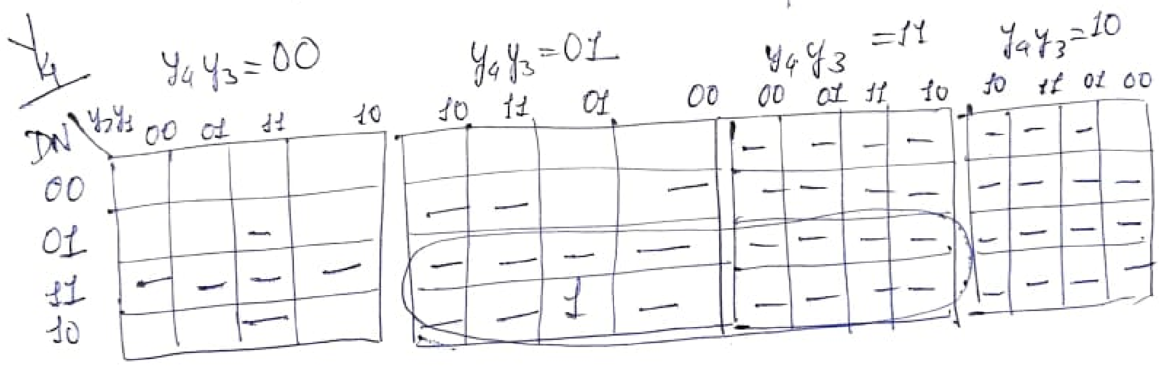
ASSIGNMENT-4
ANANNYA MATHUR
2019TT10953

Problem 8.8:
Derive the circuits that implement the state tables in Figures 8.55 and 8.56. Compare the costs of these circuits.
ANSWER:
Figure 8.55:

Present state	Next state				Output
	$DN = 00$	01	10	11	z
S1	S1	S3	S2	–	0
S2	S2	S4	S5	–	0
S3	S3	S6	S7	–	0
S4	S1	–	–	–	1
S5	S3	–	–	–	1
S6	S6	S8	S9	–	0
S7	S1	–	–	–	1
S8	S1	–	–	–	1
S9	S3	–	–	–	1

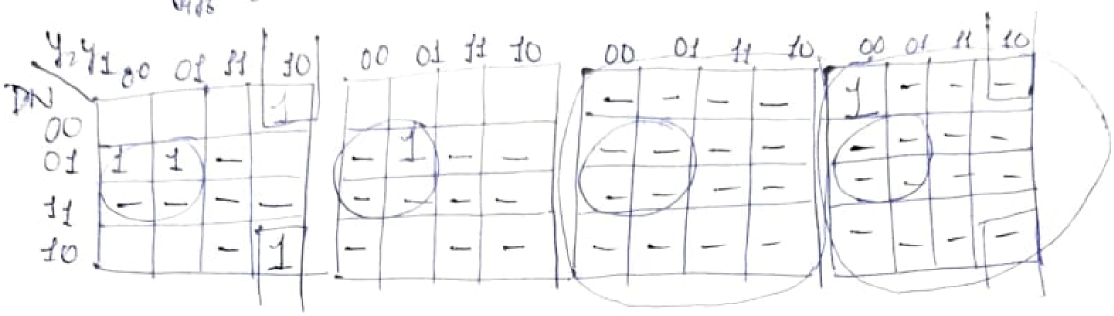
Present state $y_4y_3y_2y_1$	Next state $Y_4Y_3Y_2Y_1$, DN = 00	01	10	11	Output z
0000	0000	0010	0001	–	0
0001	0001	0011	0100	–	0
0010	0010	0101	0110	–	0
0011	0000	–	–	–	1
0100	0010	–	–	–	1
0101	0101	0111	1000	–	0
0110	0000	–	–	–	1
0111	0000	–	–	–	1
1000	0010	–	–	–	1



$\therefore Y_4 = D y_3$

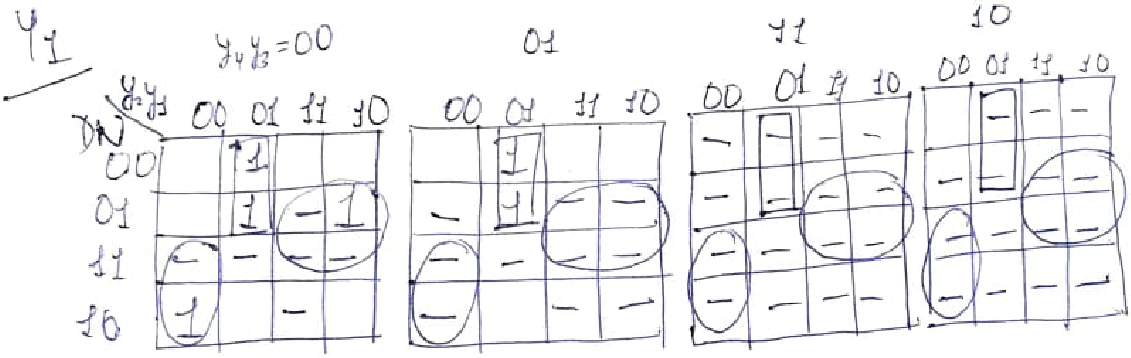
$$Y_3 = \bar{D} y_3 \bar{y}_2 y_1 + N y_2 + D y_2 + D \bar{y}_3 y_1$$

Y_2



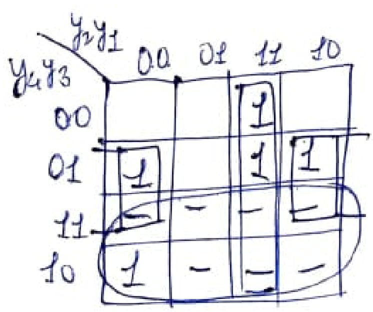
$$Y_2 = N\overline{y_2} + \overline{N}\,\overline{y_3}\,y_2\overline{y_1} + y_4$$

Y_1



$$Y_1 = D\overline{y_2}\,y_1 + Ny_2 + D\overline{y_2}\,\overline{y_1}$$

Output Z



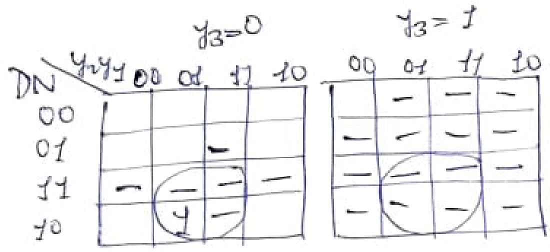
$$Z = y_3\overline{y_1} + y_1y_2 + y_4$$

Figure 8.56:

Present state	Next state				Output z
	$DN = 00$	01	10	11	
S1	S1	S3	S2	—	0
S2	S2	S4	S5	—	0
S3	S3	S2	S4	—	0
S4	S1	—	—	—	1
S5	S3	—	—	—	1

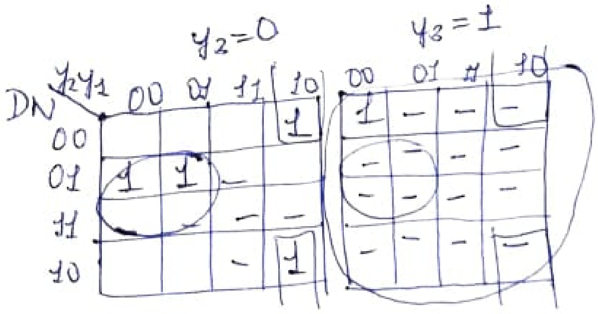
Present state $y_3 y_2 y_1$	Next state $Y_3 Y_2 Y_1$ DN=00	01	10	11	Output z
000	000	010	001	–	0
001	001	011	100	–	0
010	010	001	011	–	0
011	000	–	–	–	1
100	010	–	–	–	1

Y_3



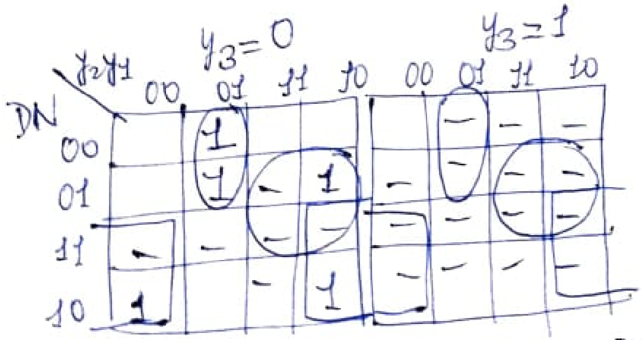
$$Y_3 = D y_1$$

Y_2



$$Y_2 = N \bar{y}_2 + \bar{N} y_2 \bar{y}_1 + y_3$$

Y_1



$$Y_1 = \bar{D} \bar{y}_2 y_1 + N y_2 \cancel{y_1} + D \bar{y}_1$$

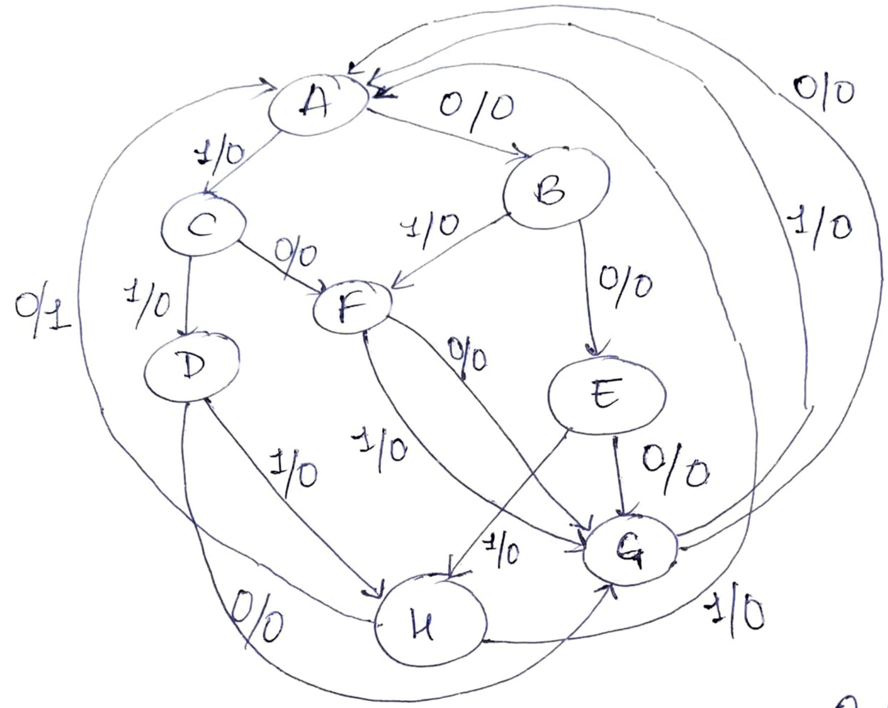
Output z

y_3 \ $y_2 y_1$	00	01	11	10
0			1	
1	1	-	-	-

$$z = y_3 \cancel{z} + y_2 y_1$$

Hence, these expressions define a much cheaper circuit than the Figure 8.55.

PROBLEM 8.11:
State A represents reset.
States F and G represent incorrect sequences.



Present state	Next state $w=0$	Next state $w=1$	Output z $w=0$	Output z $w=1$
A	B	C	0	0
B	E	F	0	0
C	F	D	0	0
D	G	H	0	0
E	G	H	0	0
F	G	G	0	0
G	A	A	0	0
H	A	A	1	0

STATE PARTITIONING :

(A B C D E F G H)

(ABCDE FG) (H)

(ABC FG) (DE) (H)

(ACFG) (B) (DE) (H)

(AFG) (C) (B) (DE) (H)

(FG) (A) (C) (B) (DE) (H)

(F) (G) ((A)) (C) (B) (DE) (H)

∴ D and E are equivalent.

Min state stable for Mealy-type FSM :

Present state	Next state w=0	Next state w=1	Output w=0	Output w=1
A	B	C	0	0
B	D	F	0	0
C	F	D	0	0
D	G	H	0	0
F	G	G	0	0
G	A	A	0	0
H	A	A	1	0

Problem 8.18:

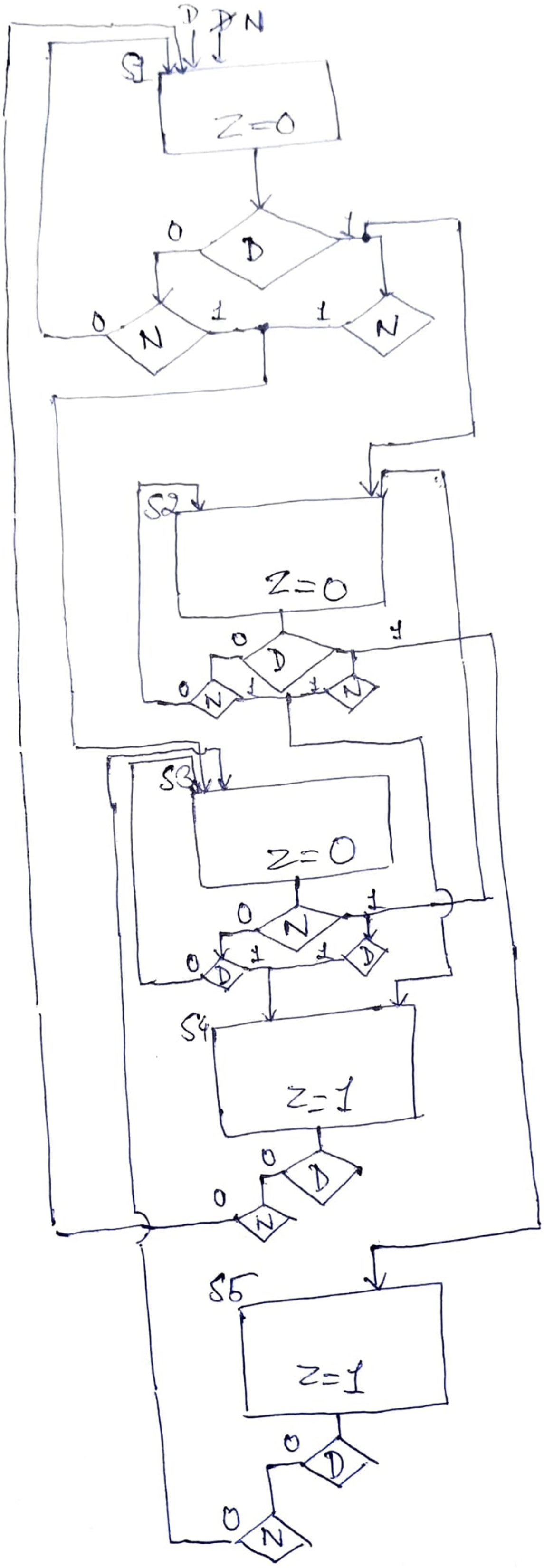
Present state	Next state $w=0$	Next state $w=1$	Output z $w=0$	Output z $w=1$
A	B	C	0	0
B	D	–	0	1
C	F	E	0	1
D	B	G	0	0
E	F	C	0	1
F	E	D	0	1
G	F	–	0	0

$P_1 = (ABCDEFG)$
$P_2 = (ADG)(BCEF)$
$P_3 = (ADG)(B)(CEF)$
$P_4 = (AD)(G)(B)(CEF)$
$P_5 = (A)(D)(G)(B)(CE)(F)$

$\therefore$ 6 states in all.
CE are equivalent.

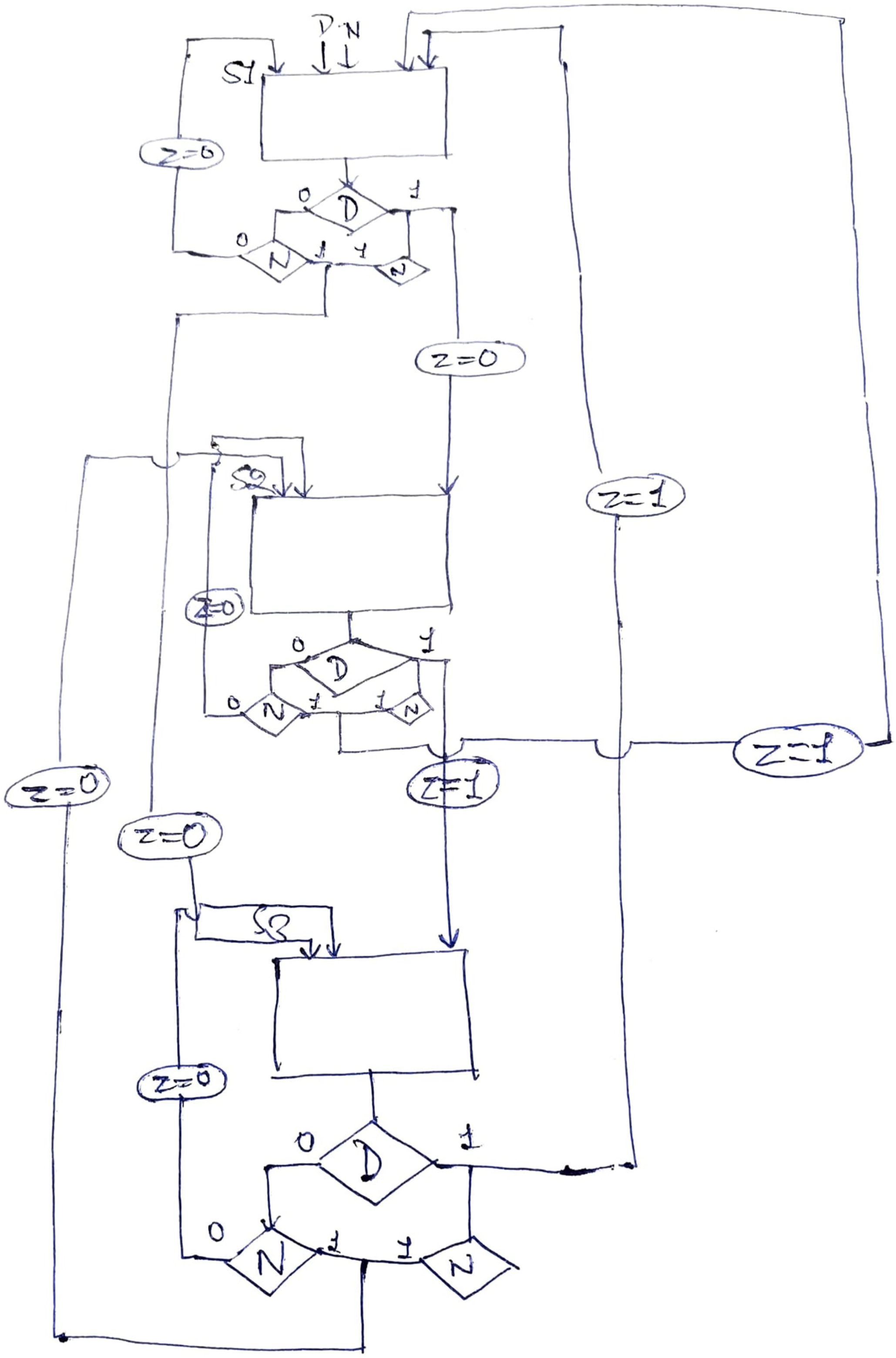
Present state	Next State $w=0$	Next State $w=1$	Output $w=0$	Output $w=1$
A	B	C	0	0
B	D	–	0	1
C	F	C	0	1
D	B	G	0	0
F	C	D	0	1
G	F	–	0	0

Problem 8.36:

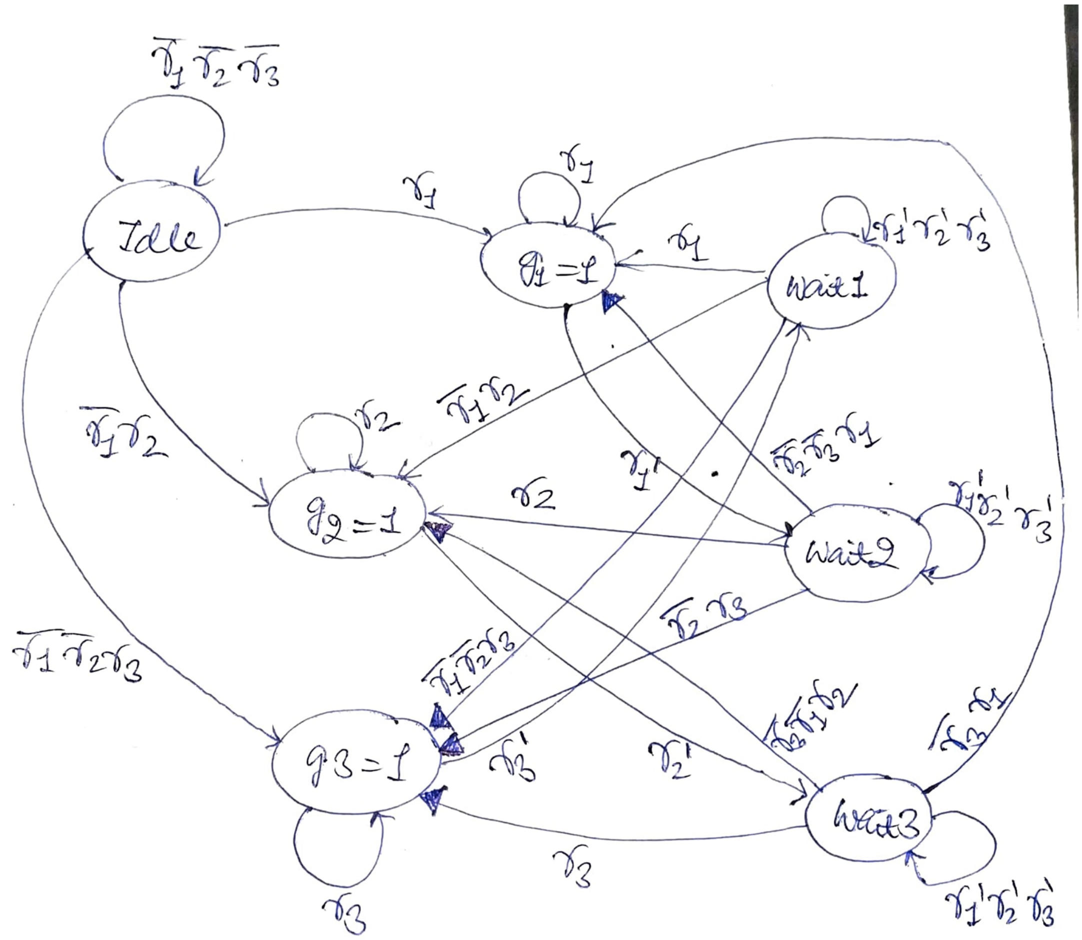


D
D
N
S1
Z=0
0
D
1
0
N
1
1
N
S2
Z=0
0
D
1
0
N
1
1
N
S3
Z=0
0
N
1
0
D
1
1
D
S4
Z=1
0
D
0
N
S5
Z=1
0
D
0
N

Problem 8.37:



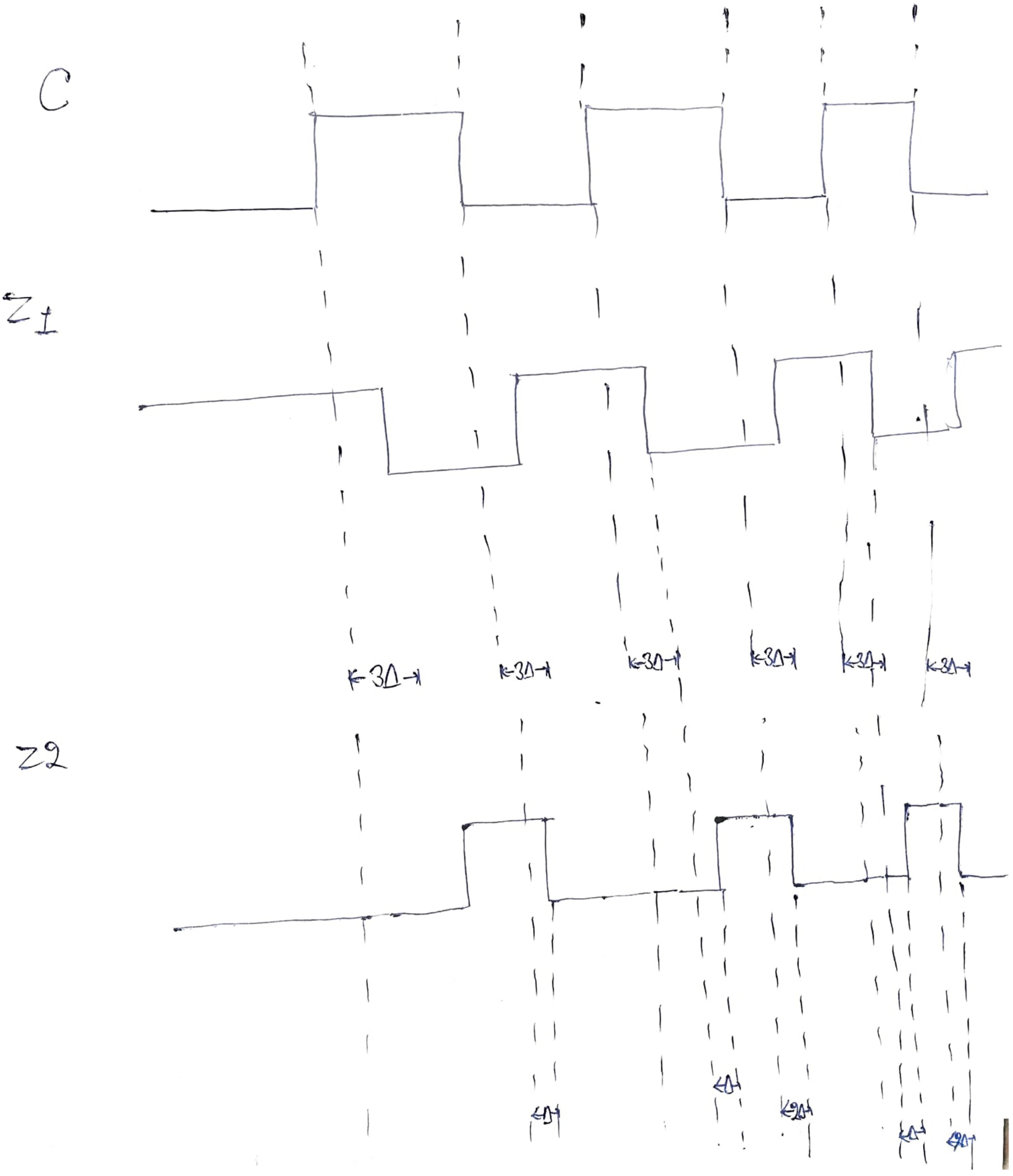
Problem 8.38



I have made use of rotating priorities.

PROBLEM 9.2:

$$z_2 = \overline{\overline{C} + z_1}$$
$$= C \cdot \overline{z_1}$$
$$z_1 = \overline{C \cdot \overline{z_1} + C}$$
$$= \overline{C}$$



Present state $z_2 z_1$		Next state C=0	C=1	Output $z_2 z_1$ C=0	C=1
0	0	01	10	01	10
0	1	01	00	01	00
1	0	01	10	01	10
1	1	01	00	01	00

Present state	Next state C=0	C=1	Output C=0	C=1
A	B	C	01	10
B	B	A	01	00
C	B	C	01	10
D	B	A	01	00

PROBLEM 9.3

P1 = (ABCDEFGHJMPRT)(IKLNOSUV)
P2 = (ADG JMPT)(BEHR)(ILOSV)(KNU)(CF)
P3 = (ADGJP)(MT)(BEH)(R)(ILOSV)(KNU)(C)(F)
P4 = (A)(GJP)(D)(MT)(B)(EH)(R)(ILOSV)(KNU)(C)(F)
P5 = (A)(G)(J)(P)(D)(MT)(B)(E)(H)(R)(ILOSV)(KNU)(C)(F)

Present state	Next state w_2w_1=00	01	10	11	Output
A	A	B	C	–	0
B	D	B	–	–	0
C	P	–	C	–	0
D	D	E	F	–	0
E	G	E	–	–	0
F	M	–	F	–	0
G	G	H	I	–	0
H	J	H	–	–	0
I	A	–	I	–	1
J	J	K	I	–	0
K	A	K	–	–	1
M	M	K	I	–	0
P	P	R	I	–	0
R	M	R	–	–	0

Partially minimised flow table
I and K = compatible states
F and R = compatible states

Present state	Next state $w_2w_1 = 00$	01	10	11	Output
A	A	B	C	—	0
B	D	B	—	—	0
C	P	—	C	—	0
D	D	E	F	—	0
E	G	E	—	—	0
F	M	—	F	—	0
G	G	H	I	—	0
H	I	H	—	—	0
I	A	—	I	—	1
J	J	I	I	—	0
M	M	I	I	—	0
P	P	F	I	—	0

Minimal flow table

PROBLEM 9.4:

(A B C E F G I L) (D H K M)

(AF) (BEGL) (CJ) (DK) (HM)

(AF) (BG) (EL) (CJ) (DK) (HM)

(A) (F) (BG) (EL) (CJ) (DK) (HM)

Present state	Next state $w_2w_1 = 00$	01	10	11	Output
A	A	B	C	—	0
B	D	B	—	H	0
C	F	—	C	H	0
D	D	E	C	—	1
E	A	E	—	H	0
F	F	E	C	—	0
H	—	B	C	H	1

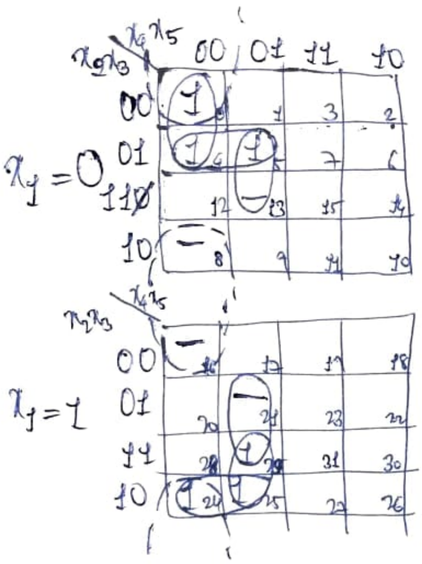
Partially minimised state

~~(B, H)~~, ~~(A, H)~~, (C, F) is a ~~are~~ compatible states.

Minimal flow table :

Present state	Next state $w_2 w_1 = 00$	01	10	11	Output
A	A	B	C	–	0
B	D	B	–	H	0
C	~~A~~C	–	C	H	0
D	D	E	C	–	1
E	A	E	–	H	0
H	–	B	C	H	1

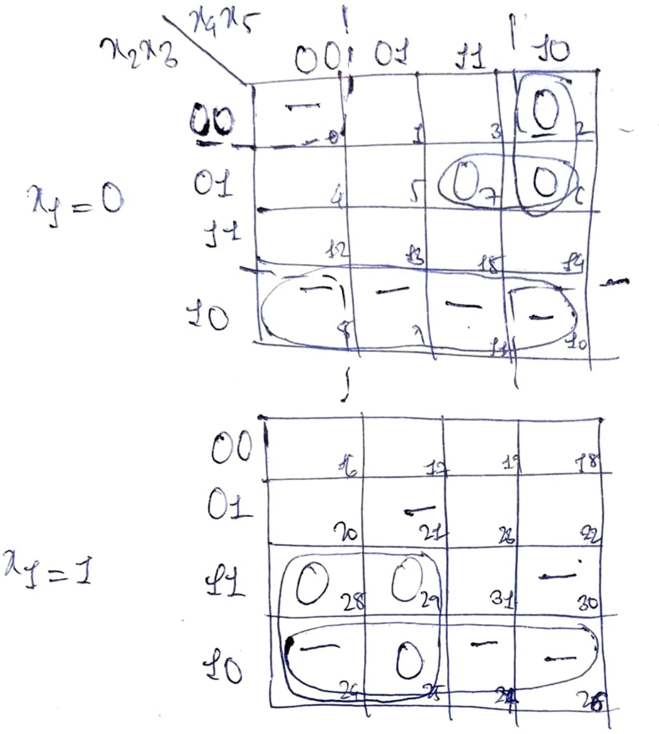
PROBLEM 9.11:



$$= \overline{x_1}\,\overline{x_2}\,\overline{x_4}\,\overline{x_5} + \overline{x_2}\,x_3\,\overline{x_1}\,\overline{x_4} + x_3\,\overline{x_4}\,x_5 + x_1 x_2 \overline{x_4} x_5 + \cancel{x_1 \overline{x_2} x_3}\, x_1 x_2 \overline{x_3}\,\overline{x_4} + \overline{x_3}\,\overline{x_4}\,\overline{x_5}$$

$$= \overline{x_1}\,\overline{x_2}\,\overline{x_4}\,\overline{x_5} + \overline{x_2}\,x_3\,\overline{x_1}\,\overline{x_4} + x_3\,\overline{x_4}\,x_5 + x_1 x_2 \overline{x_4} x_5 + x_1 x_2 \overline{x_3}\,\overline{x_4} + \overline{x_3}\,\overline{x_4}\,\overline{x_5}$$

Problem 9.13:



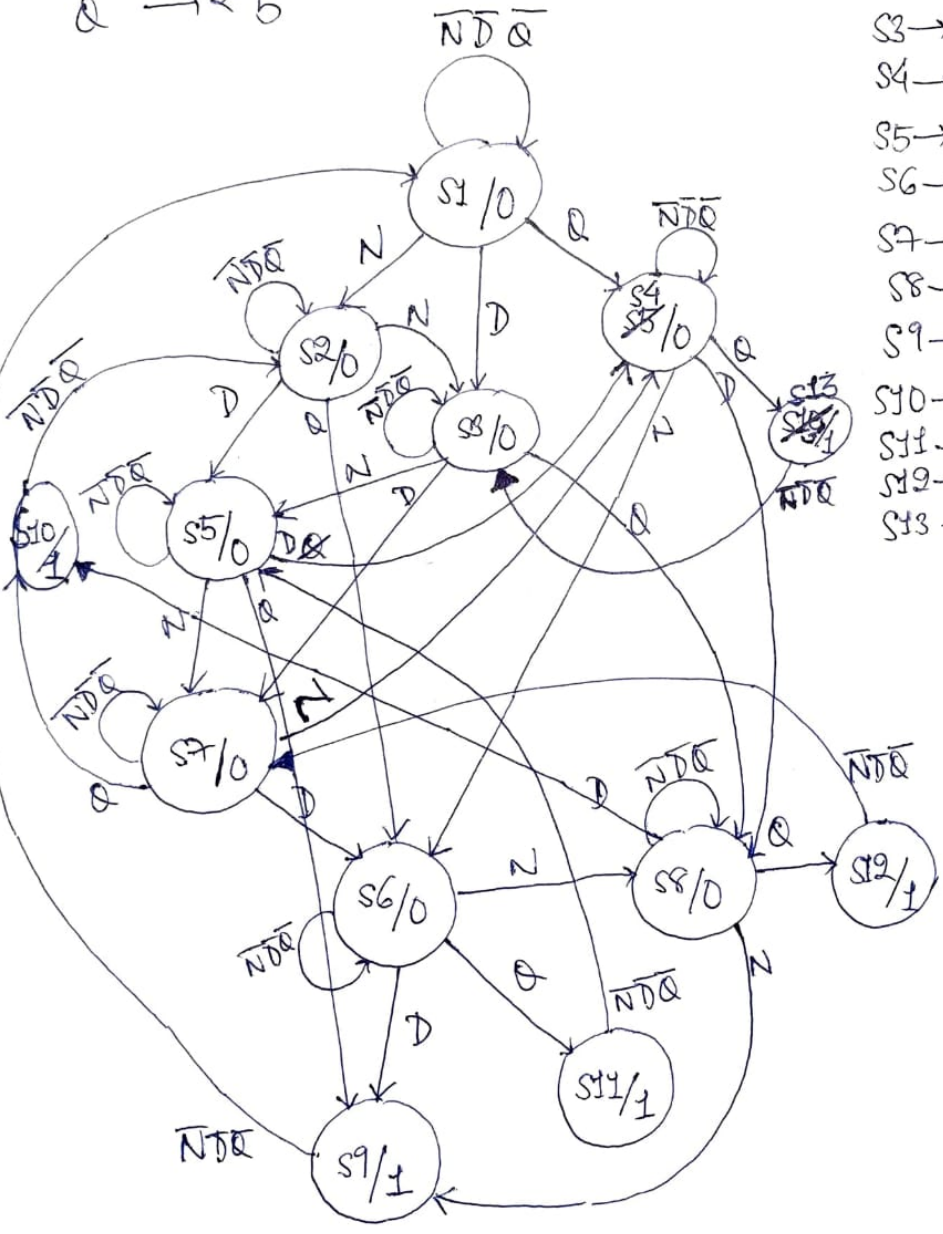
$$= \cancel{\overline{x_1}\,\overline{x_2}\,x_3\,x_4 +}$$

$$= (\overline{x_1} + \overline{x_2} + x_3 + x_4) \cdot (\overline{x_1} + \overline{x_2} + x_4 + \overline{x_5}) \cdot$$
$$(\overline{x_1} + \overline{x_3} + \overline{x_5}) \cdot (x_2 + \overline{x_3}) \cdot (x_1 + x_2 + \overline{x_4})$$

EXAMPLE 8.6:

N → ₹1
D → ₹2
Q → ₹5

S1 → ₹0
S2 → ₹1
S3 → ₹2
S4 → ₹5
S5 → ₹3
S6 → ₹6
S7 → ₹4
S8 → ₹7
S9 → ₹8
S10 → ₹9
S11 → ₹11
S12 → ₹12
S13 → ₹10



Present State	NDQ = 000	001	010	011	100	101	110	111	Output Z
S1	S1	S4	S3	-	S2	-	-	-	0
S2	S2	S6	S5	-	S3	-	-	-	0
S3	S3	S8	S7	-	S5	-	-	-	0
S4	S4	S13	S8	-	S6	-	-	-	0
S5	S5	S9	S4	-	S7	-	-	-	0
S6	S6	S11	S9	-	S8	-	-	-	0
S7	S7	S10	S6	-	S4	-	-	-	0
S8	S8	S12	S10	-	S9	-	-	-	1
S9	S1	-	-	-	-	-	-	-	1
S10	~~S10~~ S2	-	-	-	-	-	-	-	1
S11	S5	-	-	-	-	-	-	-	1
S12	S7	-	-	-	-	-	-	-	1
S13	S3	-	-	-					

P1 = (S1, S2, S3, S4, S5, S6, S7, S8)(S9, S10, S11, S12, S13)

P2 = (S1, S2, S3)(S4, S5, S6, S7, S8)(S9, S10, S13)(S11, S12)

P3 = (S1)(S2, S3)(S4, S5, S7)(S6, S8)(S9)(S10, S13)(S11, S12)

P4 = (S1)(S2)(S3)(S7, S4)(S5)(S6)(S8)(S9)(S10)(S13)(S11)(S12)

P5 = (S1)(S2)(S3)(S7)(S4)(S5)(S6)(S8)(S9)(S10)(S13)(S11)(S12)

∴ No further reduction of states possible.