EECE 238 Exam II

Name:

Problem 1	**_____/30**
Problem 2	**_____/20**
Problem 3	**_____/10**
Problem 4	**_____/15**
Problem 5	**_____/25**
Total:	**_____/100**

Good Luck!

Problem 1 (30 points total) ***Sequence Recognizer Design.***

Design a digital circuit to recognize the occurrence of the input sequence 1011. The circuit will output a 1 when the previous inputs were 101 and the current input is 1. Note that since the output depends on the input (as well as the current state), you need a ***Mealy*** solution to this problem.

1 (a) (12 points) Derive the state transition diagram.
1 (b) (10 points) Derive the state table and Flip-Flop inputs for J-K Flip-Flops.
1 (c) (5 points) Use Karnaugh maps to minimize the equations for the Flip-Flop inputs, and the output.
1 (d) (3 points) Draw the final circuit.

Problem 2 (20 points total) *Synchronous Counter Design.*

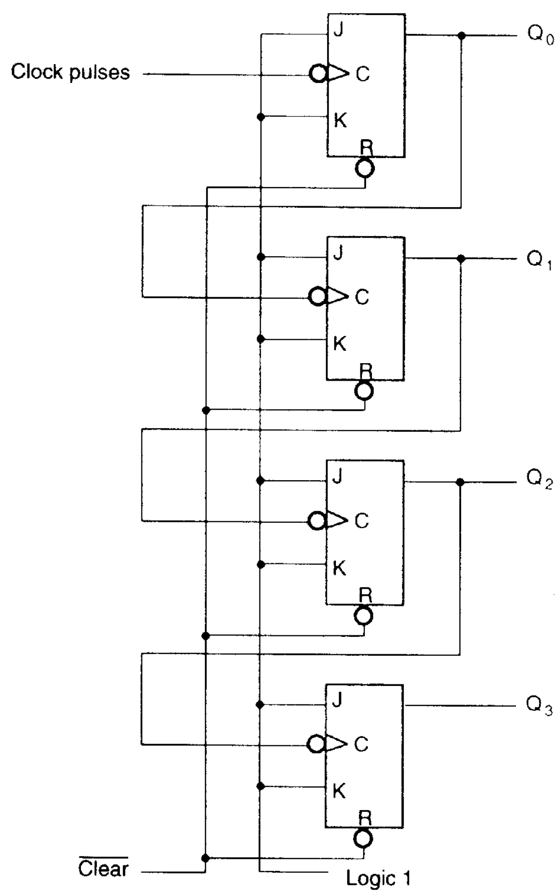
Design a binary counter that counts through the prime numbers less than 10. This means that your counter is to count: $1, 2, 3, 5, 7$ and then go back to 1. For your design, assume that there is no reset signal and you are thus forced to send any of the states $0, 4, 6$ back to 1.

2 (a) (3 points) Draw the state transition diagram.
2 (b) (7 points) Derive the state table for implementing the counter using D Flip-Flops.
2 (c) (7 points) Use K-maps to minimize the inputs to the D Flip-Flops.
2 (d) (3 points) Indicate the final circuit.

Problem 3 (10 points total) *Ripple Counting*

Consider the 4-bit Ripple Counter shown below. Assume that: $Q_0 = 1, Q_1 = 0, Q_2 = 1, Q_3 = 0$.

Clearly indicate how the states of Q_0, Q_1, Q_2, Q_3 change after 4 clock periods.



Problem 4 (15 points total) *Even Parity Detector*

Using T Flip-Flops, design an even parity detector that outputs a 1 **after** an even number of 1s have been received. Note that since the output does not depend on the current input, you will need a ***Moore*** solution to this problem.

1 (a) (3 points) Derive the state transition diagram.
1 (b) (3 points) Derive the state table and T Flip-Flop input(s).
1 (c) (3 points) Indicate the final Circuit.
1 (d) (3 points) Re-implement the Circuit using D Flip-Flop(s).
1 (e) (3 points) Re-implement the Circuit using JK Flip-Flop(s).

Problem 5 (25 points total) *Serial Addition*

Consider the Serial-Adder Circuit indicated below.

We want to use the adder to compute $1+2-4$.

Note that the following parts are independent (except for the last part). Hence, if you do not know how to do a particular part, simply move to the next part.

For full credit, you must clearly indicate:

(i) the values for all the inputs, and

(ii) how the relevant registers *A, B* and the Carry are affected with respect to the clock.

If the state of the registers or the Carry cannot be determined, simply mark them by X.

4 (a) (3 points) Initially, we do not know what value is stored in register A. Indicate how to initialize register A to zero.

4 (b) (7 points) Indicate how to (i) compute $A=0+1$, assuming that $A=0$, while at the same time, leave register B with the value: $B=2$. How many clock cycles did it take to perform the addition?

4 (c) (6 points) Indicate how to compute (i) $A=1+2$, while at the same time, leave register B with $B=-4$. Assume that register B contains $B=2$ and register A contains $A=1$. How many clock cycles did it take to perform the addition?

4 (d) (3 points) Indicate how to use the circuit to finish the computation and store the final result of $1+2-4$ in A.

4 (e) (3 points) In general, suppose that we want to add N four-bit numbers (assuming that all the results will actually fit in our 4-bit register A without causing overflows). How many clock cycles would we need?

4 (f) (3 points) Supoose that only unsigned numbers are to be added. Can you think of a simple way to detect overflows?

Hint: what happens to the Carry bit?