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Paper 2
Question 1.

a) we could either use:
$M = 0, N = 0$
or
$M = 1, N = 1$

b)

Inputs MN	Current State Q	Next Q'
0 0	0	0
0 1	0	1
1 0	0	0
1 1	0	1
0 0	1	0
0 1	1	1
1 0	1	1
1 1	1	0

c) A Moore machine is appropriate since the output is only dependant on state

d) Let there be 3 flipflops $F_2 F_1 F_0$ where F_2 is the MSB

Current State $F_2 F_1 F_0$	Input Next State $F_2' F_1 F_0$
0 0 0	0 0 1
0 0 1	0 1 0
0 1 0	0 1 1
0 1 1	1 0 0
1 0 0	1 0 1
1 0 1	1 1 0
1 1 0	0 0 0

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e) Let $M_i N_i$ be the inputs for F_i

Current State $F_2 F_1 F_0$	Next State $F_2 F_1 F_0$	Controls $M_2 N_2$	$M_1 N_1$	$M_0 N_0$
000	001	00	10	11
001	010	00	11	11
010	011	00	10	11
011	100	01	11	11
100	101	01	10	11
101	110	01	11	11
110	000	00	01	10

f) For the inputs M_i: all M_i are either ~~0 or 1~~ always 0 or always 1. So no logic is needed to compute them. So I will not draw K-maps for them.

N_2 | $F_2 F_1$

F_0	00	01	11	10
0	0	0	0	1
1	0	1	X	1

$N_2 = F_2 \bar{F}_1 + F_1 F_0$

$M_2 = 0$

~~$N_2 = F_2 F_1 + \bar{F}_2 F_1 F_0$ $M_2 = 0$~~

N_1 | $F_2 F_1$

F_0	00	01	11	10
0	0	0	1	0
1	1	1	X	1

~~$N_1 =$~~

~~$N_1 = \bar{F}_2 F_0 + \bar{F}_1 F_0 + F_2 F_1 \bar{F}_0$~~

$N_1 = F_0 + F_2 F_1$

$M_1 = 1$

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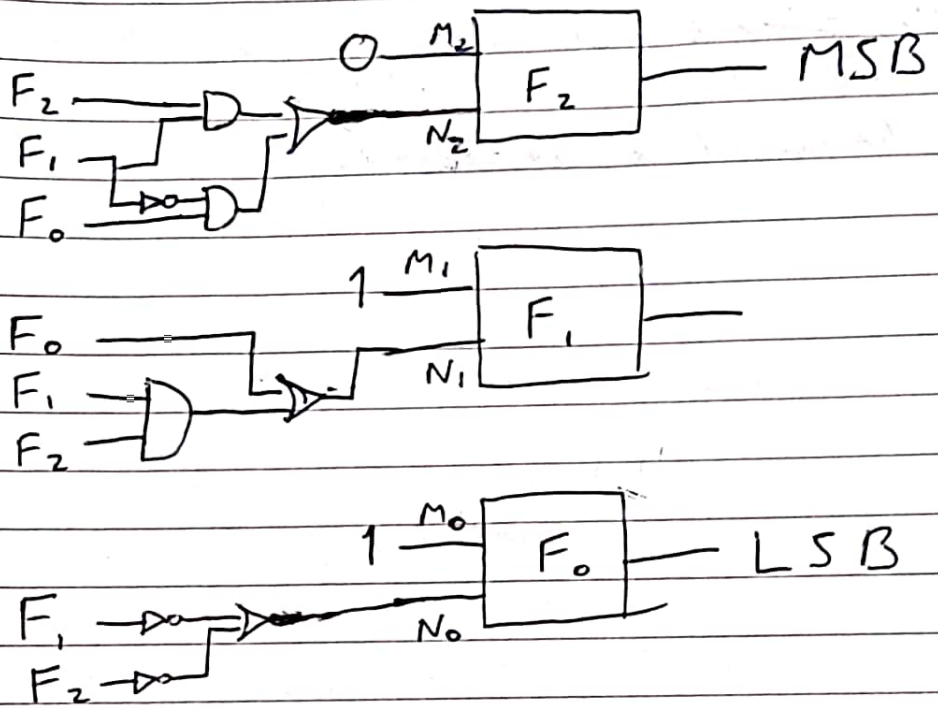
N_0

F_0 \ F_2F_1	00	01	11	10
0	1	1	0	1
1	1	1	x	1

$N_0 = \overline{F_2} + \overline{F_1}$

$M_0 = 1$

v)



Some of these circuits could be simplified with NAND and NOR. This would speed them up. But for clarity I've not included this: i.e

$N_0 = F_1 \text{ NAND } F_2$

$N_2 = (F_2 \text{ NAND } F_1) \text{ NAND } (\overline{F_1} \text{ NAND } F_0)$

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iv) The only invalid state is 111.

If $F_2 F_1 F_0 = 111$,
~~the next state is~~
$M_2 = 0, N_2 = 1 \Rightarrow F_2' = 1$
$M_1 = 1, N_1 = 1 \Rightarrow F_1' = 0$
$M_0 = 1, N_0 = 0 \Rightarrow F_0' = 1$

So the circuit will ~~enter~~ go to 101 -- a valid state.
So the circuit is self starting.