COC2070

ASSIGNMENT 4

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Q1

Assignment 4

Question 1: Design a simple Computer with following instructions:

operation Code	Mnemonic	Description	Function
00000001	ADD R	Add R to A	A ← A+R
00000010	ADI OPRD	Add opn to A	A ← A+OPRD
00000011	ADA ADRS	Add direct to A	A ← A+M[ADRS]

Soln OP-code fetch: (same for all instruction):

t_0 MAR ← PC (program code)

t_1 MBR ← M[MAR]

t_2 IR ← MBR

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q_1 high { $q_1 t_3$ A ← A+R.] (ADD R).

q_2 high { $q_2 t_3$ MAR ← PC

$q_2 t_4$ MBR ← M[MAR] PC ← PC+1] (ADI OPRD)

$q_2 t_5$ A ← A+MBR. T ← 0 reset time.

q_3 (high) { $q_3 t_3$ MAR ← PC

$q_3 t_4$ MBR ← M[MAR] PC ← PC+1] (ADD ADRS)

$q_3 t_5$ MAR ← MBR

~~$q_3 t_6$ A ← A+M[ADRS] T ← 0 reset time.~~

$q_3 t_6$ MBR ← M[MAR]

$q_3 t_7$ A ← A+MBR T ← 0 reset time

$x_1 = t_0 + q_2 t_3 + q_3 t_3$

$x_2 = q_3 t_4$

$x_3 = t_1 + q_2 t_4 + q_3 t_4$

$x_4 = q_3 t_4 + q_2 t_4$

$x_5 = q_2 t_5 + q_3 t_7$

$x_6 = q_1 t_3$

$x_7 = x_5 + x_6$

$x_8 = t_2$

MAR ← PC

MAR ← MBR

PC ← PC + 1

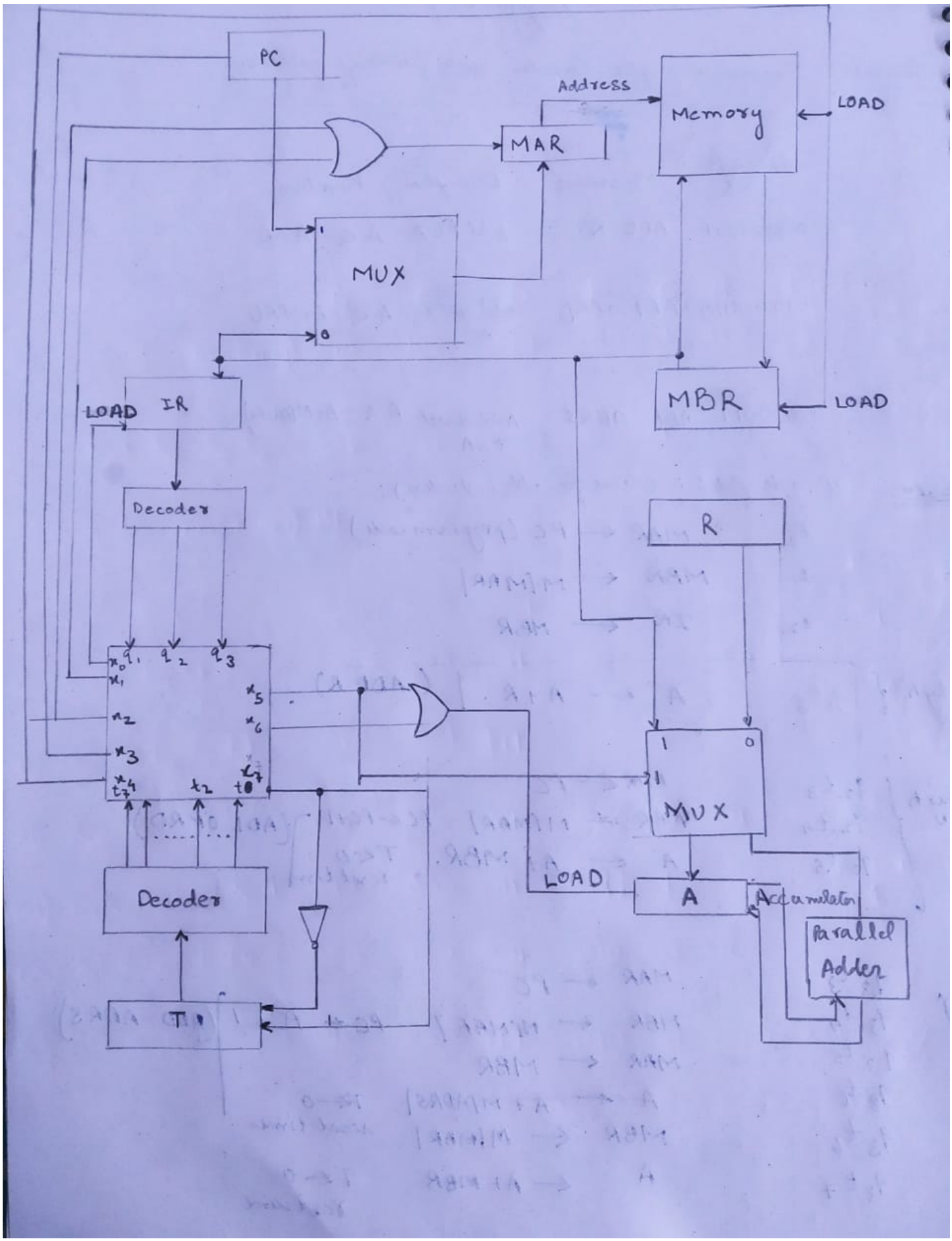
MBR ← M[MAR]

MBR ← A + MBR

A ← A + R

T ← 0

IR ← MBR


PC
Address
Memory
LOAD
MAR
MUX
LOAD
IR
MBR
LOAD
Decoder
R
MUX
LOAD
A
Accumulator
Parallel
Adder
Decoder
T

Q2

Q2. Find the control words for the following microoperations and specify the function being carried out.

Microperation	A	B	D	F	C	H	Function
i) $R_2 \leftarrow clc(R2+R4+1)$	010	100	010	010	1	110	Add R_2, R_4 & carry and circulate value to left
ii) $-R_3 + R_5 \equiv R_5 - R_3$ $\equiv \bar{R}$	101	011	000	010	1	000	Subtract R_3 from R_5
iii) Output $\leftarrow$ Shr$(R7-R2-1)$ Shr$\equiv [R_7 - (R_2+1)]$	111	010	000	010	0	001	Shift right after sub. (R_2+1) from R_7
iv) $R_1 \leftarrow$ Input	000	000	001	000	0	000	~~Set~~ Transfer Input to R_1
v) $R_3 \leftarrow \bar{R}_4 + 1$ $\equiv -R_4$	100	000	011	000	0	000	Transfer 2's complement of R_4 to R_3
vi) $R_6 \leftarrow R_2 - R_1 + 1$ $= (R_2+1) - R_2$ $= (R_2+1) + (\bar{R}_1+1)$	010	001	010	010	1	010	Subtraction with Borrow
vii) $R_5 \leftarrow 0$	000	000	101	000	0	011	Set R_5 to zero
viii) $R_3 \leftarrow R_2$, $C \leftarrow 1$	010	000	011	011	1	000	Set R_3 to R_2 with Carry 1
ix) R1 $\leftarrow$ Input $-$ R4 $-$ 1	000	100	001	010	0	000	Subtract (R_4+1) from Input by Borrow as 1.
x) R7 $\leftarrow \bar{R6}$ + Input	010	000	111	010	0	000	Add 1's compliment and input & transfer to R_7