Computer Engineering 111
Test 3
May 3, 2010

Name _____

Nine 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) **(12 Points)** Simplify the following Boolean expression:

$$A\bar{B} + \overline{(A + C)} + BC\bar{D} + A \quad = \quad F.$$

(Please note that the long bar over the top IS part of the expression!) Hint: If you get three terms with three variables each, you're probably done – provided you got the RIGHT three!

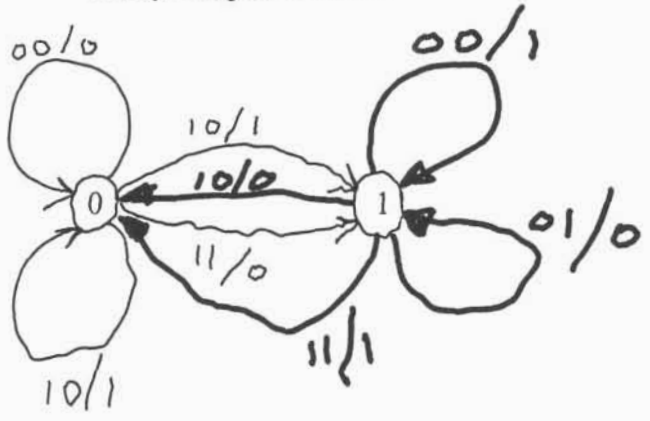
2) **(5 Points)** Find the simplest form of the function f(a,b,c,d) which is described by the following K-Map. d denotes a don't care.

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

3. (15 points) The Mealy diagram at the bottom of this problem specifies the desired behavior for a sequential logic device built from one SR flip flop, one 8-1 multiplexer, and two AND gates. Assume variables A,B and Q are available in true and complemented forms. Y is the output. Fill in the truth table below. Configure the device using the specified hardware and draw it.

ABQ^t	Q^{t+1}	Y	S	R
000				
001				
010				
011				
100				
101				
110				
111				

Mealy Diagram for Problem 3.



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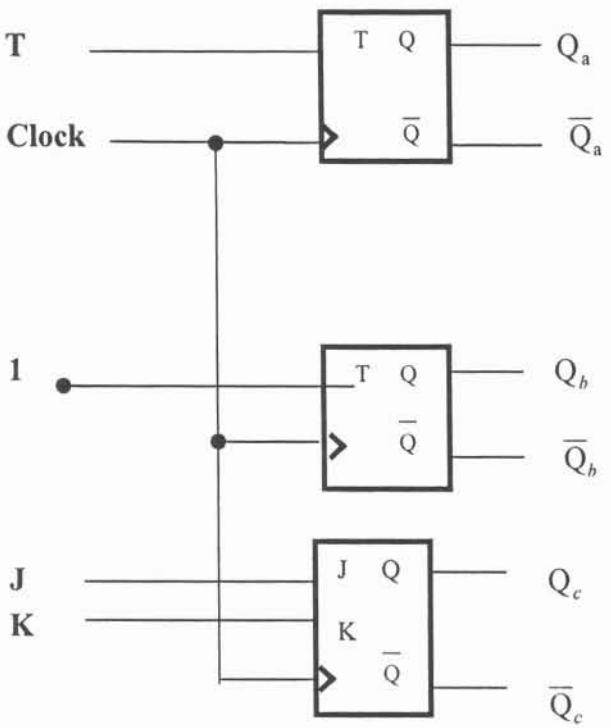
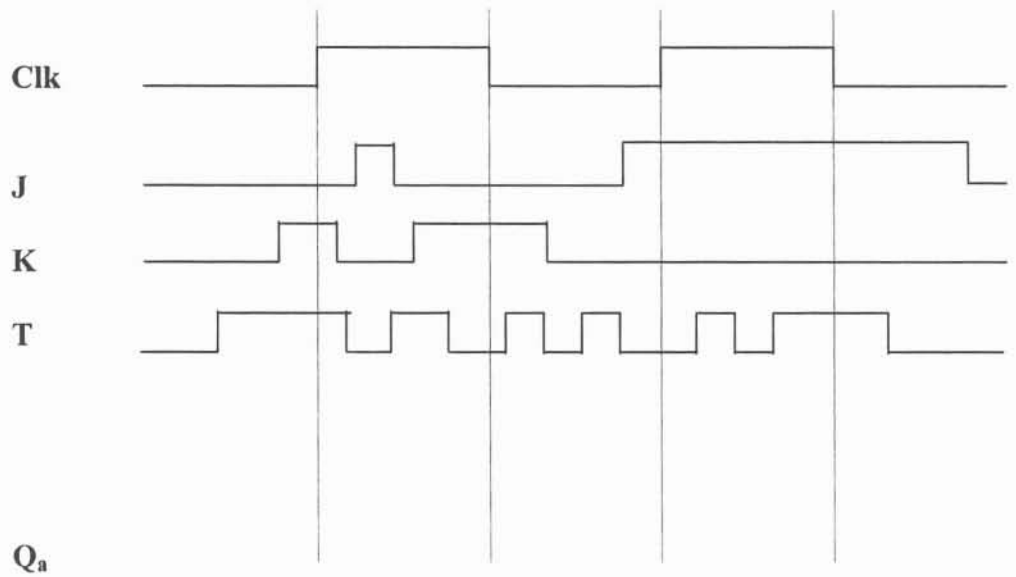
4) **(12 Points – 4 Points Each)** In the circuit below, assume an initial value of 0 for all Qi. Complete the timing diagram for Q_a, Q_b and Q_c.



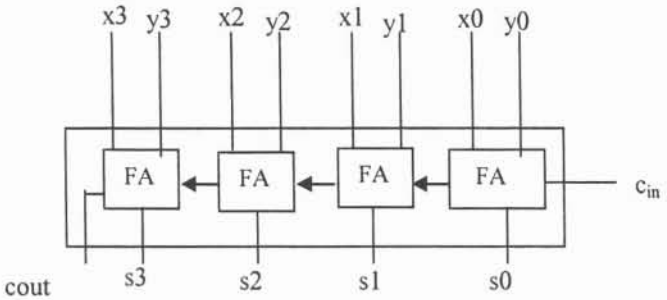


Q_a

Q_b

Q_c

5) (9 points) Consider the **ripple carry** 4-bit parallel adder (X+Y) shown.

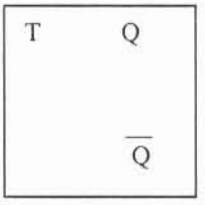


$X = x_3x_2x_1x_0$
$Y = y_3y_2y_1y_0$

Given the 4-bit word $X=x_3x_2x_1x_0$ and Y=0011. Use the 4-bit adder module above to create a module that computes X - Y. You are allowed to select up to four additional gates. You must show how you will configure ALL inputs. Assume that X is in XS3. Then what can you say about the output S?

6) **(12 points)** Make a JK flip-flop out of the T flip-flop below. Show all your work and draw the resulting circuit.

J	K	Qt	Qt+1	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		



7) (7 points) Logic expression:

$F(A,B,C,D) = \prod M(1,3,9,12) + \prod XM(0,2,11)$

Write the canonical POS expression and the minimal SOP expression for F. You don't need to draw any gates. Be careful filling in the truth table; this is slightly different than you are used to seeing these problems.

(2 points) Canonical POS: F =

(5 points) SOP: F =

Decimal	A	B	C	D	F
0	0	0	0	0	
1	0	0	0	1	
2	0	0	1	0	
3	0	0	1	1	
4	0	1	0	0	
5	0	1	0	1	
6	0	1	1	0	
7	0	1	1	1	
8	1	0	0	0	
9	1	0	0	1	
10	1	0	1	0	
11	1	0	1	1	
12	1	1	0	0	
13	1	1	0	1	
14	1	1	1	0	
15	1	1	1	1	

CD / AB	00	01	11	10
00				
01				
11				
10				

8) (20 points) Given the state table below with the state variables X(t) and Y(t), externally applied input b(t) and output g(t). Answer the questions below.

Present Input	Present State		Present Output	Next State		JK Flip Flop Inputs		JK Flip Flop Inputs	
b(t)	X(t)	Y(t)	g(t)	X(t+1)	Y(t+1)	$J_X(t)$	$K_X(t)$	$J_Y(t)$	$K_Y(t)$
0	0	0	1			0	0	0	0
0	0	1	0			0	1	0	0
0	1	0	1			0	1	1	0
0	1	1	1			0	1	0	0
1	0	0	1			0	0	1	0
1	0	1	0			1	0	0	1
1	1	0	0			0	0	1	0
1	1	1	1			0	0	1	0

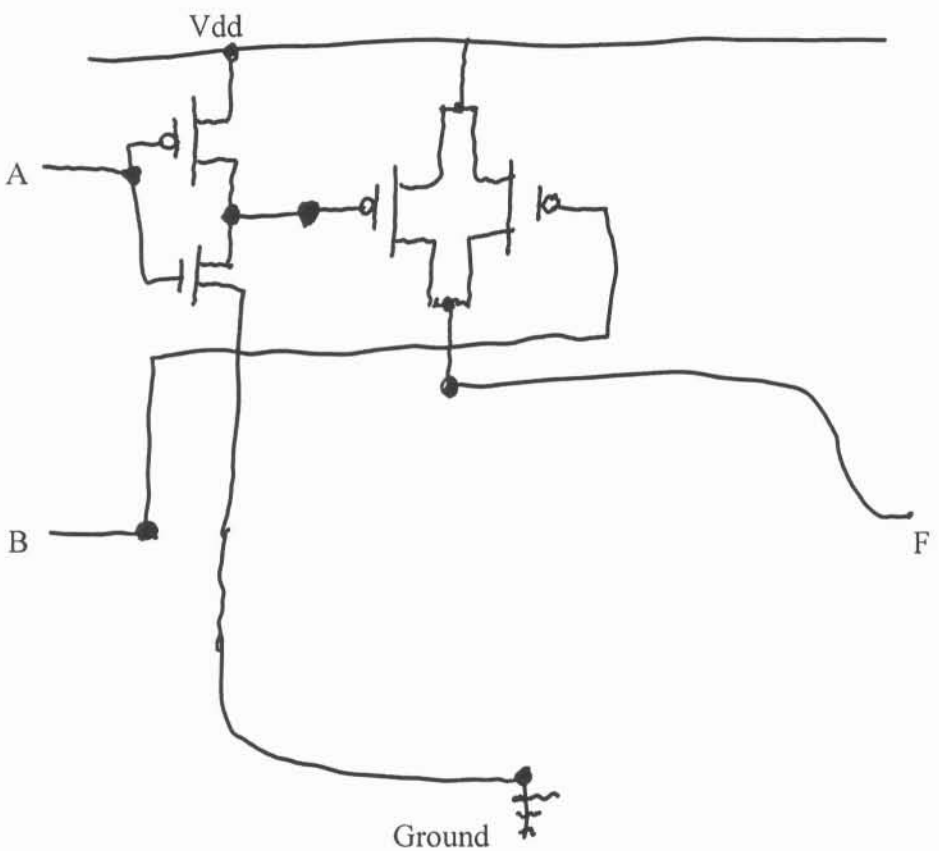
a) **(2 Points)** Fill in the Next State values.
b) **(2 Points)** Draw the output logic only. (No need to draw the flip flops.)
c) **(6 Points)** Draw the state transition diagram based on the state table. What kind of diagram MUST you use?

9) (8 points)

a) (4 points) What function is the CMOS device below performing?

F = _____

b) (4 points) Complete the diagram:



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