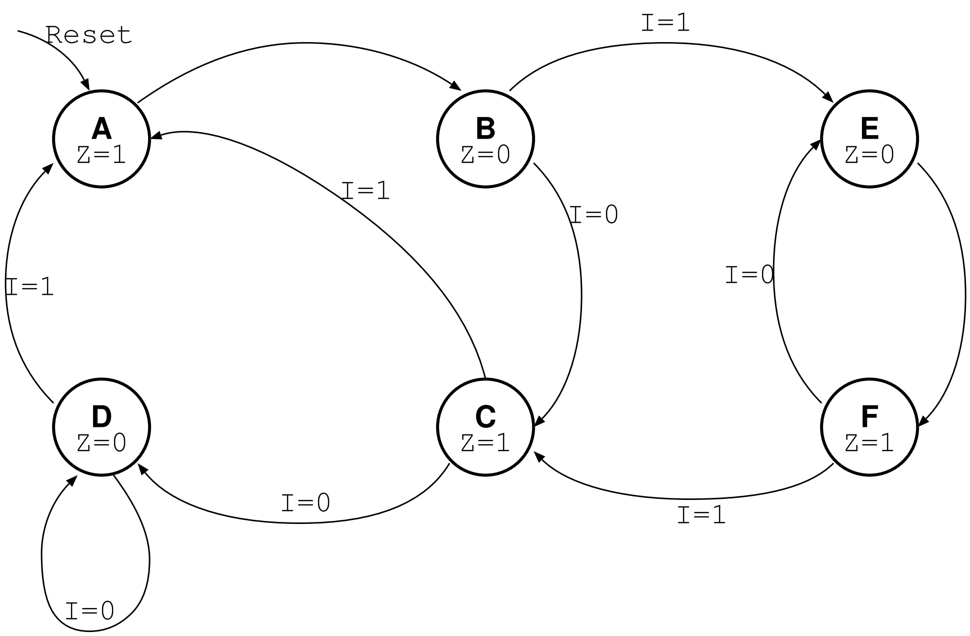
2. Consider the following state diagram of an FSM with 1-bit input (I) and 1-bit output (Z).



The state has been coded using a 3-bit vector $S = S_2\,S_1\,S_0$ according to the following table:

State			
name	S_2	S_1	S_0
A	0	0	0
B	0	0	1
C	0	1	0
D	0	1	1
E	1	0	0
F	1	0	1

(a) (1 point) Is this a Moore or Mealy type FSM? Briefly explain.

Solution: Moore, outputs depend only on the present state and nothing else.

(b) (6 points) Fill in the following state transition table that determines the next state vector $N = N_2\,N_1\,N_0$ based on the current state S and the input I.

State				Input	Next State			
name	S_2	S_1	S_0	I	name	N_2	N_1	N_0
A	0	0	0	X	B	0	0	1
B	0	0	1	0	C	0	1	0
B	0	0	1	1	E	1	0	0
C	0	1	0	0	D	0	1	1
C	0	1	0	1	A	0	0	0
D	0	1	1	0	D	0	1	1
D	0	1	1	1	A	0	0	0
E	1	0	0	X	F	1	0	1
F	1	0	1	0	E	1	0	0
F	1	0	1	1	C	0	1	0

Note that there are different ways of writing this table to represent the same result.

(c) (3 points) Write the Next State Equations from the table you have filled above using either *Product of Sums (POS)* or *Sum of Products (SOP)* form. **Do not spend time minimizing the equations, this will be next question**.

Solution:

$N_0 = \overline{S_2}\,\overline{S_1}\,\overline{S_0} + \overline{S_2}\,S_1\,\overline{S_0}\,\overline{I} + \overline{S_2}\,S_1\,S_0\,\overline{I} + S_2\,\overline{S_1}\,\overline{S_0}$

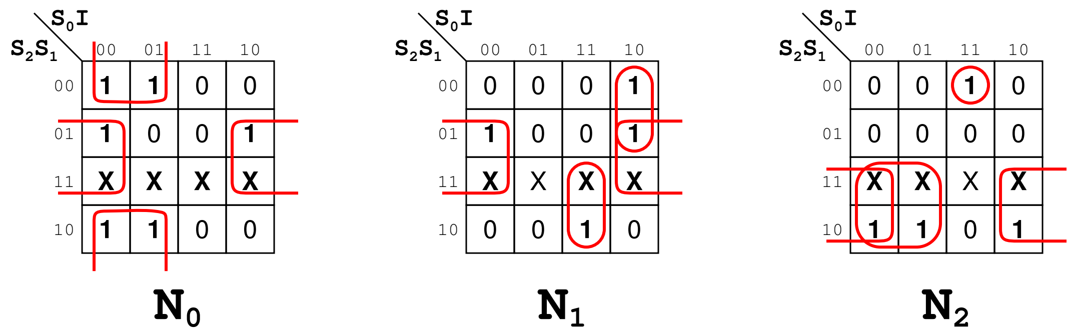
$N_1 = \overline{S_2}\,\overline{S_1}\,S_0\,\overline{I} + \overline{S_2}\,S_1\,\overline{S_0}\,\overline{I} + \overline{S_2}\,S_1\,S_0\,\overline{I} + S_2\,\overline{S_1}\,S_0\,I$

$N_2 = \overline{S_2}\,\overline{S_1}\,S_0\,I + S_2\,\overline{S_1}\,\overline{S_0} + S_2\,\overline{S_1}\,S_0\,\overline{I}$

(d) (6 points) Minimize the Next State Equations from the previous part. Note that the FSM requires only six states. This means that there are several State (S) / Input(I) combinations for which the outputs can be treated as *Don't Care*, which should help minimizing the boolean equations.
Hint: Consider using Karnaugh diagrams to solve this problem.

Solution:

It is important to note that for $S_2\,S_1 = 11$ the next state N can be taken as $N_2\,N_1\,N_0 = XXX$. This can simplify the Boolean equations significantly. It is best to use a Karnaugh map to find the simplifications.



$$N_0 = \overline{S_1}\,\overline{S_0} + S_1\,\overline{I}$$

$$N_1 = S_1\,\overline{I} + S_2\,S_0\,I + \overline{S_2}\,S_0\,\overline{I}$$

$$N_2 = S_2\,\overline{S_0} + S_2\,\overline{I} + \overline{S_2}\,\overline{S_1}\,S_0\,I$$