Computer Engineering 111
Final

Name _____

Thirteen problems, 100 points.

Closed books, closed notes, no calculators. You would be wise to read all problems before beginning, note point values and difficulty of problems, and budget your time accordingly.

Please do not open the test until I tell you to do so.

Good luck!

1) Number system conversions.

a) (**2 points**) convert to binary:

C2F (hex) =

b) (**4 points**) Convert to binary

1692.3125 (decimal) =

c) (**2 points**) Convert to hex

1010011100111010.010110110 (binary) =

2) 2s complement arithmetic.

(**2 points**) Convert –54 to 8 bit 2's complement representation.

(**1 point**) Find the 2's complement of A5H

(**4 points**) Perform the following two's complement addition operations. Give your answer as an 8-bit two's complement number. State whether overflow occurs.

```
  1 0 0 1 0 1 1 0          0 0 1 1 0 1 0 1
+ 1 1 1 1 0 0 1 1        + 0 1 1 0 0 1 1 1
```

This page is for scratch paper. Refer to it on the problem page if there is work you think needs to be considered in grading.

3) **(7 Points)** Simplify the following Boolean expression:

$f(a, b, c) = \left(a + \bar{a}\bar{b}\right)\overline{(bc + a\bar{c})}\bar{a}$

*Show your work for **full credit**.*

4) **(4 Points)** Find the simplest form of the function f(a,b,c,d) = m(0,2,4,6,7,10,11,14,15) using a K-Map. Use the K-Map grid below.

ab\cd	00	01	11	10
00				
01				
11				
10				

5) **(3 Points)** Find the simplest form of the function f(a,b,c,d) which is described by the following K-Map. - denotes a don't care.

ab\cd	00	01	11	10
00	0	1	0	0
01	1	-	-	0
11	-	-	0	0
10	1	1	0	-

6) (**8 Points**) CMOS circuits.

Implement the function $f = \bar{a}(\bar{b} + \bar{c})$ using CMOS transistor arrays.

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7) **(9 Points – 3 Points Each)** In the circuit below, assume an initial value of 0 for Q. Complete the timing diagram for Q_a, Q_b and Q_c.

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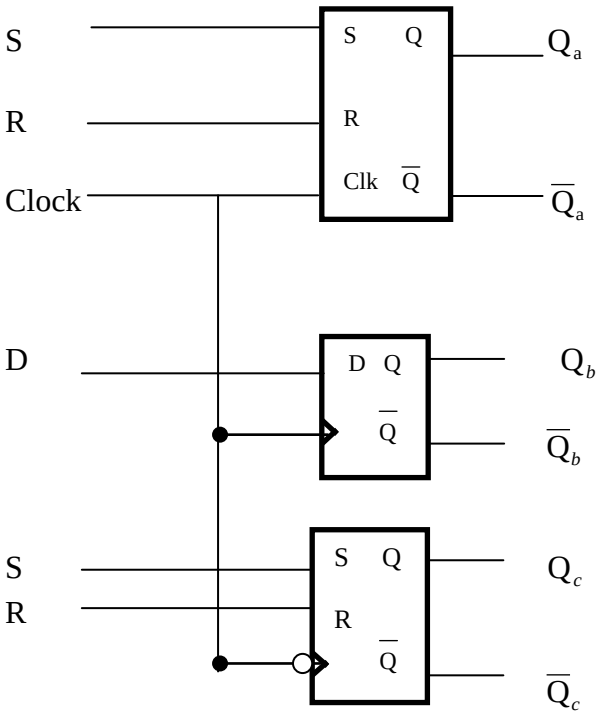
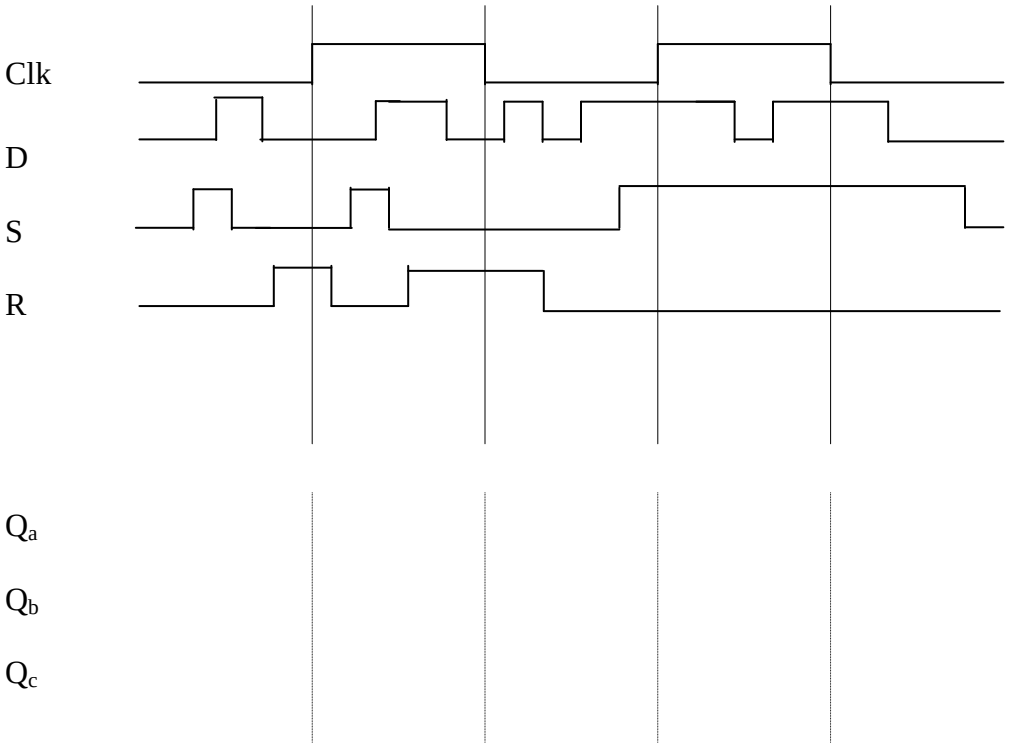
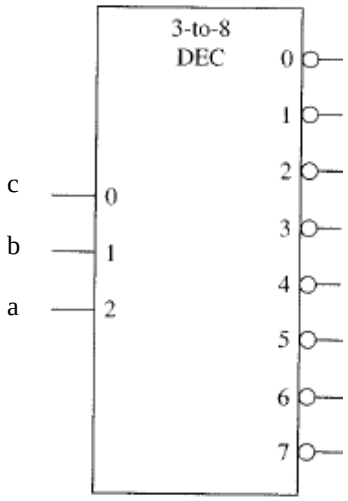
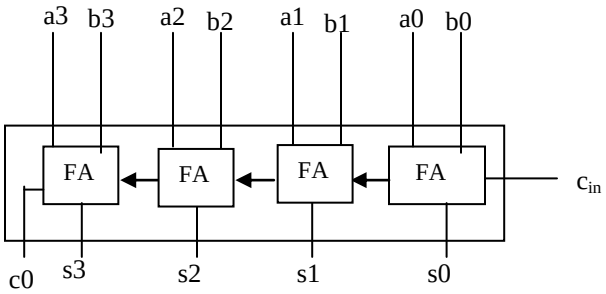




8) (**6 Points**) Modify the 3-to-8 decoder circuit below to implement the function $f(a, b, c) = ac + bc$.



9) (**6 Points**) Using the **ripple carry** 4-bit parallel adder (A+B) circuit below, answer the following question.

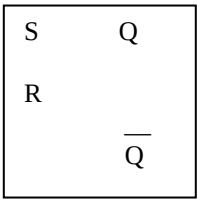


$A = a_3a_2a_1a_0$
$B = b_3b_2b_1b_0$

If $X = x_3x_2x_1x_0$, use the 4-bit adder module above to draw a module that computes -4X using an 8-bit word in 2s complement format.

10) **(7 points)** Make a T flip-flop out of the SR flip-flop below. Show all your work and draw the resulting circuit.

T	Qt	Qt+1	S	R
0	0			
0	1			
1	0			
1	1			



11) Logic expressions.
Given the function F(A,B,C,D) = ∑m(0,1,5,6,7,8,9) + ∑Xm(11,13)

Answer the questions for parts a and b below.

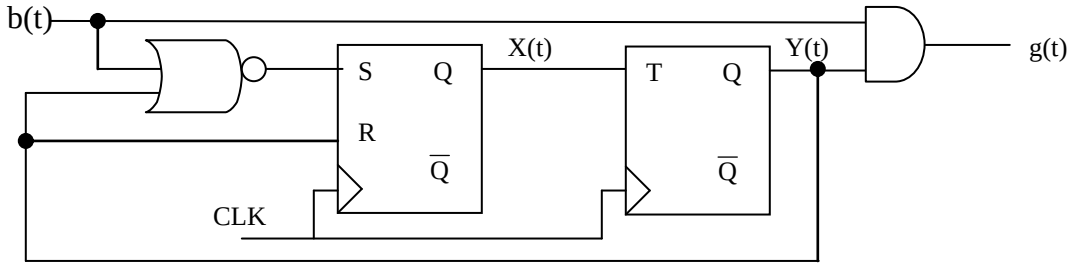
(a) (**5 Points**) Write the <u>minimal</u> NOR-NOR expression for F.

NOR-NOR: F =

AB \ CD	00	01	11	10
00				
01				
11				
10				

(b) (**4 Points**) Draw the logic network for the NOR-NOR expression for F from **part a**.

12) State table derivation.



Given the sequential circuit above with the state variables X(t) and Y(t), externally applied input b(t) and output g(t). Answer the questions for **parts a and b** below.

a) (**8 Points**) Fill in the missing values for the state table. **Show all relationships** used to fill in the state table values for *full credit*.

Present Input	Present State		Present Output	Next State		SR Flip Flop Inputs		T Flip Flop Inputs
b(t)	X(t)	Y(t)	g(t)	X(t+1)	Y(t+1)	$S_X(t)$	$R_X(t)$	$T_Y(t)$
0	0	0						
0	0	1						
0	1	0						
0	1	1						
1	0	0						
1	0	1						
1	1	0						
1	1	1						

b) (**3 Points**) Draw the state transition diagram based on the state table above.

13) **(15 Points)** Implement a synchronous sequential circuit to output the sequence 0123401234… with a reset input (R) such that the next digit in the sequence is output when R = 1 and the digit 0 is output when R = 0. Implement this machine using D flip flops by using the truth table on this page and the K-maps on this and the following pages. Take advantage of any don't cares that come up. Finally, implement the circuit on the page following the K-maps.

R	$Q_2Q_1Q_0$	$D_2D_1D_0$
0	000	
0	001	
0	010	
0	011	
0	100	
0	101	
0	110	
0	111	
1	000	
1	001	
1	010	
1	011	
1	100	
1	101	
1	110	
1	111	

D2 = _____.

Q1Q0 / RQ2	00	01	11	10
00				
01				
11				
10				

13 continued)

D1 = _____.

Q1 Q0 / RQ2	00	01	11	10
00				
01				
11				
10				

D0 = _____.

Q1 Q0 / RQ2	00	01	11	10
00				
01				
11				
10				

13 continued)

Draw the circuit below.

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