

# Computer Structure Assignment 4

## Sequential Systems

Carmi Merimovich

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When asked to build a circuit you should supply:

1. A block diagram.
2. A circuit diagram.
3. A Verilog module with the **exact** signature as specified and with **identical** file name.

1. Use nand gates (only) to synthesis the  $\bar{S}\bar{R}$ -flipflop having the following characteristic table:

$\bar{S}$	$\bar{R}$	$Q^*$
0	0	?
0	1	1
1	0	0
1	1	$Q$

2. The following are the characteristic tables of the  $JK$ -FF and  $T$ -FF:

$J$	$K$	$Q(t+1)$
0	0	$Q$
0	1	0
1	0	1
1	1	$\bar{Q}$

$T$	$Q(t+1)$
0	$Q$
1	$\bar{Q}$

Calculate the characteristic equation and the excitation table of both FFs. Synthesis both FFs using  $D$ -FFs.

3. In the lecture there were two implementations of the 3-bit Gray counter. One with  $D$ -FFs and one with  $SR$ -FFs. Both implementations used decoder. Reimplement the circuits only with the basic gates. Be efficient.

4. In the lecture we saw a 1-hot implementation of the 3b Gray counter. Use the 'usual' binary coding with a decoder and encoder so as to be able to use identical equations to the 1-hot implementation.
5. Design a counter (using only gates) for the sequence of numbers 11-12-13-14. The counter should include three control lines:

reset: Resets the counter to the starting value (11).

count: Triggers the counting operation.

direction: Determines the counting direction: counts up when direction is 0 and counts down when direction is 1.

```
module counter_11_14 (
    output reg [3:0] q,    // 4-bit output representing the counter state
    input reset,           // Resets the counter to 11
    input count,           // Enables counting
    input direction        // 0 for up, 1 for down
);
```

6. Design and implement a Moore finite state machine (FSM) with two inputs, xt and yt, and one output, z. The inputs xt and yt are 2-bit representations of the letters a, b and c as follows: a = 00, b = 01, and c = 11. z is a 1-bit output set to 1 when the FSM detects a string starting and ending with the same letter, with identical intermediate letters that differ from the start and end letters. (e.g., abbba, cac, dbbd).

The sequences are disjoint.

```
module moore_fsm (
    output z,              // Output is 1 if the specified pattern (e.g., abbba, cac, c
    input [1:0]let,        // 2-bit input representing the current letter (a = 00, b = 01
    input wire reset,      // Reset signal to initialize the FSM
    input wire clk         // Clock signal for state transitions
);
```