1\text{dB}$; $\alpha_s = 30\text{dB}$; $\Omega_p = 200$ rad/sec; $\Omega_s = 600$ rad/sec. Determine the order of the Butterworth filter.

8. Express the fraction -7/8 in sign magnitude, 2's complement and 1's complement.

PART B - (4 X16 = 64 marks)

09. (a) (i) Consider the finite sequence $x[n] = \{1, 2, 2, 1\}$. The 5-point DFT of $x[n]$ is denoted by $X(k)$. Plot the sequence whose DFT is $Y(k) = e^{-j4\pi k/5} X(k)$. **(6)**

(ii) Find the output $y[n]$ of a filter whose impulse response $h[n] = \{1, 2\}$ and input signal is $x[n] = \{1, 2, -1, 2, 3, -2, -3, -1, 1, 1, 2, -1\}$ using Overlap add method. **(10)**

(OR)

(b) Find the DFT of a sequence $x[n] = \{1, 2, 3, 4, 4, 3, 2, 1\}$ using DIT algorithm. **(16)**

10. (a) Design a High pass filter using Hamming window to meet the following specifications. **(16)**
Cut-off frequency = 250 Hz
Sampling frequency = 1 KHz
Filter length = 7
Also draw its Direct form structure.

(OR)

(b) (i) Using frequency sampling technique, design a linear phase FIR low pass filter with a cut-off frequency of 0.5π rad/sec. Assume order of the filter, M=9 **(10)**

(ii) Determine the frequency response of FIR filter described by, $y(n)=0.25x(n)+x(n-1)+0.25x(n-2)$ and also check the linear phase condition. **(6)**

11. (a) Design a digital Butterworth filter satisfying the constraint **(16)**

$$0.707 \leq |H(e^{j\omega})| \leq 1, \qquad 0 \leq \omega \leq \pi/2$$
$$|H(e^{j\omega})| \leq 0.2, \qquad 3\pi/4 \leq \omega \leq \pi$$

With T=1s using Impulse Invariant Technique.

(OR)

(b) Design a digital Chebyshev filter to satisfy the constraint **(16)**

$$0.707 \leq |H(e^{j\omega})| \leq 1, \qquad 0 \leq \omega \leq 0.2\pi$$

$$|H(e^{j\omega})| \leq 0.1, \qquad 0.5\pi \leq \omega \leq \pi$$

Using bilinear transformation and assuming T = 1s. Realize the filter using minimum number of delay units.

12. (a) Two first order filters are connected in cascade whose system functions of the individual sections are $H_1(z) = \frac{1}{1-0.8z^{-1}}$ and $H_2(z) = \frac{1}{1-0.9z^{-1}}$. Determine the overall output noise power. Assume B=8 bits. **(16)**

(OR)

(b) A digital system is characterized by the difference equation y(n)=0.875y(n-1)+x(n). Determine the dead band of the system when x(0)=0.75 and B=4 bits. **(16)**