

module code:

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28/05/2021

Question (1)

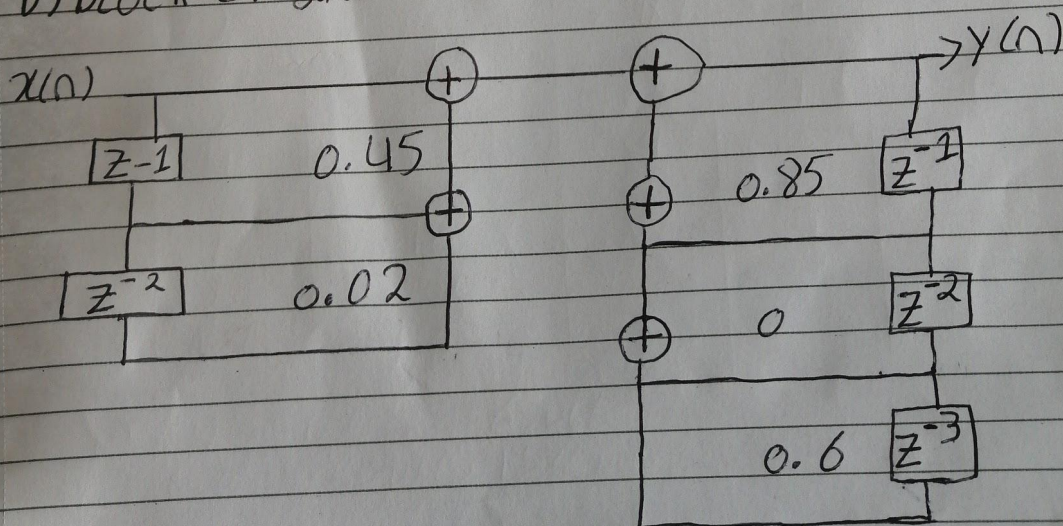
$$y(n) + 0.45x(n) - 0.85x(n-1) - 0.6x(n-3) - 0.4y(n-1) + 0.2y(n-2) = 0$$

$$a) y(n) = -0.45x(n) + 0.85x(n-1) + 0.6x(n-3) + 0.4y(n-1) - 0.2y(n-2)$$

$$Y(z) = -0.45X(z) + 0.85z^{-1}X(z) + 0.6z^{-3}X(z) + 0.4z^{-1}Y(z) - 0.02z^{-2}Y(z)$$

$$H(z) = \frac{Y(z)}{X(z)} = \frac{(1 - 0.4z^{-1} + 0.02z^{-2})}{(-0.45 + 0.85z^{-1} + 0.6z^{-3})}$$

B) Block diagram in Direct form I

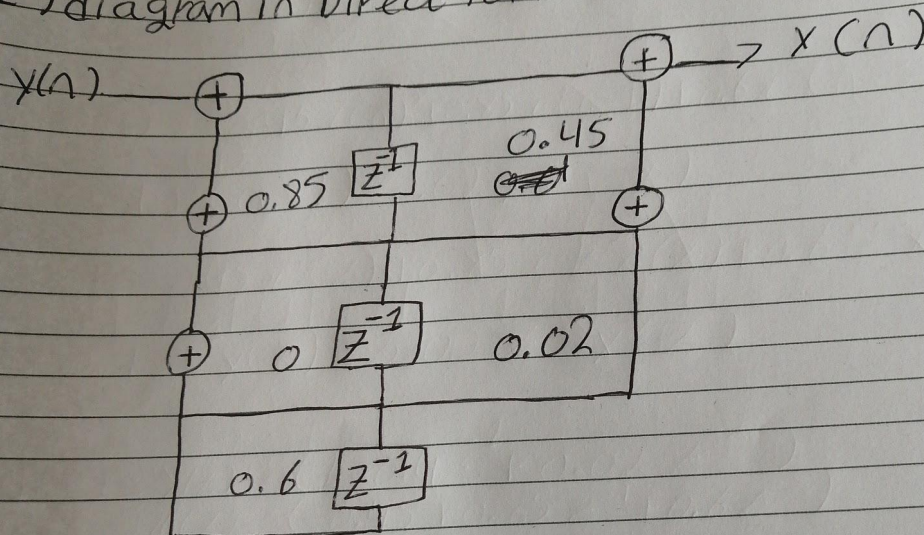


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Question (1)

(c) diagram in Direct form II



(D) Advantages

① Require fewer coefficients to execute the filtering process

② works faster

disadvantage

non linear phase response.

Direct form II require less circuitry than Direct form I.

The IIR filters can be unstable

IIR filters are much smaller than Equivalent FIR filters.

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Question 2

$$a) 2^k - 1 \geq n + k$$

So for $k = 3$

$$2^3 - 1 \geq 4 + 3$$

$$8 - 1 \geq 7$$

$$7 \geq 7$$

Bit position

1	2	3	4	5	6	7
P1	P2	D3	P4	D5	D6	D7
0	1	1	0	0	1	1

$$P1 = \text{XOR of bits } (D3, D5, D7)$$

$$= (1 + 0 + 1) = 0$$

$$P2 = \text{XOR of bits } (D3, D6, D7)$$

$$= 1 + 1 + 1 = 1$$

$$P4 = \text{XOR of bits } (D5, D6, D7)$$

$$= 0 + 1 + 1 = 0$$

$$\therefore = 0110011$$

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 question 2(b)

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15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	(p1)
1	0	1	1	0	0	1	0	1	0	1	0	0	1	0	
X		X		X		X	X		X		X		X		xOR

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	(p2)
1	0	1	1	0	0	1	0	1	0	1	0	0	1	0	
X	X			X	X			X	X			X	X		xOR

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	(p3)
1	0	1	1	0	0	1	0	1	0	1	0	0	1	0	
X	X	X	X					X	X	X	X				xOR

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	(p4)
1	0	1	1	0	0	1	0	1	0	1	0	0	1	0	
				X	X	X	X								xOR

0111

change to decimal = 7

bit positions 7 is incorrect and should be = 0

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Q 2 (c)

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For Text

Show how a Huffman code could improve transmission Efficiency:

Solution : Huffman used for reducing the size of data or message

P O O R P E O P I E P A Y
11 10 10 0010 11 011 10 11 0001 011 11 0000 0101

length of the message are 13 letters
this message it has be send as codes

letters	count	code		
A	1	0000	4×1	= 4
E	2	011	3×2	= 6
L	1	0001	4×1	= 4
P	4	11	2×4	= 8
O	3	10	2×3	= 6
R	1	0010	4×1	= 4
X	1	0101	4×1	= 4
$7 \times 8 = 56$ bits	13	23 bits		36 bits

msg size = 36 bits

truth table = 23 bits + 56 bits = 79 bits.

So total bits = 79 + 36 = 115 bits

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Q 3

$$x(t) = 4\cos(6000\pi t) + 2\cos(16000\pi t) - 2\cos[8000\pi t]$$

a) $f_1 = 4000$

$f_2 = 3000$

$f_3 = 8000$

$f_s = 2f_3 = 16000$

a) Sampling frequency double highest frequency

b) $x(t) = 4\cos(6000\pi t) - 2\cos(8000\pi t)$

(c)

(1) $f_s = 16000$ Hz sampling frequency

(2) Assuming Anti-aliasing filter

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Question 5

$$B = 3512 - 3500 = 12 \text{ MHz}$$

$$K = 1.38 \times 10^{-23}$$

$$T = 25^\circ\text{C} = 298.15 \text{ K}$$

$$P = 1 \text{ W}$$

$$G = 9$$

$$P_{\text{loss}} = 20 \log(15) + 20 \log(3512) + 32.44$$
$$P_{\text{loss}} = 127 \text{ dB}$$

$$P_r = P + G - P_{\text{loss}}$$
$$= 0 + 9 - 127 = -118 \text{ dB}$$

$$N = BKT$$
$$= 12 \times 10^6 \times 1.38 \times 10^{-23} \times 298.15$$
$$= 4.937 \times 10^{-14}$$

$$\text{SNR} = \frac{10^{-12}}{4.937 \times 10^{-14}} = 203$$

$$C = B \log_2 \left(1 + \frac{S}{N} \right) = 12 \times 10^6 \log_2 (1 + 203)$$
$$= 96 \text{ bits/s}$$
$$= 12 \times 10^6 \log_2 (204) = \text{bits.}$$

The answer = 96 bits/s

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Question 6

$$\text{Pass-band Ripple } A_p = 20 \log_{10} (2 + \delta_p)$$

$$\delta_p = \log_{10}^{-1} \left(\frac{0.1}{20} \right) - 1 = 0.0116$$

$$\text{Minimum stop-band attenuation } A_s = -20 \log_{10} (\delta_s)$$

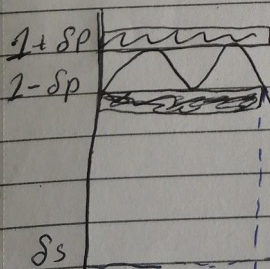
$$\delta_s = \log_{10}^{-1} \left(\frac{50}{20} \right) = 0.00316$$

The normalised pass band

$$f_p = f_p / f_s = \frac{3 \times 10^3}{8000} = 0.37$$

$$\Delta f = \Delta f / f_s = \frac{300}{8000} = 0.037$$

$$N = \frac{3.3}{0.037} = 89$$



$$f_p = [f_p + 0.5 \Delta f]$$
$$A_p = 20 \log_{10} (2 + \delta_p)$$

$$A_s = 20 \log_{10} (\delta_s)$$
$$\Delta f = f_s - f_p$$

pass band transition band stop band

Middle code:

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Question 6 continue

$$w[n] = 0.54 - 0.46 \cos \left[\frac{2\pi n}{164} \right]$$

$$h_p(n) = 2F_c \frac{\sin(n\Omega_c)}{n\Omega_c} = \frac{\sin(n\Omega_c)}{n\pi}$$

$$\Omega_c = 2\pi [f_p + 0.5 \Delta f] =$$

$$= 2\pi (0.37 + 0.01) = 2\pi (0.38)$$

$$H_p(n) = \frac{\sin(2\pi \cdot 38 \cdot n)}{\pi n}$$

$$h_p(10) = \frac{\sin(2\pi \cdot 0.38 \cdot 5)}{\pi 5} \times \left[0.54 - 0.46 \cos \left(\frac{2\pi 5}{164} \right) \right]$$

$$= \frac{0.2}{52} \times [0.54 - 0.46] \cos(0.19)$$

$$= 3.0 \times 10^{-4}$$