Question 1: 1010 sequence detector

When the sequence 1010 comes in consecutive clock periods, the circuit outputs a '1'. Otherwise it outputs a '0'.

We define 4 states:

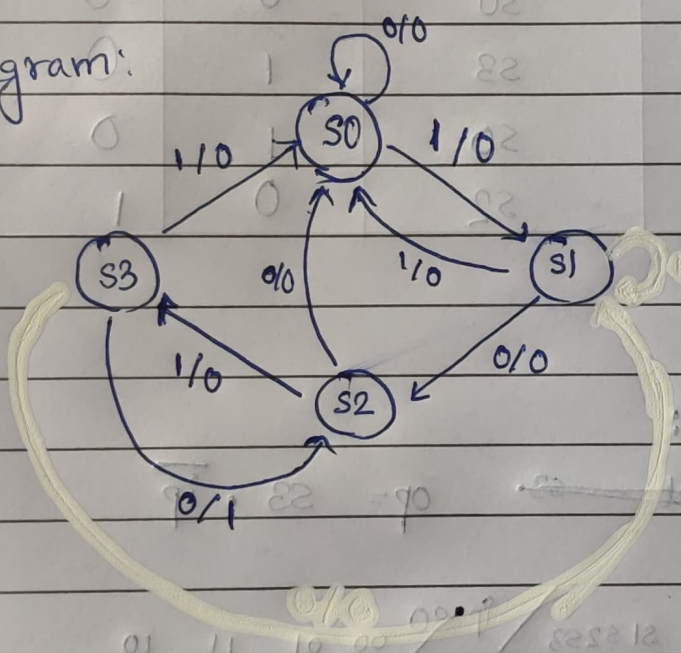
00 or S0 → The sequence has not yet started

01 or S1 → The sequence has detected the first 1

10 or S2 → The sequence has detected the second 0

11 or S3 → The sequence has detected the third 1.

State diagram:

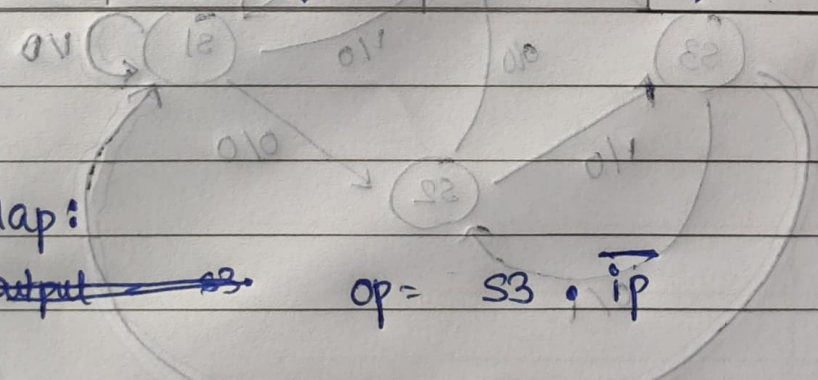


Transition and Output Table:

Present State \ Input	0		1	
	Next State	Output	Next State	Output
S0	S0	0	S1	0
S1	S2	0	S0	0
S2	S0	0	S3	0
S3	S2	1	S0	0

Excitation Table:

Present state	Next state	(ip) Input	(op) Output
S0	S0	0	0
S0	S1	1	0
S1	S2	1	0
S1	S2	0	0
S2	S0	0	0
S2	S3	1	0
S3	S0	1	0
S3	S2	0	1



K-Map:

~~Output = S3~~

$op = S3 \cdot \overline{ip}$

$S0 = S0 \cdot \bar{ip} + S1 \cdot ip + S2 \cdot \bar{ip} + S3 \cdot ip$

$S1 = S0 \cdot ip$

$S2 = S1 \cdot ip + S3 \cdot \bar{ip}$

$S3 = S2 \cdot \bar{ip}$

Logic: