B

SCHEME OF VALUATION
(Scoring indicators)

Revision:2015 Course Code:6044
Course Title: DIGITAL SIGNAL PROCESSING

Qst. No	Scoring Indicator	Split Up Score	Sub Total	Total
I	PART – A			
1.	A Discrete - time signal is a function defined only at particular time instants. It is discrete in time but Continuous in amplitude.	2	2	
2.	Let $x_1(n)$ and $x_2(n)$ are finite duration sequences both of length N with DFTs $X_1(k)$ and $X_2(k)$.	1	2	
	If $X_3(k) = X_1(k)X_2(k)$, then the sequence $x_3(n)$ Can be obtained by Circular Convolution defined as $x_3(n) = \sum_{m=0}^{N-1} x_1(m)x_2(n-m)_N$.	1		
3	FFT reduces the Computation time required to Compute discrete Fourier Transform. The FFT is based on decomposition and breaking the transform into smaller transforms and Combaining them ~~into~~ to get total transform.	2	2	
4.	1. These filters Can be easily designed to have perfectly linear phase	1	2	
	2. The impulse response of this filter is restricted to finite number of Samples.	1		

5. → The time required for a Computer to execute basic operations. 1

→ Unit for the speed of the Processor is usually in millions of instructions per second [MIPS]. 1

2

10

PART- B

II

1. Scalar multiplication

Here the signal $x(n)$ is multiplied by a scalar factor a.

$$x(n) \xrightarrow{a} y(n) = a \cdot x(n)$$

3

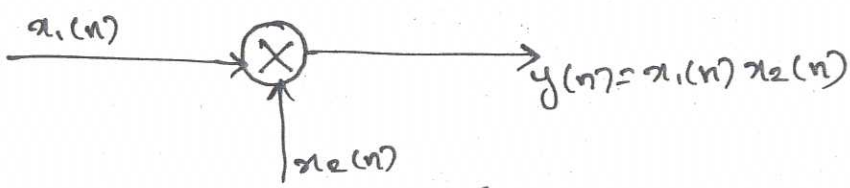
Eg:- If $x(n) = \{1, 2, 1, -1\}$ and $a = 2$,

Then the signal ~~x(n)~~ $a\,x(n) = \{2, 4, 2, -2\}$

6

Signal multiplication :-

The multiplication of two signal sequences to form another sequence.



3

Eg:- $x_1(n) = \{-1, 2, -3, -2\}$ and

$x_2(n) = \{1, -1, -2, 1\}$

$x_1(n) \cdot x_2(n) = \{-1, -2, 6, -2\}$

(2)	Properties of DFT		
	* Periodicity	1	
	* Linearity	1	
	* Circular shift of a sequence	1	6
	* Time Reversal	1	
	* Complex Conjugate Property	1	
	* Circular Convolution.	1	
	(any six)		
(3)	→ Decimation in time algorithm is used to calculate the DFT of a N-point sequence	1	
	→ The idea is to break the N-Point sequence in to two sequences.	1	
	→ Then the DFTs of [illegible] which can be Combined to give the DFT of the original N-point sequence.	1	
	→ The N-Point sequence is divided in to two $\frac{N}{2}$-Point sequences $x_e(n)$ and $x_o(n)$.	1	6
	→ which have even and odd members of $x(n)$ respectively.	1	
	→ The $\frac{N}{2}$-Point DFTs of these two sequences are evaluated and Combined to give the N-Point DFTs.	1	

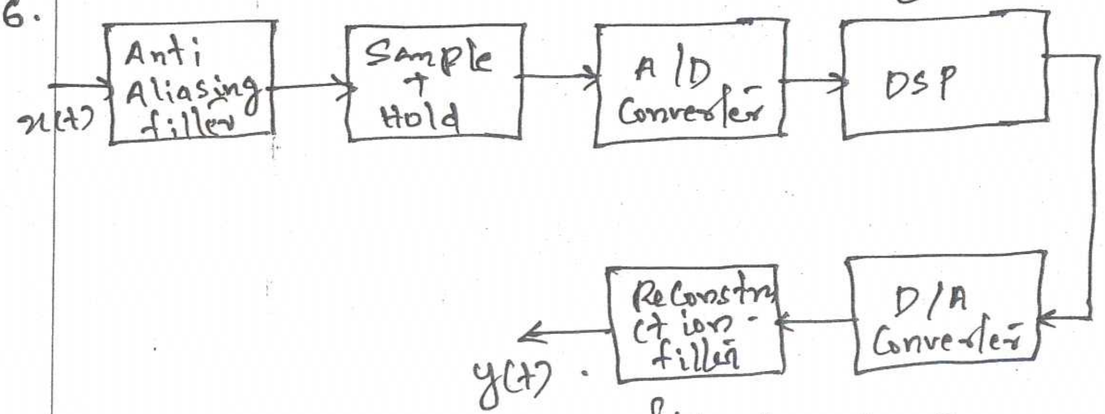
4.	FIR	IIR		
1.	The impulse response of this filter is restricted to finite number of samples	The impulse response of this filter extends over an infinite duration.	2	
2.	FIR filters can have precisely linear phase	These filters do not have linear phase.	2	6
3.	closed-from design equations do not exist	A variety of frequency selective filters can be designed using closed-from design formulas.	2	

5\.

- → Architectural features — 2
- → Execution speed — 2 — 6
- → Type of Arithmetic — 2
- → Word length.

(any three)

6\.

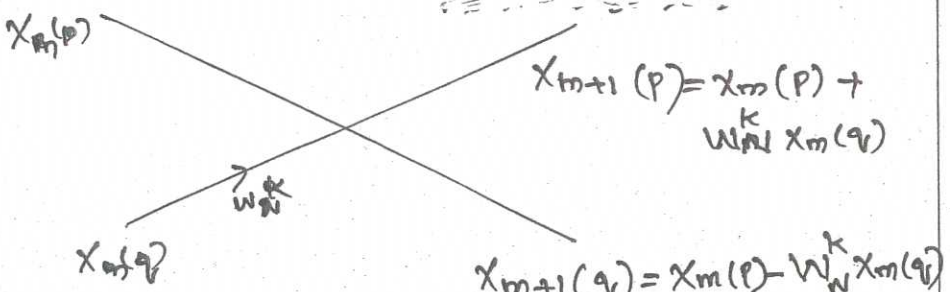


4 — 6

2

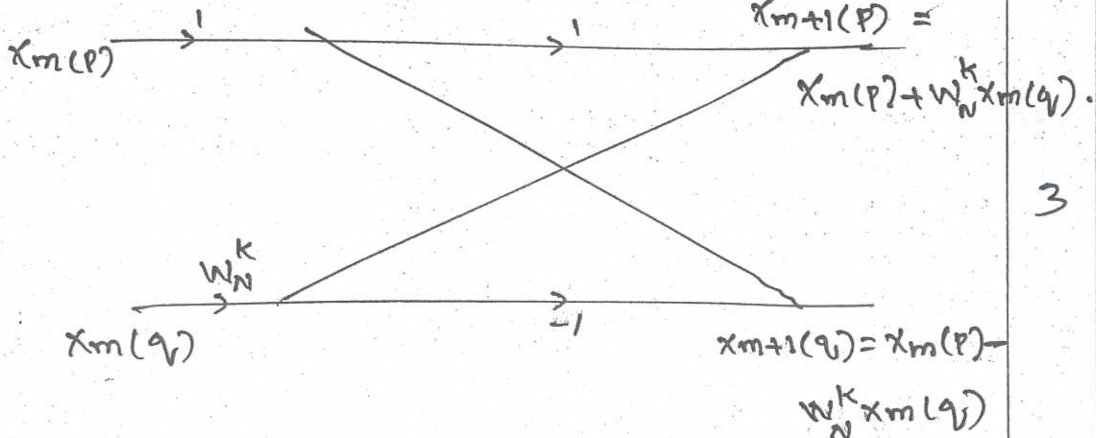
fig - 4 marks, Theory - 2

7.



3

6



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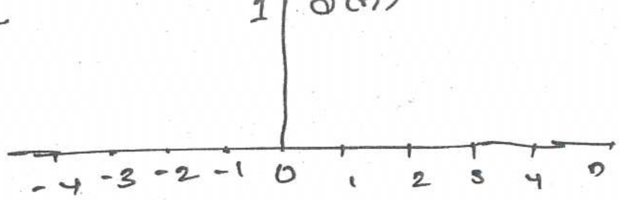
PART- C

UNIT - 1

III

(a.) unit Impulse signal



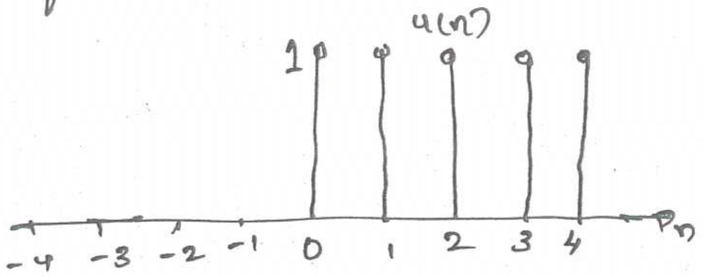
3

The unit-impulse signal is defined as.

$$\delta(n) = 1 \text{ for } n = 0$$
$$= 0 \text{ for } n \neq 0$$

$$\sum_{n=-\infty}^{\infty} x(n)\,\delta(n-n_0) = x(n_0).$$

unit step sequence

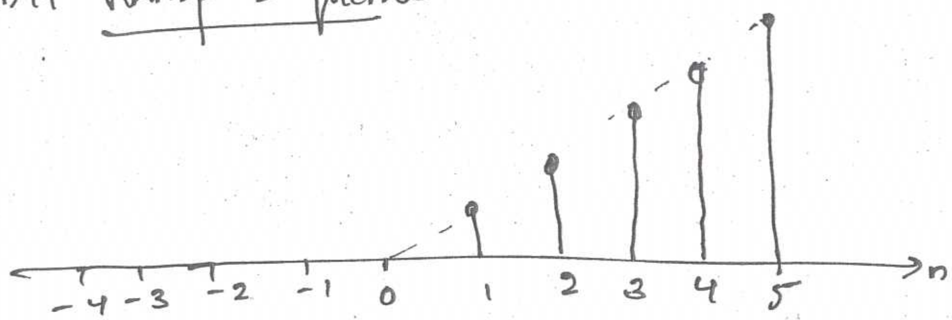


2

The unit step sequence is defined as

$$u(n) = 1 \text{ for } n \geq 0$$
$$= 0 \text{ for } n < 0$$

unit Ramp sequence -



2

The unit ramp sequence is defined as.

$$r(n) = n \text{ for } n \geq 0$$
$$= 0 \text{ for } n < 0 .$$

(b) Given

(i) $y(n) = x(n) + x(n-1)$

$$= T[x(n)] = x(n) + x(n-1)$$

If the input is delayed by 'k' units in time.

$$y(n,k) = T[x(n-k)]$$
$$= x(n-k) + x(n-k-1).$$

we delay the o/p by 'k' units in time,

$$y(n,k) = x(n-k) + x(n-k-1)$$ 4

Here $y(n,k) = y(n-k)$

$\therefore$ The system is time-invariant.

(ii) $y(n) = x(-n)$

Given, $y(n) = x(-n)$

$$y(n) = T[x(n)] = x(-n)$$

The i/p is delayed by 'k' units in time, we have,

$$y(n,k) = T[x(n-k)] = x(-n-k)$$ 4 8

The o/p is delayed by 'k' samples,

$$y(n-k) = x(-(n-k))$$

$$= x(-n+k)$$

Here $y(n,k) \neq y(n-k)$

$\therefore$ The system is time-variant.

IV

(a) (i) Given, $y(n) = x(n) + \frac{1}{x(n-1)}$.

for, n=1; $y(-1) = x(-1) + \frac{1}{x(-2)}$

For, $n=0$; $y(0) = x(0) + \frac{1}{x(-1)}$

for $n=1$; $y(1) = x(1) + \frac{1}{x(0)}$

For all the values of n, the o/p depends on Present and past inputs. | 4

∴ The said s/m is Causal

(ii) Given, $y(n) = x(n^2)$

For, $n=-1$; $y(-1) = x(1)$

$n=0$; $y(0) = x(0)$ | 4 | 8

$n=1$; $y(1) = x(1)$

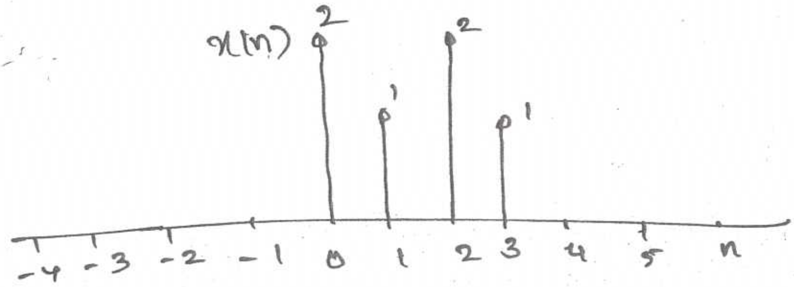
For all values of n, (except for $n=0$ and $n=1$), the s/m depends on future i/ps.

So, the s/m is non-causal.

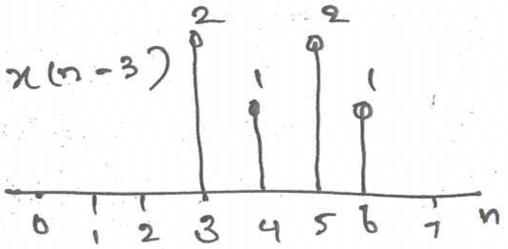
(b) shifting.

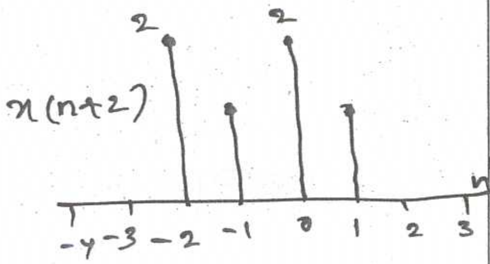
$y(n) = x(n-k)$

$x(n)$ is the i/p and $y(n)$ is the o/p. If 'k' is Positive, the shifting delays the sequence, If 'k' is negative the shifting advances the sequence.



2





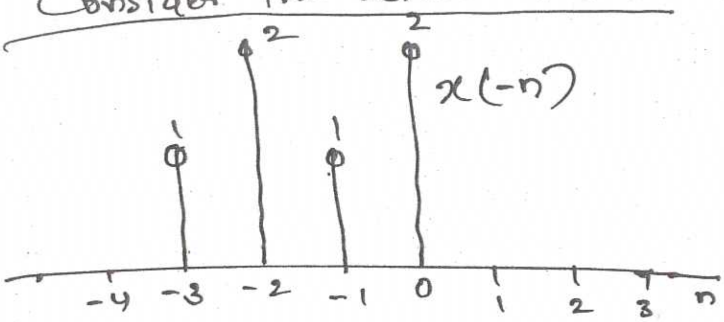
7

Delayed Version.

Advanced version

Time Reversal

Consider the above $x(n)$.

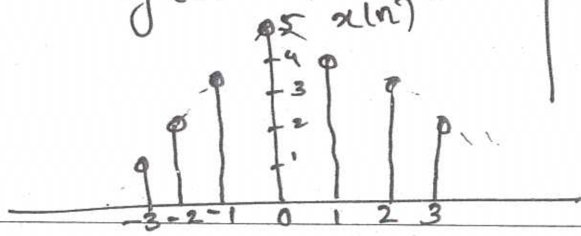


Time reversal signal of $x(n)$.

2

Time Scaling.

$y(n) = x(2n)$



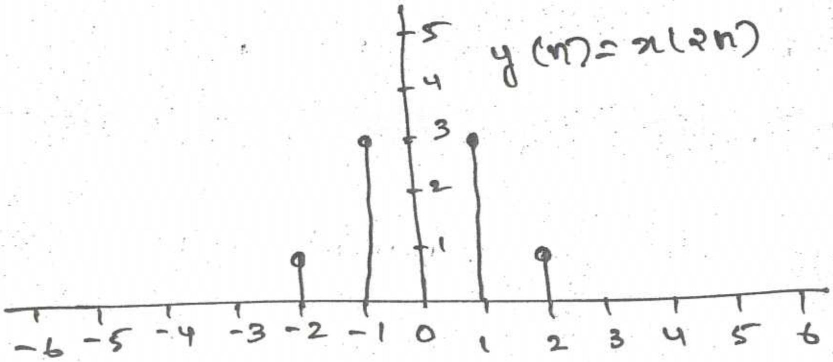
$y(0) = x(0) = 5$

$y(1) = x(2) = 3$

$y(2) = x(4) = 1$

3

$$y(n) = x(2n)$$



V

UNIT - II

(a)

Given. $x(n) = \{1, 1, 0, 0\}$

Let us assume $N = L = 4$

$$X(k) = \sum_{n=0}^{N-1} x(n) e^{-j2\pi nk/N}, \quad k = 0, 1, \ldots N-1$$ 5

$$X(0) = \sum_{n=0}^{3} x(n) = x(0) + x(1) + x(2) + x(3)$$

$$= 1 + 1 + 0 + 0 = \underline{\underline{2}}$$

111ly

$X(1) = 1 - j$

$X(2) = 0$

$X(3) = 1 + j$. $\therefore X(k) = \underline{\underline{\{2, 1-j, 0, 1+j\}}}$ 3

b.	If two finite duration sequences $x_1(n)$ and $x_2(n)$ are linearly Combined as, $x_3(n) = a x_1(n) + b x_2(n)$	4		
	Then the DFT of $x_3(n)$ is, $X_3(k) = a X_1(k) + b X_2(k)$		7	
	$\boxed{DFT\left[a_1 x_1(n) + a_2 x_2(n)\right] = a_1 X_1(k) + a_2 X_2(k)}$	3		
VI (a)	Given, $X(z) = \frac{1+3z^{-1}}{1+3z^{-1}+2z^{-2}}$ First, eleminate the -ve Power, x ing numerator and denominator by z^2 $X(z) = \frac{z(z+3)}{z^2+3z+2} = \frac{z(z+3)}{(z-1)(z-2)}$ ÷ing X(z) by z $\frac{X(z)}{z} = \frac{(z+3)}{(z+1)(z+2)}$ The above equation can be written in Partial fraction form as $\frac{X(z)}{z} = \frac{C_1}{z+1} + \frac{C_2}{z+2}$	4		

$$c_1 = (z+1)\frac{X(z)}{z}\bigg|_{z=-1}$$

$$= (z+1)\frac{z+3}{(z+1)(z+2)}\bigg|_{z=-1}$$

$$= \underline{\underline{2}}$$

$$C_2 = (z+2)\frac{X(z)}{z}\bigg|_{z=-2}$$

$$= (z+2)\frac{z+3}{(z+1)(z+2)}\bigg|_{z=-2}$$

$$= \underline{\underline{-1}}$$

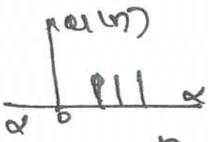
$$\therefore \frac{X(z)}{z} = \frac{2}{z+1} - \frac{1}{z+2}$$ 4 8

$$X(z) = 2\frac{z}{z+1} - \frac{z}{z+2}$$

As ROC is $|z|>2$ the sequence is causal and by $x(n) = 2(-1)^n u(n) - (-2)^n u(n)$.

(b.) Z- Transform of unit step response -

$\cancel{ZX}$ ZT[u(n)]



$$ZT[x(n)] = X(z) = \sum_{n=-\alpha}^{\alpha} x(n) z^{-n}$$

$$ZT[u(n)] = \sum_{n=-\alpha}^{\alpha} u(n) z^{-n}$$

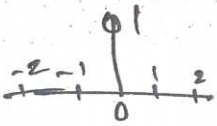
$$= \sum_{n=0}^{\infty} z^{-n}$$

$$\boxed{\sum_{n=0}^{\infty} a^n = \frac{1}{1-a}}$$

$$= \sum_{n=0}^{\infty} [z^{-1}]^n = \frac{1}{1-z^{-1}} = \frac{z}{z-1}$$ 3

Z- Transform of unit impulse function.

$$\delta(n) = \begin{cases} 1 & n = 0 \\ 0 & n \neq 0 \end{cases}$$



$$ZT[\delta(n)] = z$$

$$ZT[x(n)] = \sum_{n=-\infty}^{\infty} x(n) z^{-n}$$ 7

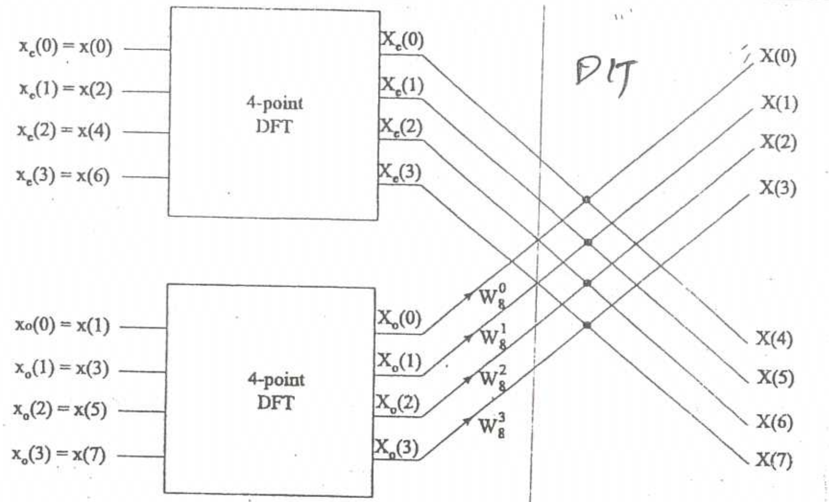
$$ZT[\delta(n)] = \sum_{n=-\infty}^{\infty} \delta(n) z^{-n}$$ 4

$$= \delta(-2) z^{2} + \delta(-1) z^{1} + \delta(0) z^{0} + \delta(1) z^{-1} + \cdots$$

$$\therefore \; X(z) = 1$$

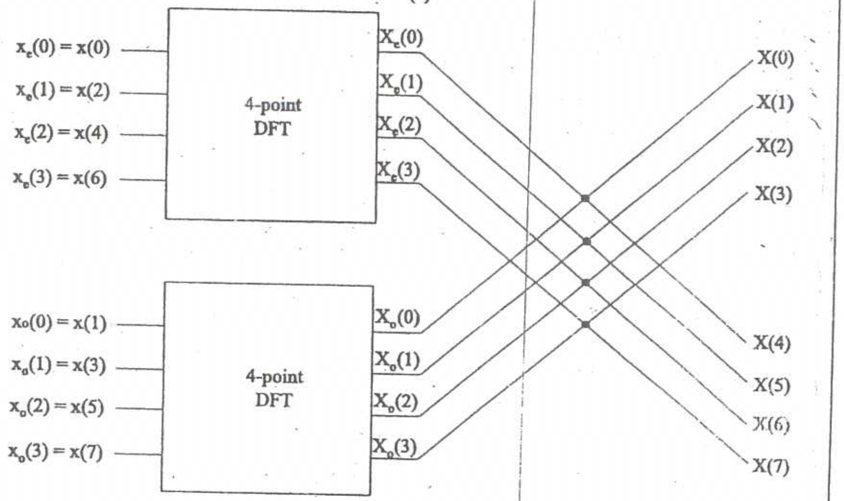
VII

(a)



(a)

5



(b)

3

8

b. Differences

⇒ For DIT, the i/p is bit reversal while the o/p is in natural order, where as for DIF, the i/p is in natural order while the o/p in bit reversal. 4

⇒ The DIF Butterfly is slightly different from the DIT butterfly, the difference being that the Complex multiplication takes place after the add-subtract operation in DIF.

Similarities

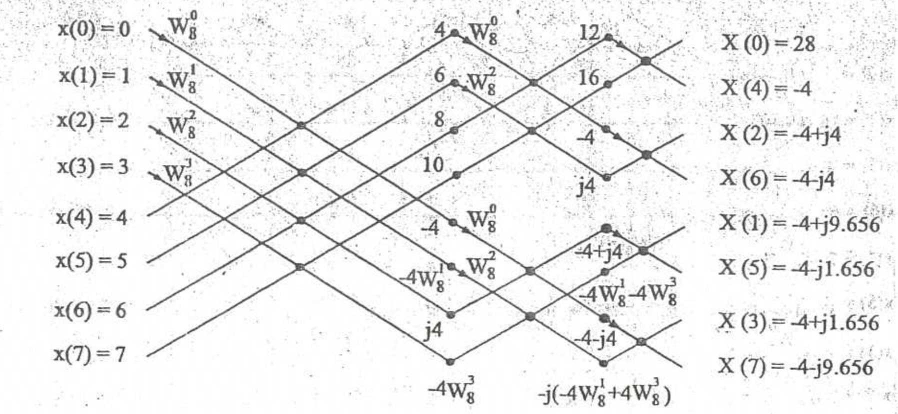
⇒ Both algorithms require same number of operations to compute the DFT. 3 7

⇒ Both algorithms can be done in-place and both need to perform bit reversal at some place during the computation.

VIII

(a)

Solution

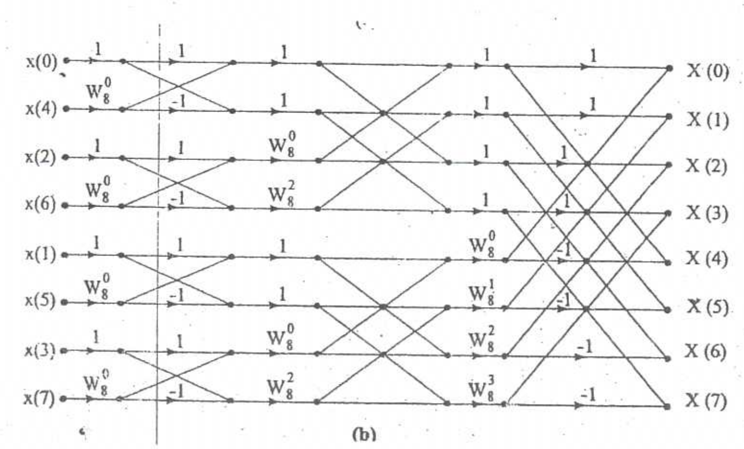


8

8

$$X(k) = \{28, -4 + j9.656, -4 + j4, -4 + j1.656, -4, -4 - j1.656, -4 - j4, -4 - j9.656\}$$ 3

(b)

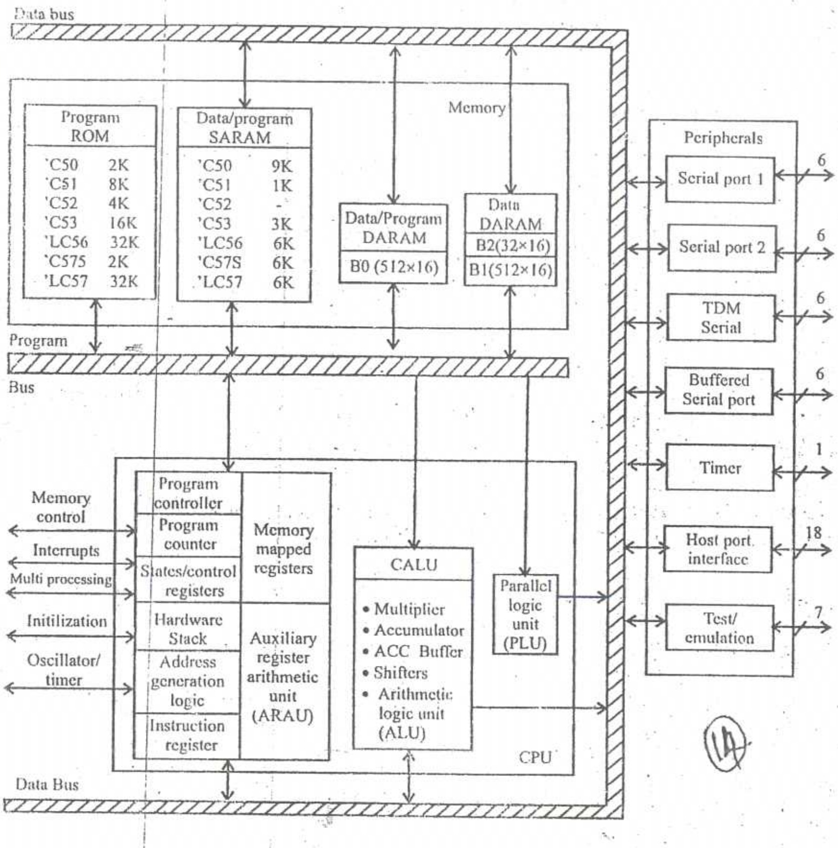


(b)

4 7

3

17 (a)



The functional block diagram of TMS320C50 (Texas instruments)

7 10 3 (14)

(b)

FIR filters

→ FIR filters are always ~~stab~~ stable. 1

→ FIR filters with exactly linear - phase can easily be designed. 1

→ FIR filters can be realized in both recursive and non-recursive structures. 1

→ FIR filters are free of limit cycle oscillations, when implemented on a finite word length digital systems. 1

→ Excellent design methods are available for various kinds of FIR filters. 1

5

X (a)

Addressing modes.

The addressing modes in TMS 32050 are

* Immediate addressing
* Indirect addressing
* Register addressing
* memory maped Register addressing
* Direct addressing
* Circular addressing.

6

I - Types of Indirect addressing.

* Auto increment
* Auto decrement
* Post indexing by adding the Contents of AR0
* Post indexing by subtracting the Contents of AR0
* Single indirect addressing with no increment.
* Single indirect addressing with no decrement
* Bit reversal addressing.

2 10

(b) Applications of DSP.

1. Telecommunication.
2. Instrumentation and Control.

1

3 - Speech Processing
4 - militarry.
5 - medicine.
6 - Image Processing.

	1	
	1	5
	1	