



ECE 281

Lesson 21 Notes

Objectives:

- Know the three main parts of any FSM
- Understand the differences between Mealy and Moore machines
- Know the five steps in FSM design and analysis, and be able to apply them
- Demonstrate the ability to use various state encodings in FSM design, but particularly on-hot encoding and binary encoding

Review

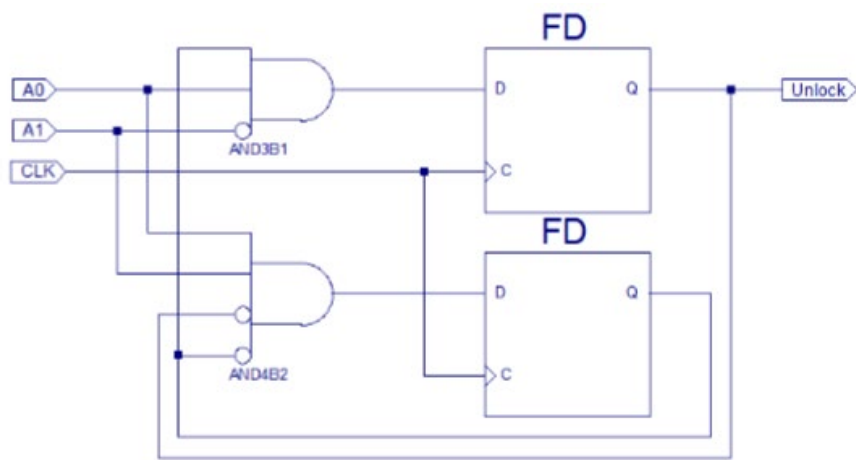
Over the last two lessons we talked about design of the **Moore and Mealy FSM**. Recall that both FSMs are sequential logic because the output depends on current and previous inputs. Today, we will essentially flip the last two lessons around, and instead of talking about design of a FSM, we will talk about analysis of a FSM.

How to design a state machine:

1. Description
2. State Transition Diagram
3. State Transition Table and Output Table
4. Next State and Output State Equations
5. Schematic

Finite State Machine (FSM) Analysis – Simple Garage Door Opener Example #1:

Analysis Step 1. – Schematic Analysis



Is this a Moore or Mealy Machine?

Thanks to

Analysis Step 2/3. – Produce Next State and Output State Equations and develop state transition and output tables

Next State Equations:

Output Equations

State / Output Table			
Current State		Output	State Name

Table 1 Next State table

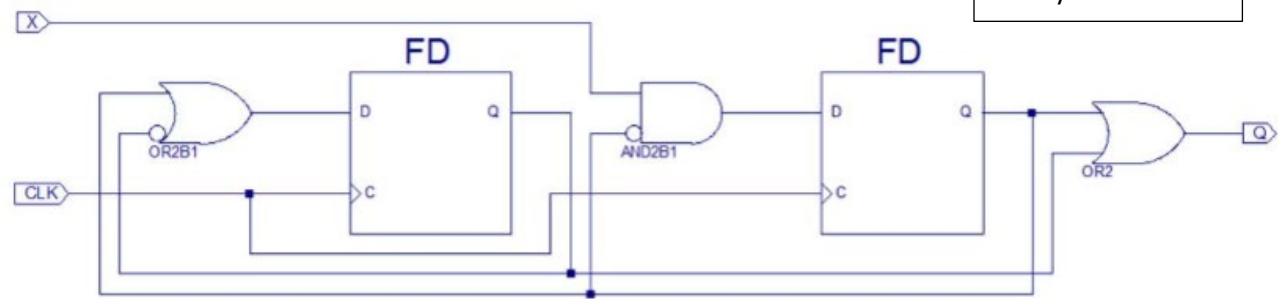
Current State		Inputs		Next State		Next State Name
S1	S0	A1	A0	S1*	S0*	
0	0	0	0			
0	0	0	1			
0	0	1	0			
0	0	1	1			
0	1	0	0			
0	1	0	1			
0	1	1	0			
0	1	1	1			
1	0	0	0			
1	0	0	1			
1	0	1	0			
1	0	1	1			
1	1	0	0			
1	1	0	1			
1	1	1	0			
1	1	1	1			

Analysis Step 4. – Produce State Transition Diagram

Analysis Step 5. – Describe the behavior of your finite state machine

Finite State Machine (FSM) Analysis – Take home practice Example #2:

Analysis Step 1. – Schematic Analysis



Analysis Step 2/3. – Produce Next State and Output State Equations and develop state transition and output tables

Table 2 Next State table

Next State Equations:

Current State		Inputs	Next State		Next State Name
S1	S0		S1*	S0*	
<div></div>					
<div></div>					
<div></div>					
<div></div>					

Output Equations

State / Output Table			
Current State		Output	State Name

Analysis Step 4. – Produce State Transition Diagram

Analysis Step 5. – Describe the behavior of your finite state machine

Up until now, our design and analysis of FSMs in class dealt solely with binary-encoding. We will now transition to a discussion on One-Hot Encoding that was presented in zyBooks reading 13.5

One-hot state encodings

From zyBooksA **one-hot encoding** uses N bits for N states, with each encoding having exactly one bit set to 1. A one-hot encoding uses more bits and thus a larger state register than a binary encoding, but may yield fewer gates, especially for relatively few states.

Example Design Problem with one hot encoding:

Design Step #1 – FSM Description: Design an FSM that represents a very simple soda machine that will only accept quarters and only sells Mountain Dew. As soon as you put in the proper amount of money, the soda machine will spit out a soda. The soda machine will not give change.

Design Step #2 - State Transition Diagram:

Design Step 3 - State Transition Table & Output Table:

Current State			Input	Next State		
S2	S1	S0	C	S2*	S1*	S0*

Current State			Output
S2	S1	S0	D

Design Step 4 - Next State and Output State Equations:

Design Step 5 – Schematic:

I