CE 211
Digital Systems

Homework # 5

Note: To get the full mark, you need to show all the steps in details (Final answers are not acceptable).

Question 1: Design a synchronous BCD counter using JK flip-flops. (Show all the steps.)

Question 2: Design a G-L F.F. that behaves as follows:

- when G=0, the F.F. does not change its output state.
- when G=1, the output state of the F.F. is equal to L.

(a) Derive the characteristic equation of the G-L F.F.

(b) Convert S-R F.F. to G-L F.F.

Question 3: Design 3-bit synchronous counter that counts $0 \rightarrow 1 \rightarrow 2 \rightarrow 4 \rightarrow 7$ and back to zero. Also, when the counter starts from undefined state (i.e., states 3, 5, and 6), it jumps to state 0, and continues its operation. Obtain the state transition table and the K-Map's for each input of each flip-flop. Use J-K flip-flops. Draw the logic diagram of the counter.

Question 4: Design a sequence detector as a moore machine that can detect the pattern 101 using D-flip flops.

(a) Build the state graph for the machine.

(b) Find the number of FFs required.

(c) Build the state and the transition table of the machine and extend it to include the inputs of the FFs.

(d) Find the minimum SOP expression for each input of each flip-flop.

(e) Build the logic circuit of the sequence detector.

Question 5: Design a 4-bit synchronous counter that counts the prime integer numbers greater than one and less than 15. The counter shall start counting from the smallest prime integer up to the greatest prime integer in the above range. Once the counter reaches the greatest prim integer, it goes back and starts counting from the smallest prime integer. Use JK flip flops and any necessary logic gates to build this counter.

(a) Write down the excitation table of the J-K flip flops.

(b) Draw the state diagram of the counter.

(c) Specify how many flip flop required to build this counter (explain your answer)?

(d) Write down the transition table.

(e) Plot the k-maps for the flip flop inputs.

(f) Plot the logic circuit of your counter.

The problems below are from the Textbook (5^{th} edition):
Question 6. Problem 5.6
Question 7. Problem 5.10
Question 8. Problem 5.19 (a)