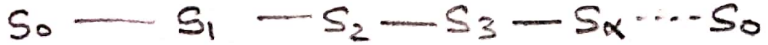
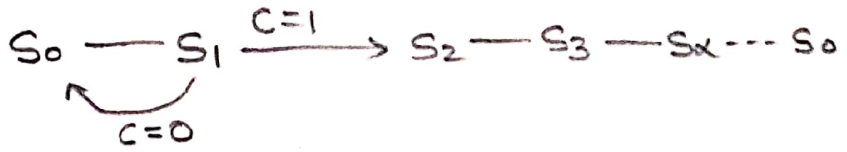
Instructions : State transitions:-

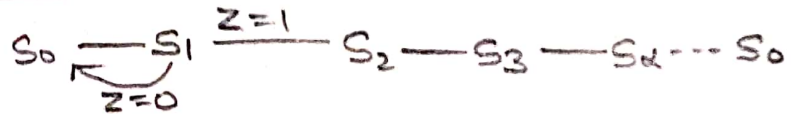
1) ADD:-



2) ADC :-



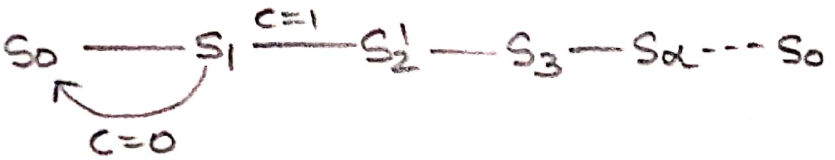
3) ADZ :-



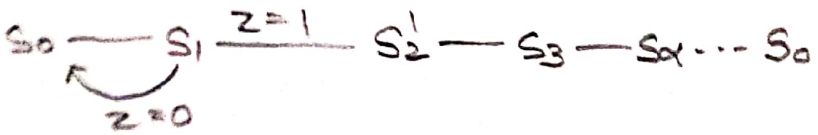
4) ADI :-

5) NDU:-

6) NDC:-

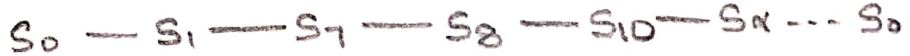


7) NDZ :-



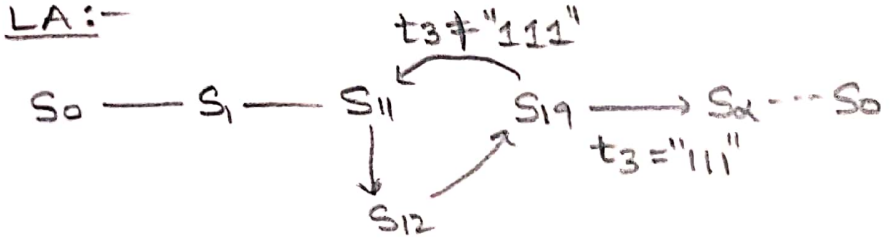
8) LHI:-

9) LW:-

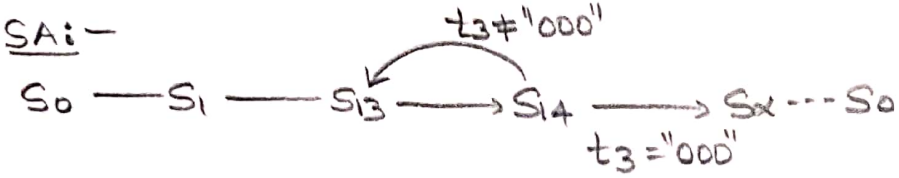


10) SW :-

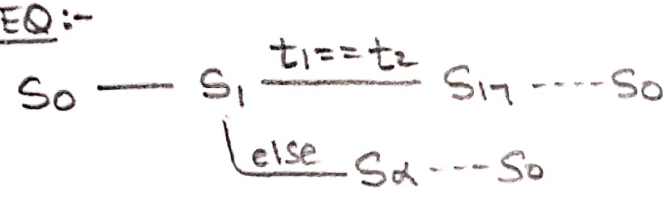
11) LA:-



12) SAi-



13) BEQ:-



14) JAL:-

15) JLR:-

States:-

S_0:

PC → mem_addr | IR.WR

mem_D → IR

S_α:

PC → ALUa | PC.WR

+1 → ALUb

ALUc → PC

S_1:

IR_{11-9} → RF_A1 | t_1.WR

IR_{8-6} → RF_A2 | t_2.WR

RFD1 → t_1 | t_3.WR

RF_D2 → t_2

$\overrightarrow{0}_{16}$ → t_3

S_2:

t_1 → ALUa | t3.WR

t_2 → ALUb

ALUc → t_3

S_2':

t_1 → ALUa | t_3.WR

t_2 → ALUb | ALU.nand

ALUc → t_3

S_3:

t_3 → RF_D3 | RF.WR

IR_{5-3} → RF_A3

S_4:

t_1 → ALUa | t_3.WR

$SE_6(IR_{5-0})$ → ALUb

ALUc → t_3

S_5:

t_3 → RF_D3 | RF.WR

IR_{8-6} → RF_A3

S_6:

$Imm9e16(IR_{8-0})$ → RF_D3 | RF.WR

IR_{11-9} → RF_A3

S_7:

t_2 → ALUa (asyncronous)

$SE_6(IR_{5-0})$ → ALUb | t_2.W

ALUc → t_2 (syncronous)

S_8:

t_2 → mem_addr | t_3.WR

mem_D → t_3

S_9:

t_2 → mem_addr | mem.WR

t_1 → mem_in

S_{10}:

IR_{11-9} → RF_A3 | RF.WR

t_3 → RF_D3

S11:

$t_1 \rightarrow mem\_addr$
$mem\_D \rightarrow t_2$

| $t_2 \cdot wr$

S12:

$t_2 \rightarrow RF\_D_3$
$t_{3\ 2-0} \rightarrow RF\_A3$
$t_3 \rightarrow ALUa$
$+1 \rightarrow ALUb$
$ALUc \rightarrow t_3$

| $RF \cdot wr$
| $t_3 \cdot wr$

S19:

$t_1 \rightarrow ALUa$
$+1 \rightarrow ALUb$
$ALUc \rightarrow t_1$

| $t_1 \cdot wr$

S13:

$t_3 \rightarrow ALUa$
$+1 \rightarrow ALUb$
$ALUc \rightarrow t_3$
$t_3 \rightarrow RF\_A1$
$RF\_D1 \rightarrow t_2$

| $t_3 \cdot wr$
| $t_2 \cdot wr$

S14:

$t_1 \rightarrow ALUa$
$+1 \rightarrow ALUb$
$ALUc \rightarrow t_1$
$t_1 \rightarrow mem\_addr$
$t_2 \rightarrow mem\_in$

| $t_1 \cdot wr$
| $Mem \cdot wr$

S15:

$PC \rightarrow ALUa$
$SE_9(IR_{8-0}) \rightarrow ALUb$
$ALUc \rightarrow PC$

| $PC \cdot wr$

S16:

$IR_{11-9} \rightarrow RF\_A3$
$PC \rightarrow RF\_D3$
$IR_{8-6} \rightarrow RF\_A2$
$RF\_D2 \rightarrow t_2$

| $RF \cdot wr$
| $t_2 \cdot wr$

S17:

$PC \rightarrow ALUa$
$SE_6(IR_{5-0}) \rightarrow ALUb$
$ALUc \rightarrow PC$

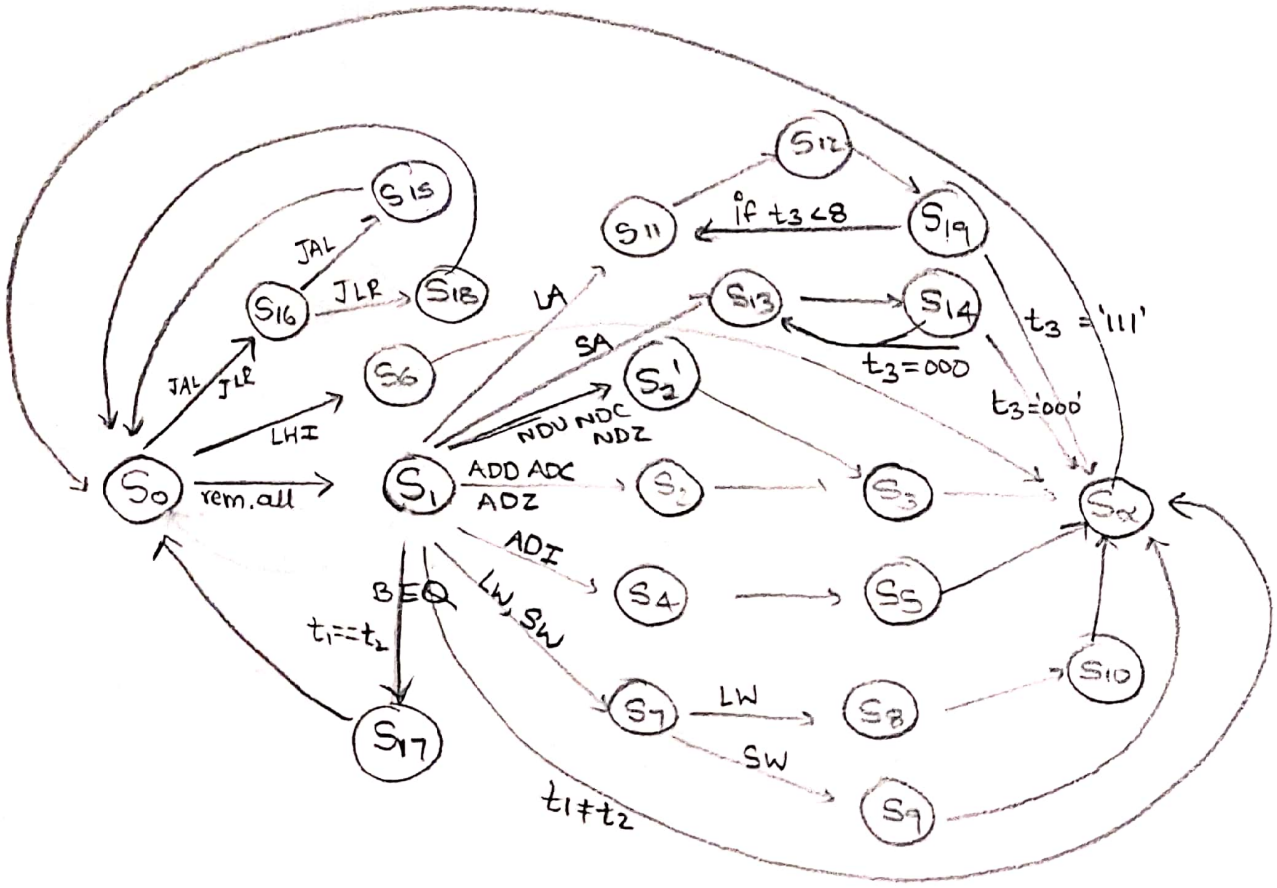
| $PC \cdot wr$

S18:

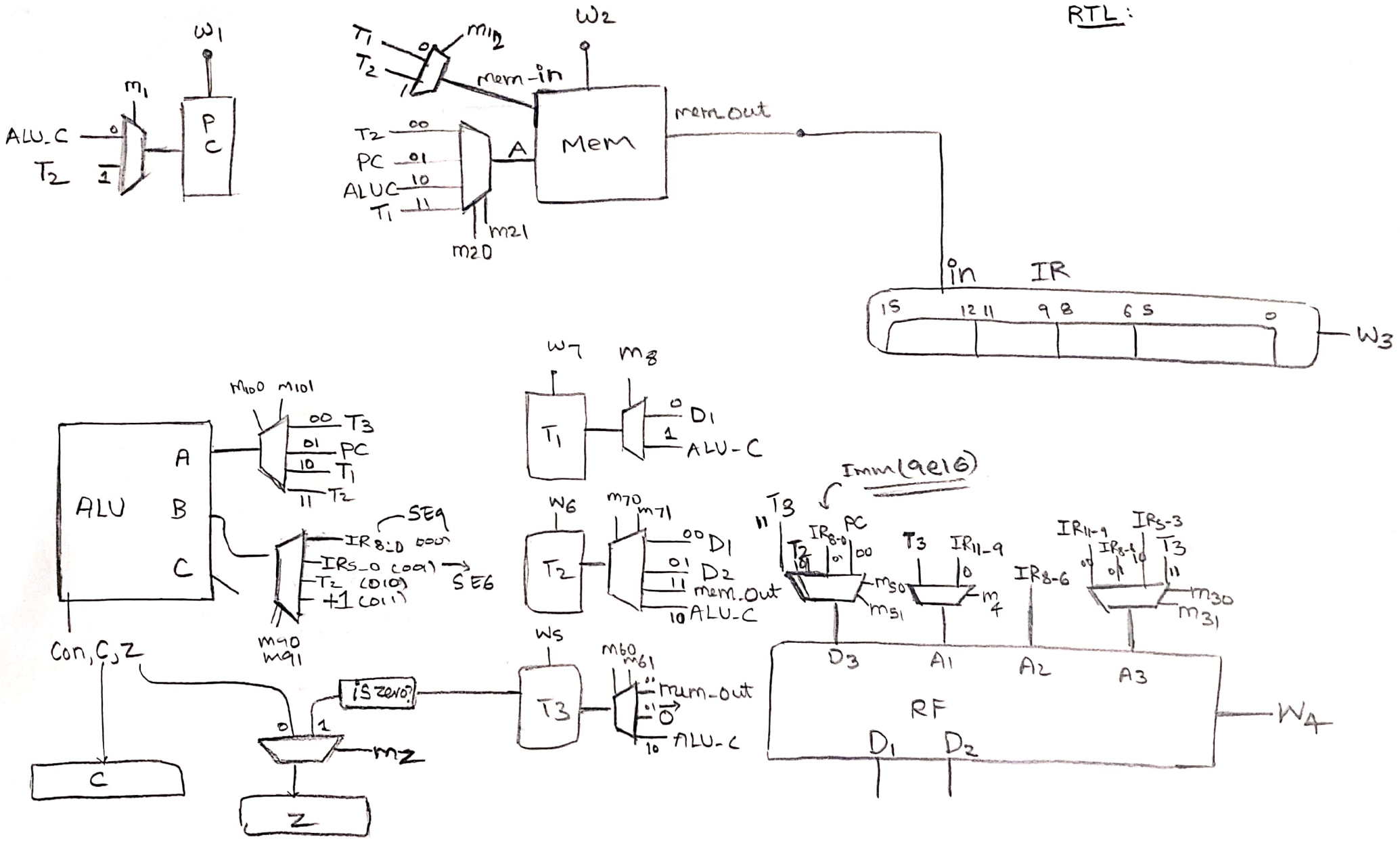
$t_2 \rightarrow PC$

| $PC \cdot wr$

State diagram:-



RTL:


W1
m1
ALU_C
T2
PC
W2
m12
T1
T2
mem-in
T2 00
PC 01
ALUC 10
T1 11
A
Mem
mem_out
m20
m21
in IR
15 12 11 9 8 6 5 0
W3
W7
m8
T1
0 D1
1 ALU-C
m100 m101
00 T3
01 PC
10 T1
11 T2
A
ALU
B
C
SE9
IR8:0 000
IR5_0 (001)
T2 (010)
+1 (011)
SE6
m40
m41
W6
m70 m71
T2
00 D1
01 D2
11 mem.out
10 ALU-C
Imm(9e16)
T3
11
IR8-0
PC
T2
10
01
00
m50
m51
T3
IR11-9
0
m4
IR8-6
IR11-9
IR8-6
IR5-3
T3
m30
m31
Con, C, Z
W5
m60
m61
IS zero?
T3
mem-out
0
ALU-C
m2
C
Z
D3
A1
A2
A3
RF
D1
D2
W4