Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering

End Sem (Even) Examination May-2018

EC3CO06/EI3CO06 Digital Signal Processing

Programme: B.Tech. Branch/Specialisation: EC/EI

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

Q.1 i. In N-point DFT of L-point sequence, the value of N to avoid aliasing in frequency spectrum is, **1**

(a) $N \neq L$ (b) $N \leq L$ (c) $N \geq L$ (d) $N = L$

ii. Which of the following is true regarding the number of computations required to compute an N-point DFT? **1**

(a) N^2 complex multiplications and N(N-1) complex additions

(b) N^2 complex additions and N(N-1) complex multiplications

(c) N^2 complex multiplications and N(N+1) complex additions

(d) N^2 complex additions and N(N+1) complex multiplications

iii. The condition for the impulse response to be anti-symmetric is, **1**

(a) h(n) = -h(N – 1 - n) (b) h(n) = h(-n)

(c) h(n) = h(N – 1 - n) (d) All of these

iv. Which of the following is true for a chebyshev analog filter? **1**

(a) In type-1, the magnitude response is monotonic in pass-band and equi-ripple in stop-band.

(b) In type-1, the magnitude response is monotonic in pass-band and stop-band.

(c) In type-2, the magnitude response is equi-ripple in pass-band and stop-band.

(d) In type-2, the magnitude response is monotonic in pass-band and equi-ripple in stop-band.

v. The direct form-I and II structure of IIR system will be identical in, **1**

(a) All pole system

(b) All zero system

(c) Both (a) and (b)

(d) First-order and second-order systems

P.T.O.

vi. Number of multiplier and adders required for direct form realization of N^{th} order FIR system are, **1**
(a) N, N+1 (b) N, N-1 (c) N+1, N (d) N-1, N

vii. The Fourier transform of autocorrelation sequence $\gamma_{xx}(m)$ gives the **1**
(a) Periodogram (b) Energy spectrum
(c) Power spectrum (d) Variance

viii. A random process X(n) is called wide sense stationary is **1**
(a) First order moment is constant
(b) Second order moment is constant
(c) Autocorrelation is independent of time
(d) All of these

ix. The architecture that employs instruction level parallelism is, **1**
(a) Von Neumann architecture
(b) Harvard architecture
(c) Modified Harvard architecture
(d) VLIW architecture

x. The features in which PDSP is superior to advance microprocessor is **1**
(a) Low cost (b) Low power
(c) Computational speed (d) Real time input output capabilities.

Q.2 i. Compare the DIT and DIF Radix-2 FFT. (Any Four) **2**

ii. Compute linear and circular convolution of the following sequences using DFT x (n) = {1, .02, -1} and h (n) = {1, -1, 0.2}. **8**

OR iii. Draw the flow graph and show computation of 9-point DFT using Radix-3 DIT FFT algorithm. **8**

Q.3 i. Explain the mapping of s-plane to z-plane in the bilinear transformation. **2**

ii. Derive the bilinear transformation to transform an analog system to digital system. For the analog transfer function, H(s) $=\frac{(s+1)}{s^2+2s+5}$, determine H (z) using impulse invariant transformation if T = 1 second. **8**

OR iii. Design a linear phase FIR low pass filter using rectangular window by taking 7 samples of window sequence and with cut-off frequency $w_c = 0.2\ \pi$. Determine the frequency response and verify the design by sketching the magnitude response. **8**

Q.4 i. What are the basic elements used to construct the realization structure of discrete time system? **2**

ii. Determine the direct form-I, II, cascade and parallel realization of the following LTI system. H(z) $=\frac{(z^3-8z^2+13z-5)}{(z-.075)(z^2+z-.025)}$ **8**

OR iii. Draw the linear phase realization structure of an N^{th} order FIR system when 'N' is even. Also Draw the direct form structure of the FIR systems described by the following equations, $y(n) = x(n) + \frac{1}{2}x(n-1) + \frac{1}{4}x(n-2) + \frac{1}{6}x(n-3) + \frac{1}{8}x(n-4)$ **8**

Q.5 Attempt any two:

i. What are statistical averages? Explain each of them with mathematical expression. **5**

ii. Let $x(n)$ be a random process that is generated by filtering a unit variance white noise $v(n)$by an LTI filter having transfer function. $H(z) = \frac{1}{1-0.5z^{-1}}$ Find the autocorrelation of the output process $x(n)$. **5**

iii. What is the relationship between autocorrelation function and Power spectral density? Write down the properties of PSD. **5**

Q.6 Attempt any two:

i. Explain the any types of digital signal processors offered by Texas Instruments. **5**

ii. Discuss the various special hardware requirements of digital signal processors. **5**

iii. Write the salient feature of TMS320C6713 DSK of digital signal processors. **5**

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Marking Scheme
EC3CO06/EI3CO06 Digital Signal Processing

Q.1	i.	In N-point DFT of L-point sequence, the value of N to avoid aliasing in frequency spectrum is, (c) $N \geq L$	1
	ii.	Which of the following is true regarding the number of computations required to compute an N-point DFT? (a) N^2 complex multiplications and N(N-1) complex additions	1
	iii.	The condition for the impulse response to be anti-symmetric is, (a) h(n) = -h(N – 1 - n)	1
	iv.	Which of the following is true for a chebyshev analog filter ? (d) In type-2, the magnitude response is monotonic in pass-band and equi-ripple in stop-band.	1
	v.	The direct form-I and II structure of IIR system will be identical in, (c) Both (a) and (b)	1
	vi.	Number of multiplier and adders required for direct form realization of N^{th} order FIR system are, (b) N, N-1	1
	vii.	The Fourier transform of autocorrelation sequence $\gamma_{xx}(m)$ gives the (c) Power spectrum	1
	viii.	A random process X(n) is called wide sense stationary is (d) All of these	1
	ix.	The architecture that employs instruction level parallelism is, (d) VLIW architecture	1
	x.	The features in which PDSP is superior to advance microprocessor is (d) Real time input output capabilities.	1
Q.2	i.	Comparison DIT and DIF Radix-2 FFT. (Any Four) Each point of 0.5 mark (0.5 mark * 4)	2
	ii.	Linear convolution 4 Marks Circular convolution 4 Marks	8
OR	iii.	Algorithm 6 Marks Flow graph 2 Marks	8
Q.3	i.	Mapping of s-plan to z-plan in the bilinear transformation.	2
	ii.	Derivation of bilinear transformation 5 Marks Numerical problem 3 Marks	8
OR	iii.	Formula & Define Rectangular window 2 marks Find h(n) 3 marks h(z) 1 mark $h(e^{\tau w})$ 1 mark Response 1 mark	8
Q.4	i.	Realization structure of discrete time system	2
	ii.	Direct form-I 2 marks Direct Form-II 2 marks Cascade 2 marks Parallel realization 2 marks.	8
OR	iii.	Linear phase realization structure of an n^{th} order FIR system 4 marks Direct form of FIR systems 4 marks.	8
Q.5	i.	Statistical averages 2 marks Explain with mathematical expression. 1 marks For each (1 mark * 3) 3 marks	5
	ii.	Formula 1 mark Find h(z) 3 marks $R_X(K)$ 1 mark	5
OR	iii.	Relationship between autocorrelation function and Power spectral density 2 Marks Properties of PSD 3 Marks	5
Q.6		Attempt any two:	
	i.	Types of digital signal processors released by Texas Instruments.	5
	ii.	Hardware requirements of digital signal processors. (Any five) 1 mark for each. (1 mark * 5)	5
	iii.	Salient feature of TMS320C6713 DSK of digital signal processors.	5

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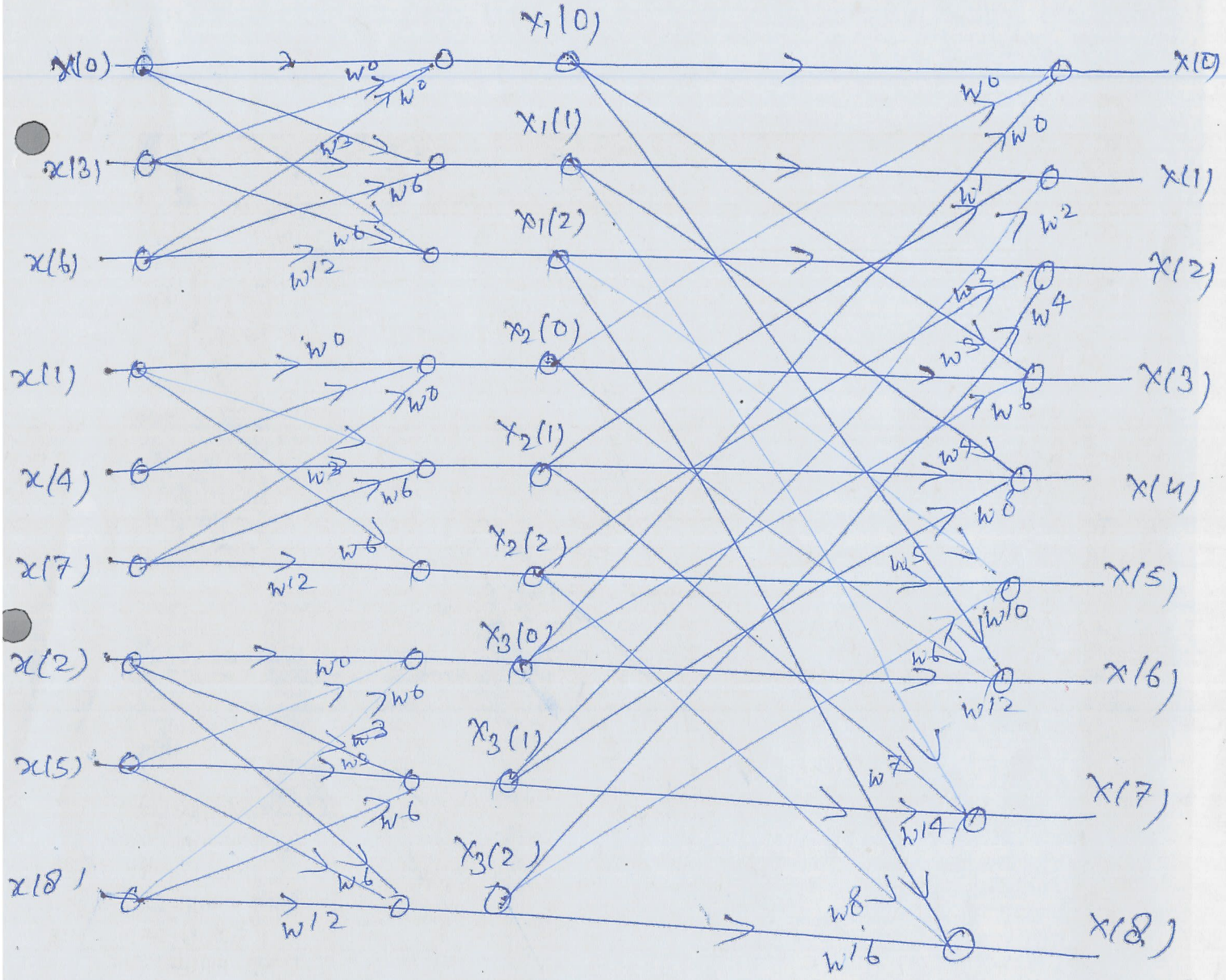
Q. 2 (ii) (A) Linear convolu. [1, -0.8, -1, 1.04, -2]

(B) Circular convolu. [2.04, -1, -1]

For Each Part — For steps — 2 M, Answer — 2 M.

(iii)



Radix-3 DIT-FFT Flow diagram for N=9

Q.3 (II) $H(s) = \frac{b}{s+a}$

Bilinear $H(z) = \frac{Y(z)}{X(z)} = \frac{b}{\frac{2}{T}\left(\frac{1-z^{-1}}{1+z^{-1}}\right)+a}$

$$s = \frac{2}{T}\left(\frac{1-z^{-1}}{1+z^{-1}}\right) = \frac{2}{T}\left(\frac{z-1}{z+1}\right)$$ 5M

Impulse Invariant

$$\frac{s+a}{(s+a)^2+b^2} \longrightarrow \frac{1-e^{-aT}(\cos bT)\,z^{-1}}{1-2e^{-aT}(\cos bT)z^{-1}+e^{-2aT}z^{-2}}$$ 1M

$a=1, \quad b=2, \quad T=1$

2M

$$H(z) = \frac{1-0.366z^{-1}}{1-0.733z^{-1}+0.135z^{-2}}$$

(III)

Rectangular window formula & figure — 1M

Formula $h_d(n)$ — 1M

Finding Expression $h_d(n) = \frac{\sin \omega_c (n-\alpha)}{\pi(n-\alpha)}$ 1M

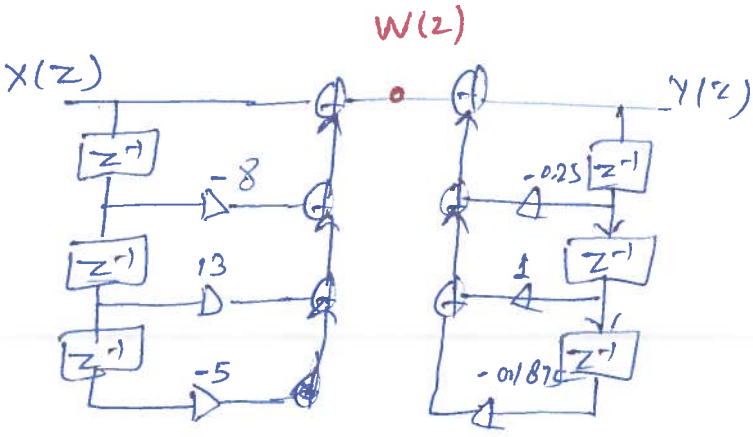
Finding $H(z) = \sum_{n=0}^{6} h(n) z^{-n}$

$H(z) = 0.1009[1+z^{-6}] + 0.1514[z^{-1}+z^{-5}] +$ 3M

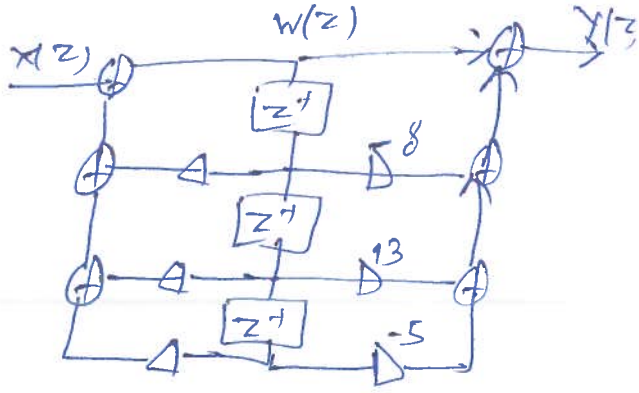
$0.1871[z^{-2}+z^{-4}] + 0.2z^{-3}$

magnitude Response plot 2M

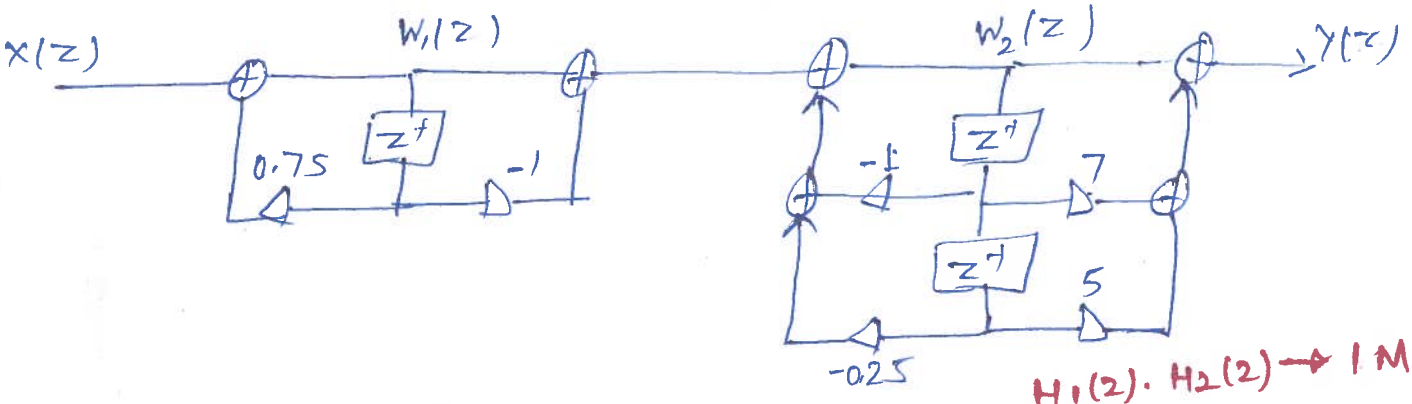
Q.4. (11)



Direct form I — Steps 1M, figure 1M



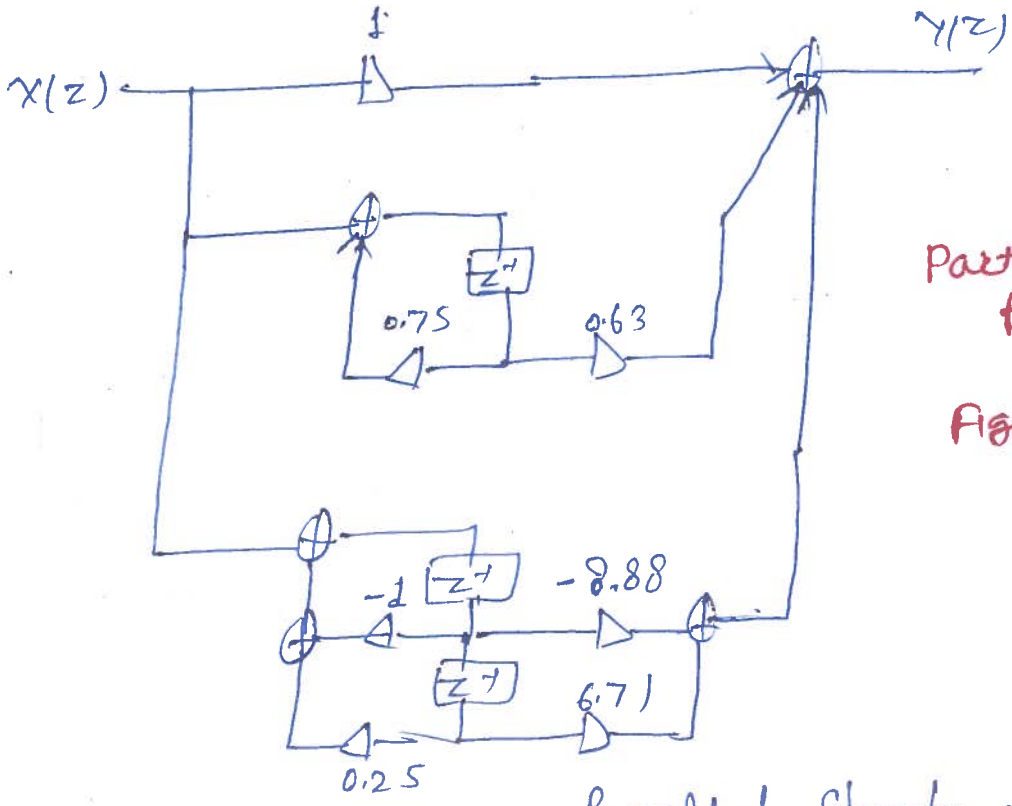
Direct form - II — Steps 1M, figure 1M



$H_1(z) \cdot H_2(z)$ → 1M

figure - 1M

Cascade Structure



Partial fraction — 1M

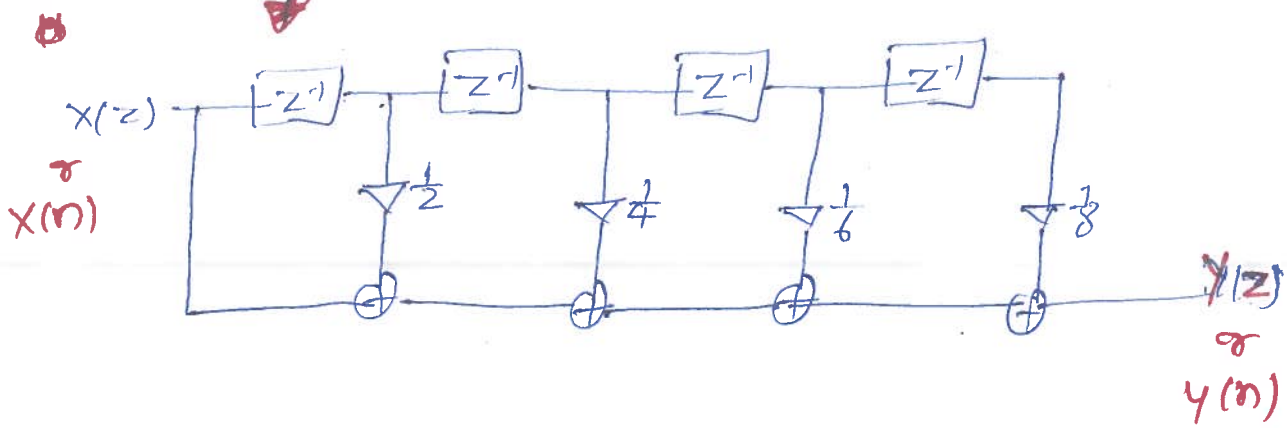
figure — 1M

Parallel Structure

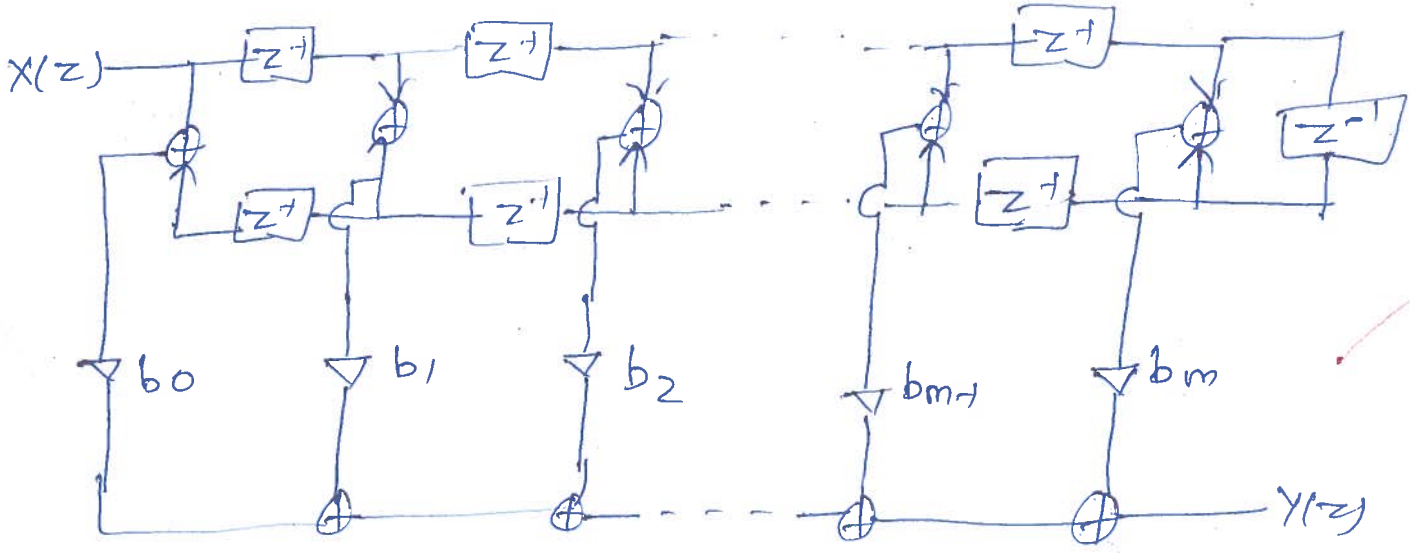
Q.4 (iii) Linear phase Nth order — 4M

— 4M

y(n) — Linear phase



Linear phase Nth order (even)



$$Y(z) = b_0\left[X(z) - z^{-(N-1)}X(z)\right] + b_1\left[z^{-1}X(z) + z^{-(N-2)}X(z)\right]$$

$$+ \cdots + b_{\frac{N}{2}-2}\left[z^{-(\frac{N}{2}-2)}X(z) + z^{-(\frac{N}{2}+1)}X(z)\right]$$

$$+ b_{\frac{N}{2}-1}\left[z^{-(\frac{N}{2}-1)}X(z) + z^{-\frac{N}{2}}X(z)\right]$$

Q.5 (II) Autocorrelation

Formula — PSD

$$H(z) = \frac{1}{1-0.5z^{-1}}$$

$$S_Y(e^{j\omega}) = |H(e^{j\omega})|^2 \cdot S_X(e^{j\omega})$$ — 1M

$$S_Y(e^{j\omega}) = \frac{4}{3}\left[\frac{1}{1-0.5e^{-j\omega}} - \frac{1}{1-2e^{-j\omega}}\right]$$

— 3M

$$R_{XX}(l) = \frac{4}{3}\left[(0.5)^l u(l) - (2)^l u(l)\right]$$

— 1M

(III) Relation/formula Autocorrelation & PSD — 2M

Properties PSD — 3M

Q.6 (1) Signal Processor – TMS320 C6713 or C6748

block diagram, feature, etc — 5M

(2) Special hardware – Von Neuman Harward/Super VLIW, etc MAC, Buffered unit — 5M

(3) features – MAC, Parallelism, pipelining etc — 5M