Practice Problems - Lab 4: Motor Drive Circuit

Flip-flops

1. What are flip-flops? What are they used for in digital electronics?

2. (True or False) Flip-flops are considered combinational logic digital devices.

3. How many inputs and outputs does a flip-flop have?

4. What is the difference between the preset signal and the clear signal? What are they used for?

5. Explain the function of the clock signal and how its behavior affects the flip-flop.

Finite State Machines

1. What are finite state machines? What are they used for?

2. What kind of logic do finite state machines use?

3. What are state diagrams? What do they consist of?

4. What is a state transition table?

5. What important component do finite state machines use in every design?

6. If we desire to build a 2-bit counter that follows the sequence 00→11→10→11 and then repeats itself, how many flip-flops will we need for this finite state machine design?

    a. Draw a state diagram.
    b. Create a state transition table. Also, find the logic equations for the D output(s) of the flip-flop(s).
    c. Design, on paper, the combinational logic portion for this counter.
    d. Include the flip-flop(s) to your design from part c to create the full design of the counter.
    e. Implement your counter design on your DEB using LEDs for the Q outputs. Take a picture of your breadboard design.

Solutions

Flip-flops

Question 1:

In digital electronics, flip-flops are memory devices used for storing data synchronously.

Question 2:

False. Flip-flops are sequential logic devices, meaning that the previous state of inputs as well as the current state of inputs affects the state of the outputs.

Question 3:

Generally, A flip-flop has four input signals and one output signal.

Question 4:

The difference between the preset signal and the clear signal is that the preset signal, when true, sets the Q output of the flip-flop to 1 or high. On the other hand, the clear signal, when true, sets the Q output of the flip-flop to 0 or low.

Question 5:

The clock signal of a flip-flop controls when the output changes and when data is preserved. If the flip-flop is positive-edge triggered, then when a rising edge is encountered by the clock, the output of the flip-flop changes. As long as the clock does not encounter a rising edge, the data in the flip-flop will be preserved. If, on the other hand, the flip-flop is negative-edge triggered, a falling edge of the clock will cause a change of the outputs.

Finite State Machines

Question 1:

Finite state machines are circuits whose outputs depend on both the previous state of the inputs and the current of the inputs. Usually, state machines are used for applications that follow a specific sequence of outputs like a counter.

Question 2:

Finite state machines use both combinational logic and sequential logic.

Question 3:

State diagrams are illustrations that show the sequence that a certain state machine implementation will follow. These diagrams consist of nodes representing states and arrows that indicate the state transitions.

Question 4:

A state transition table is similar to a truth table that shows the current state of the flip-flops, which are the Q outputs, and the next state of the flip-flops, which are the D inputs.

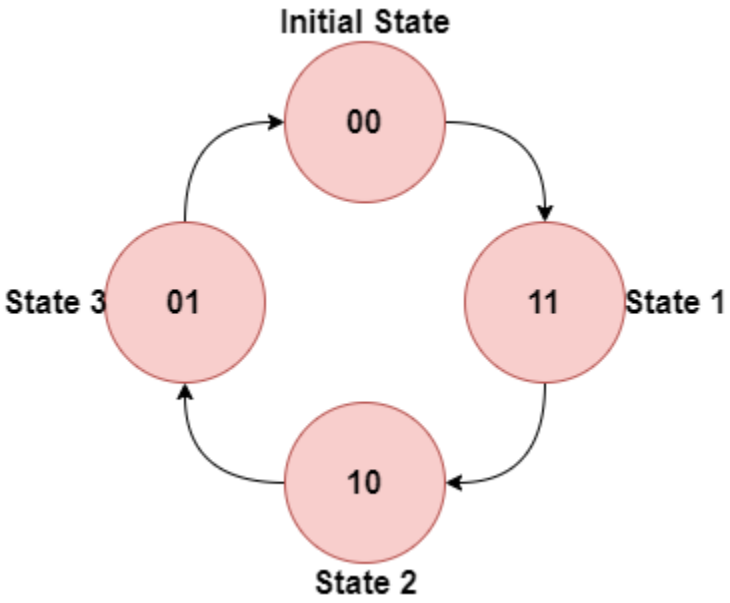
Question 5:

Finite state machines use flip-flops for the sequential logic portion of their design.

Question 6:

2 flip-flops.

a.

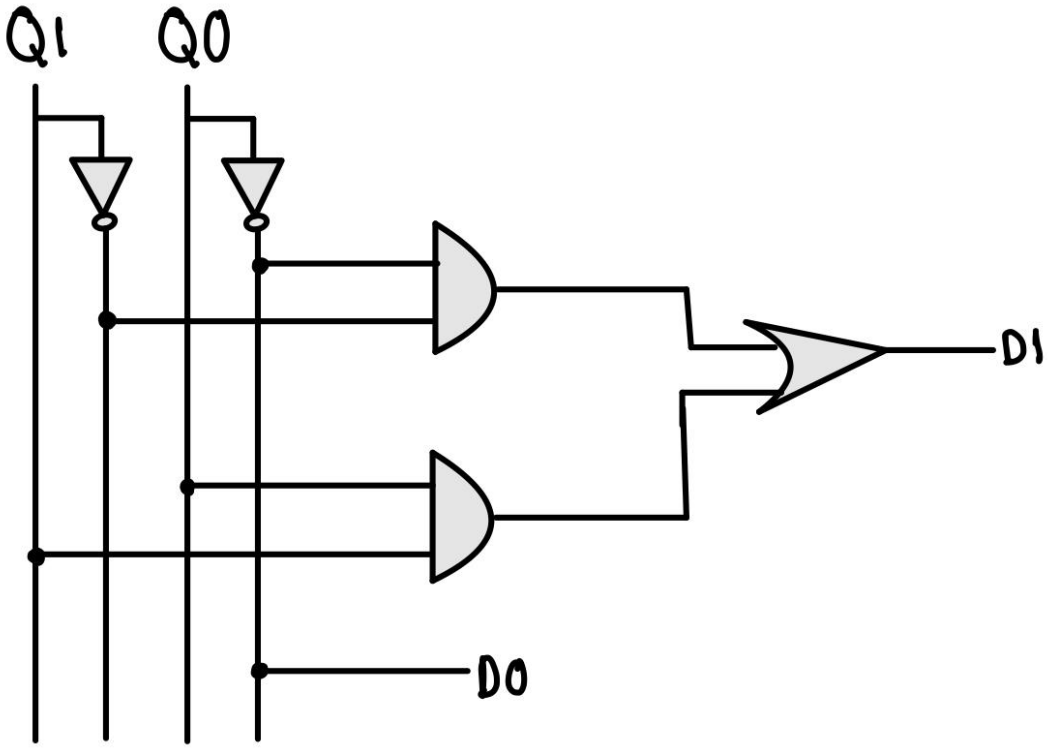


b.

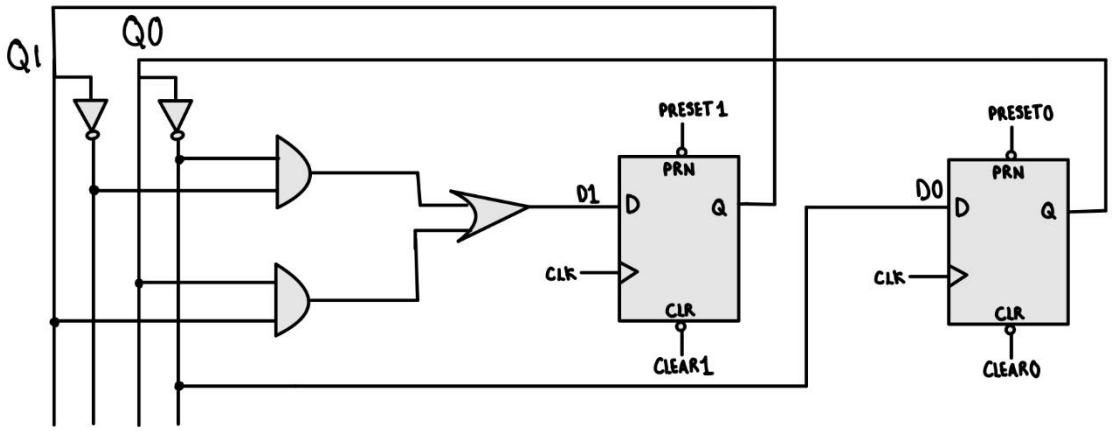
Current State		Next State	
Q1	**Q0**	**D1**	**D0**
0	0	1	1
1	1	1	0
1	0	0	1
0	1	0	0

$$D1 = /Q1 * /Q0 + Q1 * Q0$$
$$D0 = /Q0$$

c.



d.



e.