CMSC 311 Midterm #1 (Fall 1995)
(solutions)

1.) (15 points) Define the following terms:

a) RAM - Random Access Memory. A type of storage that permits random access to words of memory. It permits both reading and writing to memory, but looses what is stored in it when the power is turned off.

b) decoder - a circuit that takes n inputs and produces 2^n ouputs where only one of the 2^n outputs is a 1.

c) ASCII - A code to represent letters and numbers. It uses 7 bits to encode 127 characters.

d) overflow - when the result of a computation will not fit in the available space to store it. It can occur in addition when adding two positive or two negative numbers.

e) Gray code - a code to represent numbers in which the representation of any two consecutive numbers differs by exactly one bit. Used in K-maps.

2.) (10 points) Convert the following numbers to 8-bit two's complement notation, and perform the indicated operation. Indicate if an overflow occurs.

a) 30 + 97

```
 0001 1110
 0110 0001
-----------
 0111 1111      No Overflow
```

b) -80 - 90

```
 1011 0000
 1010 0110
-----------
 0101 0110      Overflow
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3.) (15 points) Consider the family of 2 input, 1 output clocked sequential circuits that can be built using exactly 4 flip-flops. How many possible state graphs are there if the output is a function of the current state? To receive full credit, explain your answer.

Each state Table

4 FF's imply 16 states

2 inputs means 4 possible input patterns

therefore there are 64 lines in each state table

Possible state tables (wo output)

each line can transition to one of 16 possible states

therefore there are 16^{64} possible tables

Output

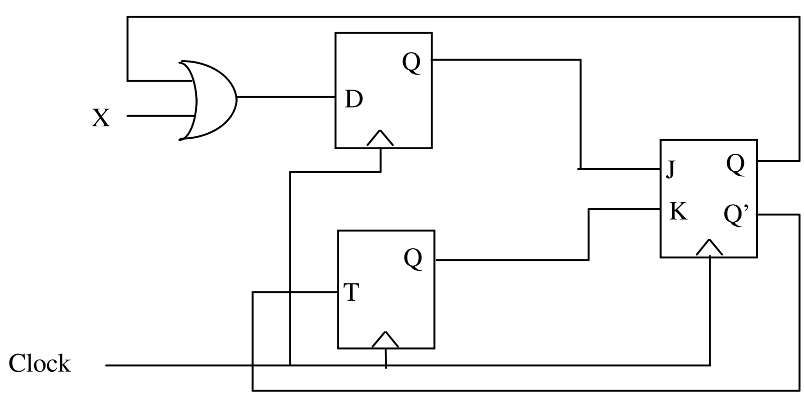
output is a function on current state so each of the 16 states can produce 0 or 1

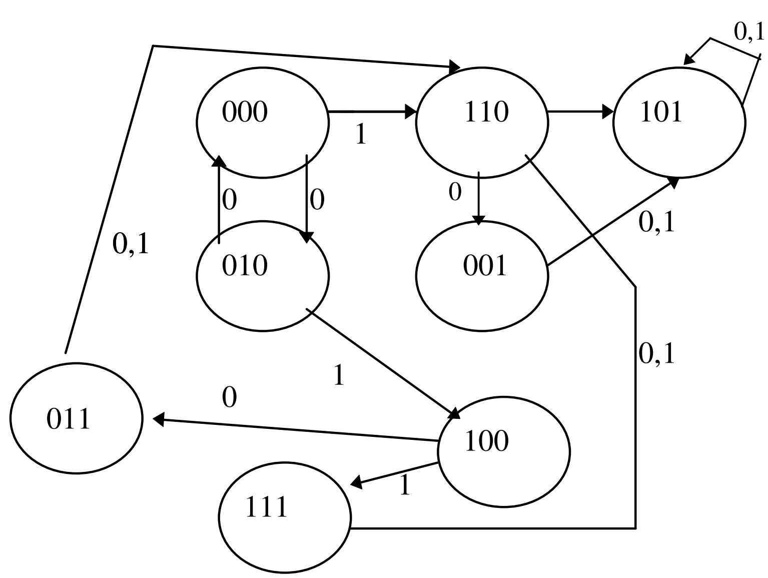
therefore there are 2^{16} possible outputs per state table

Overall

16^{64} possible tables times 2^{16} outputs = 2^{262}

4.) (20 points) Consider the circuit shown below. Show the state diagram for the circuit (make sure you show **all** states). Note the varying flip-flop types and proceed carefully.





5.) (20 points) Consider the following state table:

Input	Present State		Next State		Output
I	S1	S0	S1	S0	Y
0	0	0	1	1	0
0	0	1	0	1	0
0	1	0	1	0	1
0	1	1	1	0	1
1	0	0	0	1	0
1	0	1	1	1	0
1	1	0	0	0	1
1	1	1	0	0	1

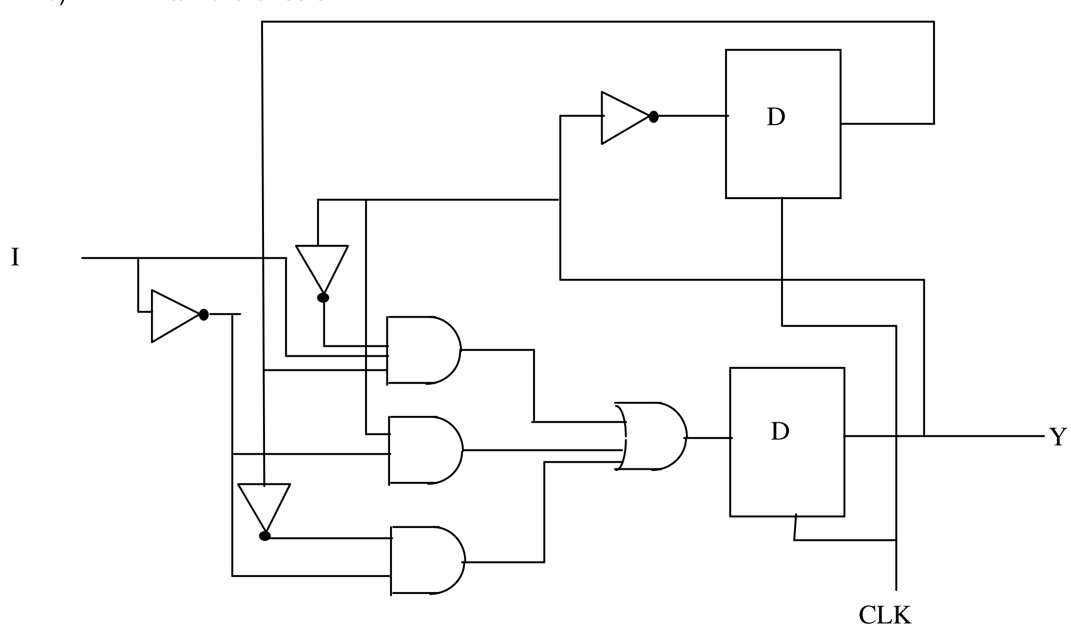
a) Use K-maps to minimize the number of gates required to implement the state table using D flip-flops. Also show the K-map for the output.

S1	00	01	11	10
0	1	0	1	1
1	0	1	0	0

S0	00	01	11	10
0	1	1	0	0
1	1	1	0	0

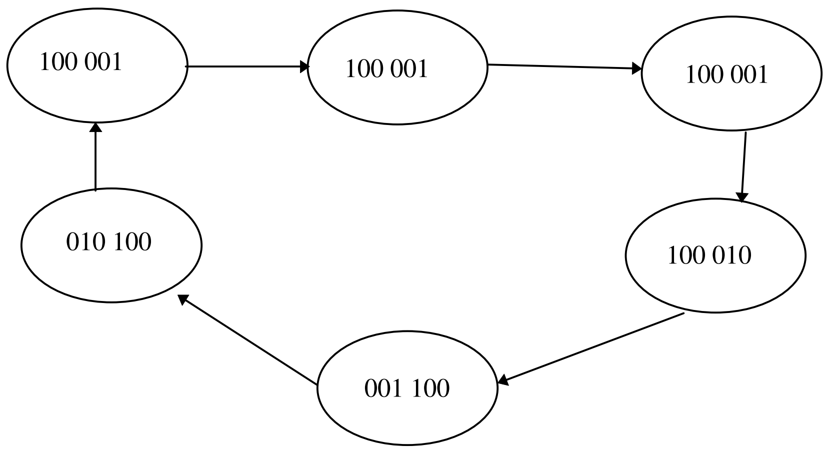
Y	00	01	11	10
0	0	0	1	1
1	0	0	1	1

b) Draw the circuit.



6.) (20 points) You have been assigned by the city of College Park to design a traffic light.

a) The signal should be green in the North-South direction for one unit of time, and green in the East-West direction for three units of time. Before changing from green to red, the signal should be yellow for one unit of time. The circuit should have 6 outputs (red-NS, yellow-NS, green-NS, red-EW, yellow-EW, and green-EW). A zero indicates the light is off and a one that it is on. Show the state graph for the circuit (but do not show the circuit itself).



b) Traffic has increased at the intersection, and you must now design a traffic signal with a left turn light from the North and South bound directions. However, to reduce traffic delays, a left turn light will only turn green if a car is waiting for it (call these inputs left-N and left-S). To simplify the circuit, left turns from the North and South will be at the same time and immediately before the North-South light turns green. Left turn lights are green for one unit of time and then yellow for one unit of time. Show the state graph for the circuit (but do not show the circuit itself).