EE309 Project

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1) ADD

PC → mem_A, alu_A mem_D → IR +1 → alu_B alu_out → PC	S1 S2
IR_{11-9} → RF_A1 IR_{8-6} → RF_A2 RF_D1 → t1 RF_D2 → t2	S2 S3
t1 → alu_A t2 → alu_B alu_out → t3	S3 S4
t3 → RF_D3 IR_{5-3} → RF_A3	S4 IB

2) ADC

PC → mem_A, alu_A mem_D → IR +1 → alu_B alu_out → PC	S5 S6
IR_{11-9} → RF_A1 IR_{8-6} → RF_A2 RF_D1 → t1 RF_D2 → t2	S6 SB

C = 1

t1 → alu_A t2 → alu_B alu_out → t3	S7 S8
t3 → RF_D3 IR_{5-3} → RF_A3	S8 IB

C = 0

	S9 IB

3) ADZ

PC → mem_A, alu_A mem_D → IR +1 → alu_B alu_out → PC	S10 S11
IR_{11-9} → RF_A1 IR_{8-6} → RF_A2 RF_D1 → t1 RF_D2 → t2	S11 SB

Z = 1

t1 → alu_A t2 → alu_B alu_out → t3	S12 S13
t3 → RF_D3 IR_{5-3} → RF_A3	S13 IB

Z = 0

	S14 IB

4) ADL

PC → mem_A, alu_A mem_D → IR +1 → alu_B alu_out → PC	S15 S16
IR_{11-9} → RF_A1 IR_{8-6} → RF_A2 RF_D1 → t1 RF_D2 → t2	S16 S17
t1 → alu_A t2 → 1s → alu_B alu_out → t3	S17 S18
t3 → RF_D3 IR_{5-3} → RF_A3	S18 IB

S17 m

5) ADI

PC → mem_A, alu_A Mem_D → IR +1 → alu_B alu_out → PC	S19 S20
IR_{11-9} → RF_A1 IR_{8-6} → RF_A2 RF_D1 → t1 RF_D2 → t2	S20 S21
t1 → alu_A IR_{5-0} → SE16 → alu_B alu_out → t3	S21 S22
t3 → RF_D3 IR_{8-6} → RF_A3	S22 IB

6) NDU

PC → mem_A, alu_A mem_D → IR +1 → alu_B alu_out → PC	S23 S24
IR_{11-9} → RF_A1 IR_{8-6} → RF_A2 RF_D1 → t1 RF_D2 → t2	S24 S25
t1 → alu_A t2 → alu_B alu_out → t3	S25 S26
t3 → RF_D3 IR_{5-3} → RF_A3	S26 IB

7) NDC

PC → mem_A, alu_A mem_D → IR +1 → alu_B alu_out → PC	S27 S28
IR_{11-9} → RF_A1 IR_{8-6} → RF_A2 RF_D1 → t1 RF_D2 → t2	S28 SB

C=1

t1 → alu_A t2 → alu_B alu_out → t3	S29 S30
t3 → RF_D3 IR_{5-3} → RF_A3	S30 IB

C=0

	S31 IB

8) NDZ

PC → mem_A, alu_A mem_D → IR +1 → alu_B alu_out → PC	S32 S33
IR_{11-9} → RF_A1 IR_{8-6} → RF_A2 RF_D1 → t1 RF_D2 → t2	S33 SB

Z=1

t1 → alu_A t2 → alu_B alu_out → t3	S34 S35
t3 → RF_D3 IR_{5-3} → RF_A3	S35 IB

Z=0

	S36 IB

9) LHI

PC → mem-A, alu-A mem-D → IR +1 → alu-B alu-out → PC	S37 S38
IR_{8-0} → S_7 → alu-A 0 → alu-B alu-out → t3	S38 S39
t3 → RF-D3 IR_{11-9} → RF-A3	S39 IB

10) LW

PC → mem-A, alu-A mem-D → IR +1 → alu-B alu-out → PC	S40 S41
IR_{8-6} → RF-A2 RF-D2 → t2	S41 S42
t2 → alu-A IR_{5-0} → SE16 → alu-B alu-out → t3	S42 S43
t3 → mem-A mem-D → t3	S43 S44
t3 → RF-D3 IR_{11-9} → RF-A3	S44 IB

11) SW

PC → mem-A, alu-A mem-D → IR +1 → alu-B alu-out → PC	S45 S46
IR_{11-9} → RF-A1 IR_{8-6} → RF-A2 RF-D1 → t1 RF-D2 → t2	S46 S47
t2 → alu-A IR_{5-0} → SE16 → alu-B alu-out → t3	S47 S48
t3 → mem-A t1 → mem-D	S48 IB

12) LM

PC → mem-A, alu-A mem-D → IR +1 → alu-B alu-out → PC	S49 S50
IR_{11-9} → RF-A1 RF-D1 → t1	S50 S51
+1 → NUM, t2	S51 S52
NUM → alu-A IR_{8-0} → SE16 → alu-B alu-out → t3 NUM → IS → NUM	S52 SB
t1 → mem-A mem-D → t1	S53 S54
t1 → RF-D3 t2 → 16 to 3 bit → RF-A3	S54 S55
t2 → alu-A +1 → alu-B alu-out → t2	S55 S56
t1 → alu-A +1 → alu-B alu-out → t1	S56 S52

make separate unit to check the register

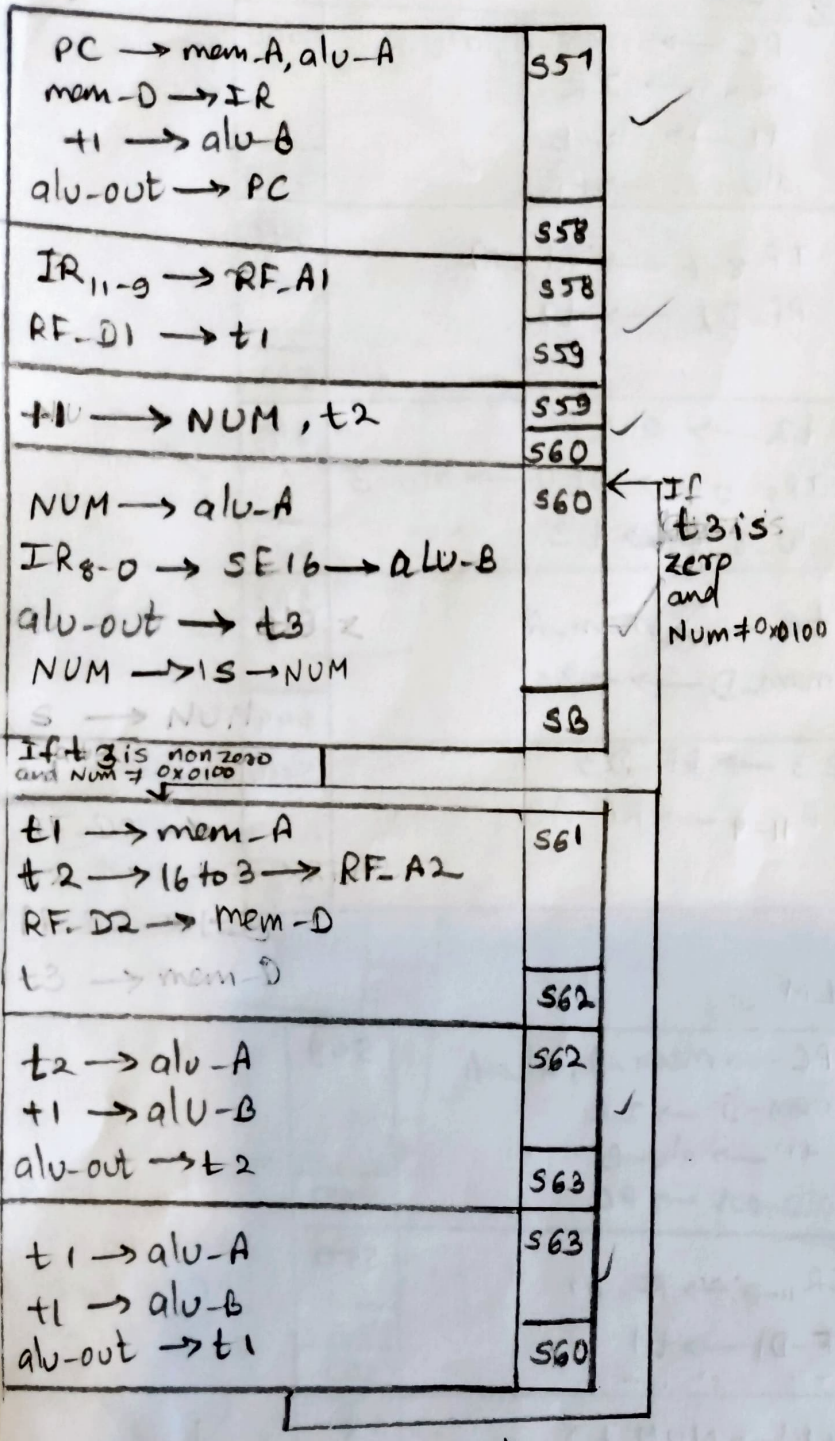
If t3 is zero and NUM ≠ 0x0100

If t3 is non zero and NUM ≠ 0x0100

If NUM = 0x0100, next instruction

S52, S43, S48, S53, S54
P Q R S T

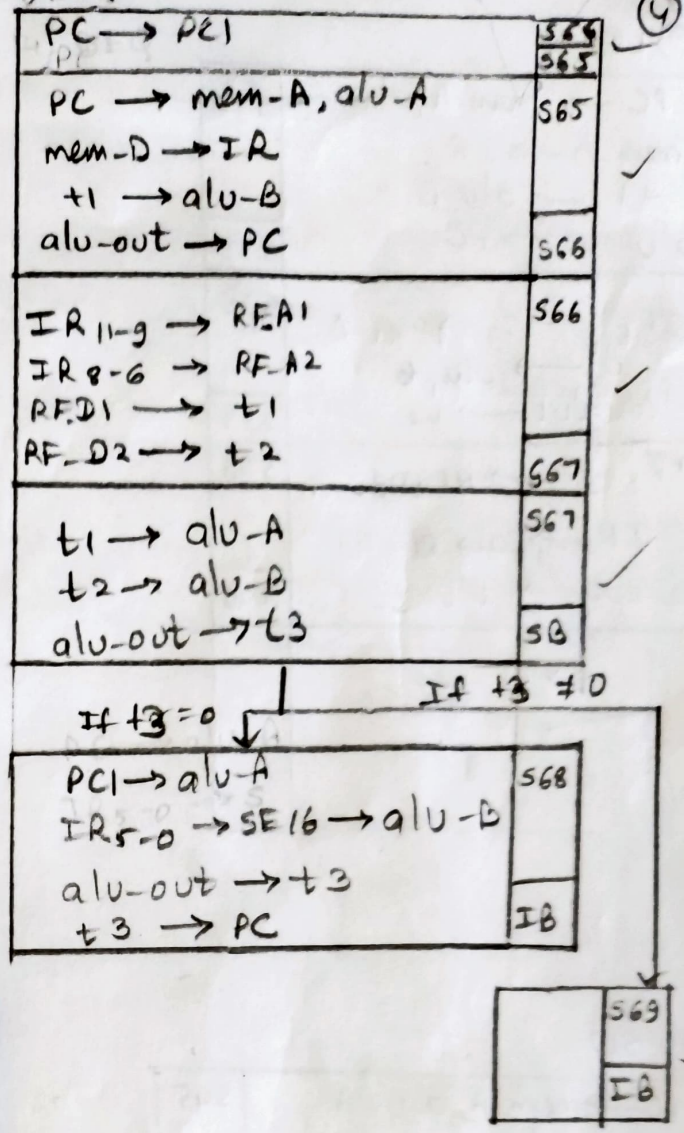
13) SM



If NUM = 0x0100, next instruction

16) JLR

14) BEQ



15) JAL

PC → PC1	S70 S71
PC → mem-A, alu-A mem-D → IR +1 → alu-B alu-out → PC	S71 S72
alu-out → t3 t3 → RF-D3 IR_{11-9} → RF-A3	S72 S73
PC1 → alu-A IR_{8-0} → SE16 → alu-B alu-out → PC	S73 IB

16) JLR

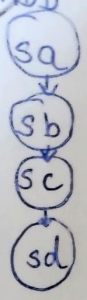
PC → mem-A, alu-A mem-D → IR +1 → alu-B alu-out → PC	S74 S75
alu-out → t3 t3 → RF-D3 IR_{11-9} → RF-A3	S75 S76
IR_{8-6} → RF-A2 RF-D2 → t2 t2 → PC	S76 IB

17) JRI

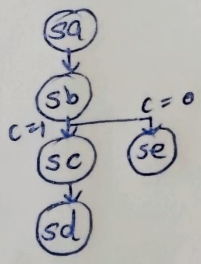
PC → mem-A, alu-A mem-D → IR +1 → alu-B alu-out → PC	S77 S78
IR_{11-9} → RF-A1 RF-D1 → t1	S78 S79
t1 → alu-A IR_{8-0} → SE16 → alu-B alu-out → t3	S79 S80
t3 → PC	S80 IB

S73	S79	S80	S76
w	x	y	z

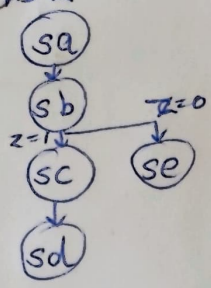
ADD



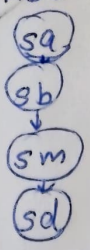
ADC



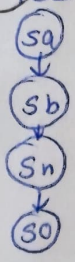
ADZ



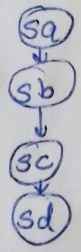
ADL



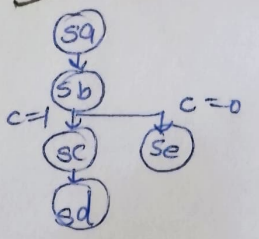
ADI



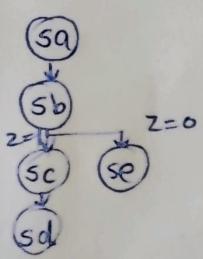
NDU



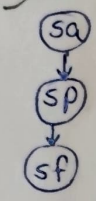
NDC



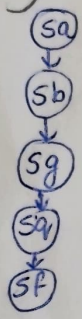
NDZ



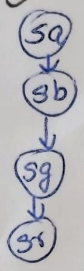
LHI



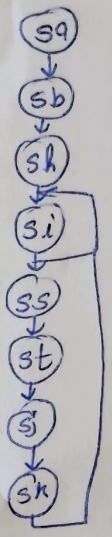
LW



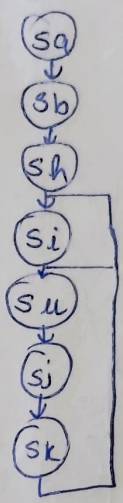
SW



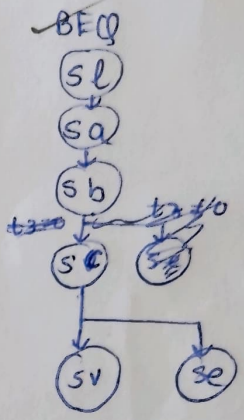
LM



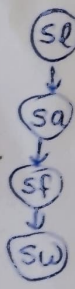
SM



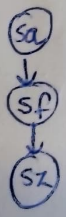
BEQ



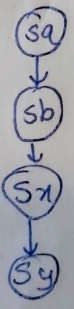
JAL



JLR



JRI



sa = s1 = s5 = s10 = s15 = s19 = s23 = s27 = s32 = s37 = s40 = s45 = s49 = s57 = s65 = s71 = s74 = s77

sb = s2 = s6 = s11 = s16 = s20 = s24 = s28 = s33 = s41 = s46 = s50 = s58 = s66 = s78

sc = s3 = s7 = s12 = s25 = s29 = s34 = s67

sd = s4 = s8 = s13 = s26 = s30 = s18 = s35

se = s9 = s14 = s31 = s36 = s69

sf = s39 = s44 = s72 = s75

sg = s42 = s47

sh = s51 = s59

si = s52 = s60

sj = s55 = s62

sk = s56 = s63

sl = s64 = s70

sm = s17

sn = s21

so = s22

sp = s38

sq = s43

sr = s48

ss = s53

st = s54

su = s61

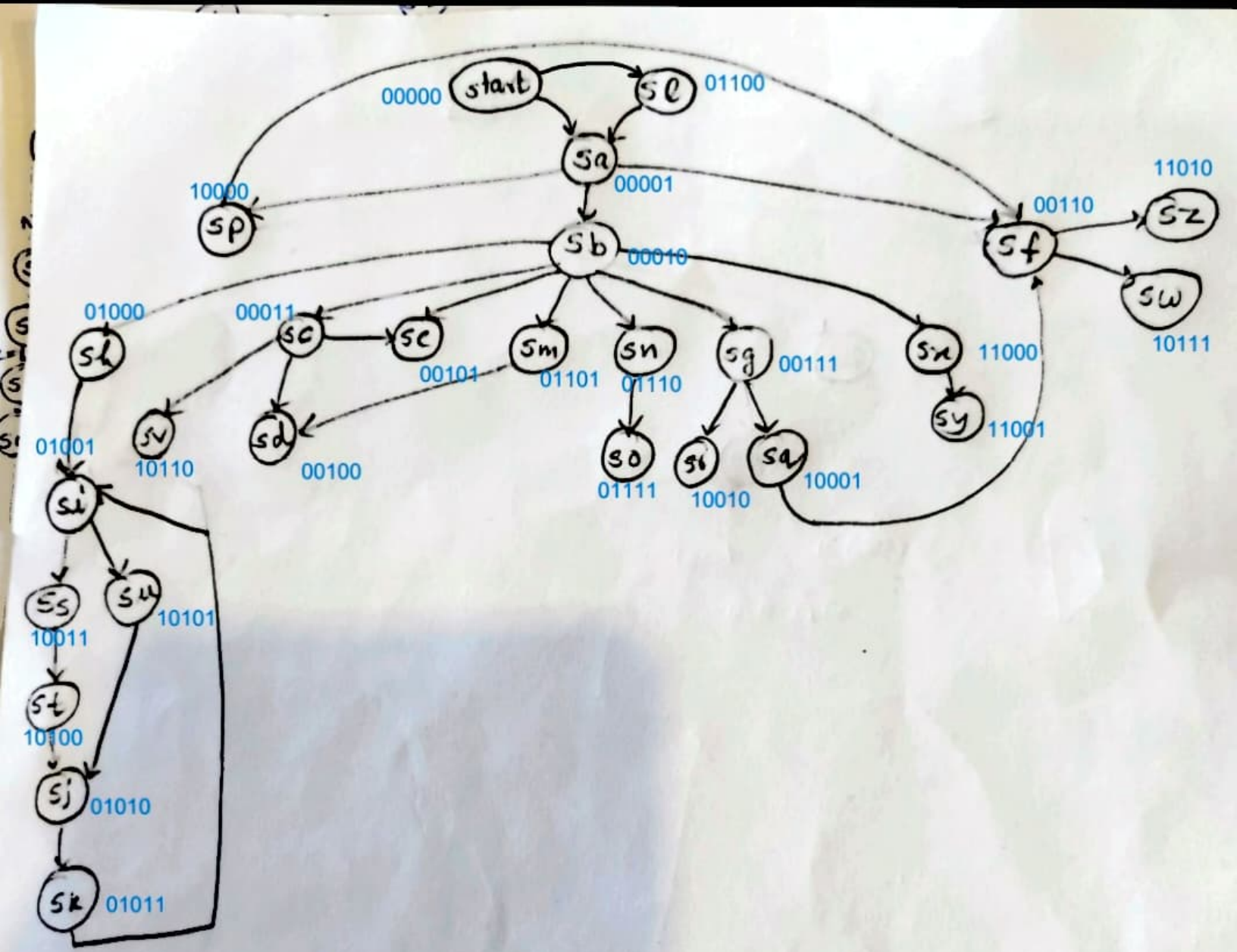
sv = s68

sw = s73

sx = s79

sy = s80

sz = s76


start
00000
sl
01100
sa
00001
sp
10000
sb
00010
sf
00110
sz
11010
sw
10111
sk
01000
sc
00011
se
00101
sm
01101
sn
01110
sg
00111
sx
11000
sy
11001
sv
10110
sd
00100
so
01111
sr
10010
sq
10001
si
01001
ss
10011
su
10101
st
10100
sj
01010
sk
01011

if reset = '1' then

ns <= "00000" sl = "01100"

else if [cs <= "00000"] then sa = "00001"

ns[4) <= '0' sl. REG + JAL

ns(3) <= $\theta_3\bar{\theta}_2\bar{\theta}_1$

ns(2) <= $\theta_3\bar{\theta}_2\bar{\theta}_1$

ns(1) <= 0

ns[0) <= $(\theta_3\bar{\theta}_2\bar{\theta}_1)$

else if cs <= "01100" then sp - 10000

ns <= "00001" sb - 00010

else if cs <= "00001" then sf - 00110

ns(4) <= $\bar{\theta}_3\bar{\theta}_2\bar{\theta}_1\bar{\theta}_0$ (LHI)

ns(3) <= '0'

ns(2) <= $\theta_3\bar{\theta}_2(\bar{\theta}_1\theta_0 + \theta_1\bar{\theta}_0)$ (JAL/JLR)

ns(1) <= $[\bar{\theta}_3\bar{\theta}_2\bar{\theta}_1\bar{\theta}_0]$

ns(0) <= '0'

else if cs <= "10000" then

ns <= "00110"

else if cs <= "00010" then sh = 01000

ns(4) <= $\theta_3\bar{\theta}_2\theta_1\theta_0$ sc - 00011

ns(3) <= $\bar{\theta}_1(\theta_3\theta_2 + \bar{\theta}_3\bar{\theta}_2) + \theta_3\bar{\theta}_2\theta_1\theta_0$ se - 00101

ns(2) <= $\bar{\theta}_3\theta_2[\bar{\theta}_1\theta_0 + \theta_1\bar{\theta}_0](c\bar{z} + \bar{c}z)$ sm - 01101

$+ \bar{\theta}_3\theta_2\bar{\theta}_1 + \bar{\theta}_3\theta_2\theta_0$ sn - 01110

sg - 00111

sx - 11000

$ns(1) <= \bar{\theta}_3\bar{\theta}_2\bar{\theta}_1\theta_0 (c\bar{z}\bar{c} + c\bar{z}c_4 + \bar{c}zz_1) + \bar{\theta}_3\bar{\theta}_2\theta_1\bar{\theta}_0[c\bar{z}\bar{c} + c\bar{z}c_4 + \bar{c}zz_1) + \theta_3\bar{\theta}_2\bar{\theta}_1\bar{\theta}_0 + \bar{\theta}_3\theta_2\theta_0$

$ns(0) <= \theta_3\theta_2\bar{\theta}_1 + \bar{\theta}_2[\bar{\theta}_3\bar{\theta}_1\theta_0 + \theta_3\theta_1\theta_0]$

else if cs <= "00110" then

ns(4) <= '1'

ns(3) <= $\theta_3\bar{\theta}_2\theta_1\bar{\theta}_0$

ns(2) <= $\theta_3\bar{\theta}_2\bar{\theta}_1\theta_0$

ns(1) <= '1'

ns(0) <= $\theta_3\bar{\theta}_2\bar{\theta}_1\theta_0$

else if cs <= "01000" then

ns <= "01001"

else if cs <= "00011" then

ns(4) <= $\theta_3\bar{\theta}_1\bar{\theta}_1\bar{\theta}_0 z_1$

ns(3) <= '0'

ns(2) <= '1'

ns(1) <= $\theta_3\bar{\theta}_2\bar{\theta}_1\bar{\theta}_0 z_1$

ns(0) <= $\bar{\theta}_3\bar{\theta}_2\bar{\theta}_1\theta_0$ [$c\bar{z}\bar{c}_1 + \bar{c}z\bar{z}_1) + \theta_3\bar{\theta}_2\theta_1\bar{\theta}_0$ [$c\bar{z}\bar{c}_1 + \bar{c}z\bar{z}_1$] + $\theta_3\bar{\theta}_2\bar{\theta}_1\bar{\theta}_0\bar{z}_1$

sw - 10111

sz - 11010

sv - 10110

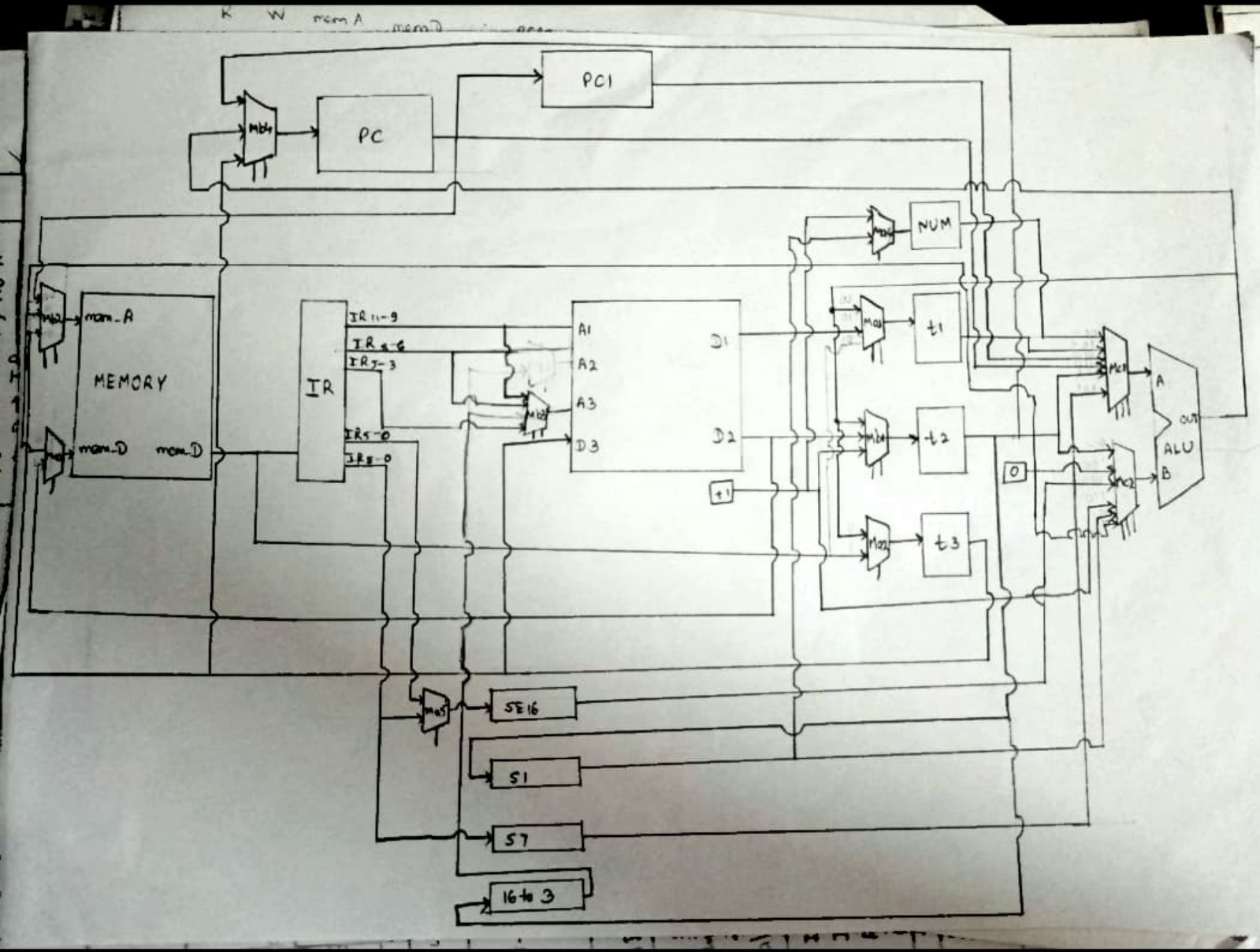
sd - 00100

se - 00101

```
elsif ps <= "00101" then
    ns <= "00000"
elsif ps <= "01101" then
    ns <= "00100"
elsif ps <= "01110" then
    ns <= "01111"
elsif ps <= "00111" then
    ns(4) <= '1'.
    ns(3) <= '0'
    ns(2) <= '0'
    ns(1) <= θ3θ2θ1θ0
    ns(0) <= θ3θ2θ1θ0.
elsif ps <= "11000" then
    ns <= "11001"
elsif ps <= "01001" then
    ns(4) <= '1'
    ns(3) <= '0'
    ns(2) <= θ3θ2θ1θ0.
    ns(1) <= θ3θ2θ1θ0
    ns(0) <= '1'
elsif ps <= "10011" then
    ns <= "10100"
elsif [ps <= "10101" or ps <= "10100"] then
    ns <= "01010"
```

ST - 10010
SQ - 10001
SW
SS - 10011
SU - 10101

```
else if cs <= "01010" then
        ns <= "01011".
else if cs <= "01011" then
        ns <= "01001".
else if cs <= "10001"
        ns <= "00110".
else if [cs <= "10110" or cs <= "00100" or cs <= "011111" or
                cs <= "10010" or cs <= "11001" or
                cs <= "10111" or cs <= "11010"] then
    ns <= "00000"
```


PC1
PC
NUM
MEMORY
mem_A
mem_D
IR
IR 11-9
IR 8-6
IR 5-3
IR 5-0
IR 8-0
A1
A2
A3
D3
D1
D2
t1
t2
t3
+1
0
A
B
ALU
OUT
SE16
S1
S7
16 to 3

	R	W	Mem_a	Mem_d	RE_A2	REA3	pc	RW	T1	T2	T3	aluA	aluB	Z	c	SE16	NVM
Sa			00				01					011	011				
Sb									1	00							
Sc											0	000	000				
Sd						10											
Se																	
Sf						00											
Sg											0	100	010			0	
Sh										10							0
Si											0	000	010			1	1
Sj										00		100	101				
Sk									00	00		000	101				
Sl	x																
Sm	-											000	100				
Sn												000	010		0		
So						01											
Sp											0	101	001				
Sq			10								1						
Sr			10	0													
Ss			01						10								
St	x																
Su			01	1													
Sv							10				0	010	010		0		
Sw							01					010	010		1		
Sx											0	000	010		1		