Computer Engineering 111
Final

Name _____

Twelve 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) (3 points) convert to hex and binary:

6637 (octal) = (binary) = (hex)

b) (6 points) convert to binary, octal and hex:

9089.8125 (decimal) = (binary)

9089.8125 (decimal) = (octal)

9089.8125 (decimal) = (hex)

c) (3 points) convert to octal

1011011001.1011010100001 (binary) = (octal) = (hex)

2) 2s complement arithmetic.

(1 point) convert 87 and –87 to 8 bit 2's complement representation.

(1 point) convert 28 and –28 to 8 bit 2's complement representation.

(2 points) Perform the addition 87 + 28 in 8 bit 2's complement representation.

(2 points) Perform the subtraction 87 - 28 in 8 bit 2's complement representation.

(2 points) Perform the subtraction 28 - 87 in 8 bit 2's complement representation.

This page is for scratch paper. Don't put final answers here, please. Refer to it on the problem page if there is work you think needs to be considered in grading. Feel free to tear this page out and keep it.

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

f(a,b,c) = ((a+bc+a'c)(a'+c'))'

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

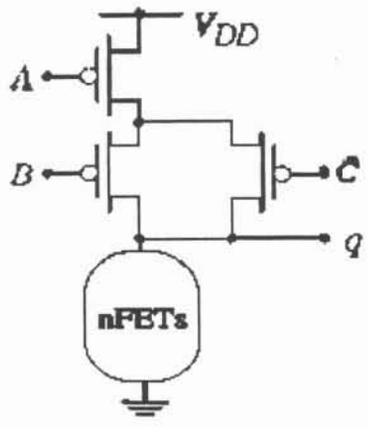
4) (4 Points) Find the simplest form of the function f(a,b,c,d) which is described by the following K-Map.

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

5) (4 Points) Find the simplest form of the function f(a,b,c) which is described by the following K-Map. d denotes a don't care.

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

6) Given the circuit below, answer the questions in parts a and b.



a) (4 Points) Find the function output q(A,B,C).

b) (4 Points) Implement the nFET (NMOS) portion of the circuit above.

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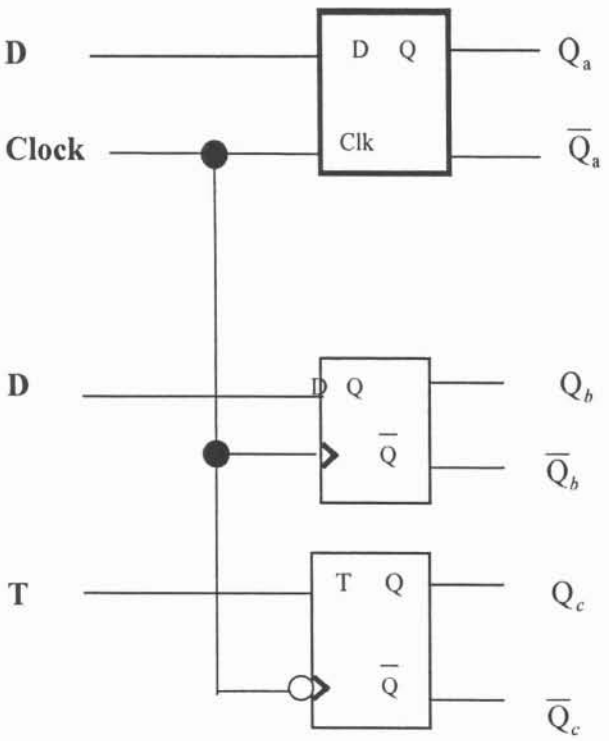
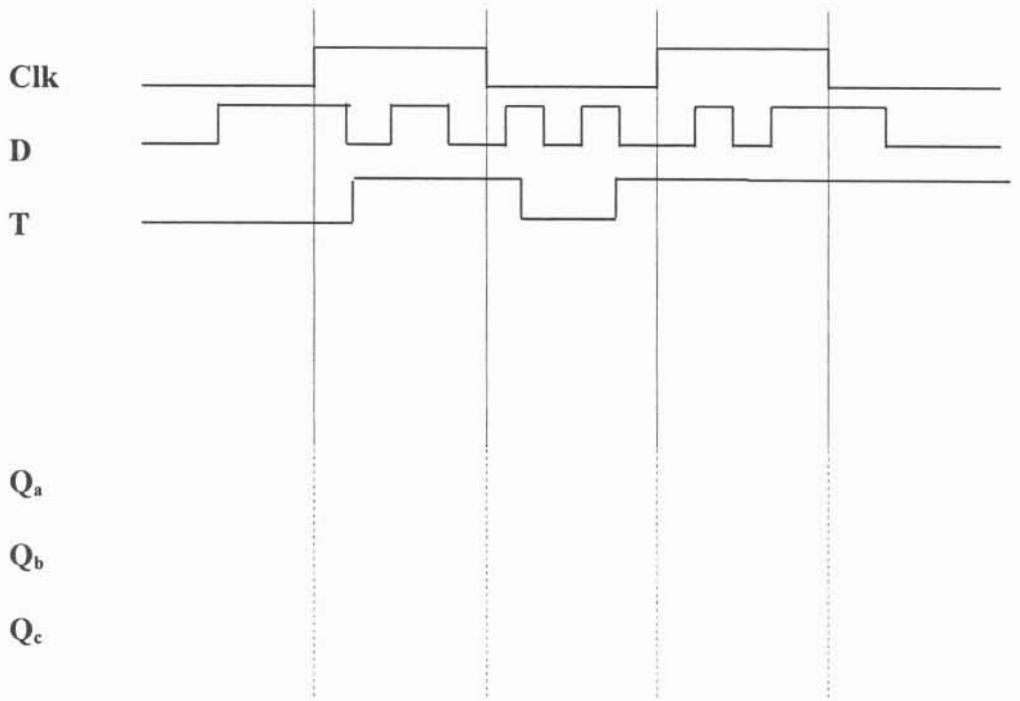
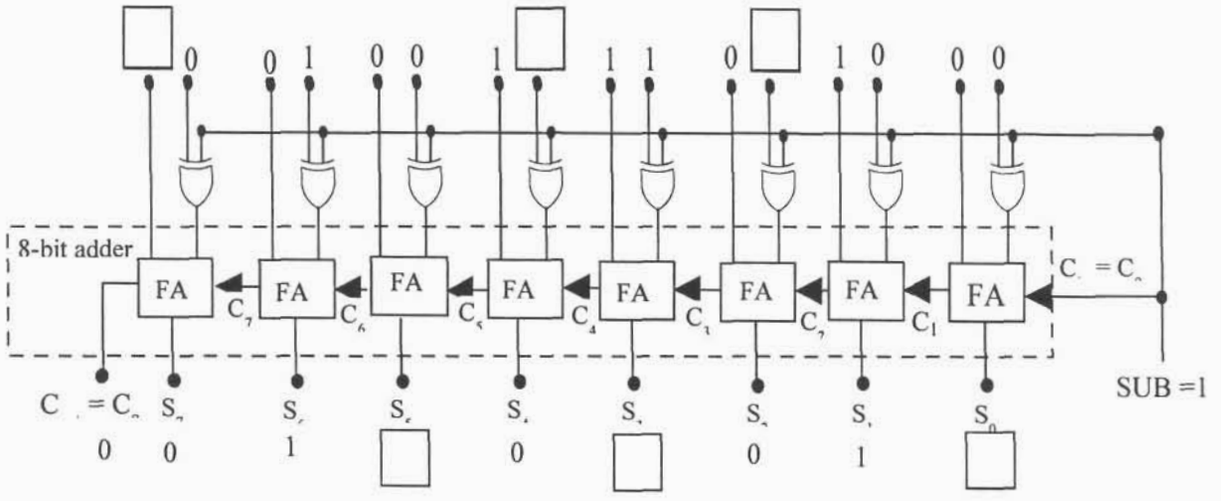
7) (9 Points) Latch and Flip-Flops.

In the circuit below, assume an initial value of 0 for Q. Complete the timing diagram for Q_a, Q_b and Q_c.



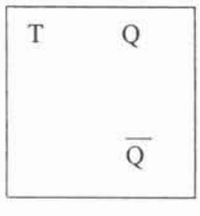


8) (6 points) Label the six missing quantities in the figure below.



9) (7 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		



10) Logic expressions.

$F = \prod M(1,2,5,6,9, 10, 13) + \prod XM(0,7,8,12,15)$

Write the canonical POS expression and the minimal NOR-NOR expression for F. You don't need to draw any gates.

(2 points) Canonical POS: F =

(4 points) NOR-NOR: 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	

AB \ CD	00	01	11	10
00				
01				
11				
10				

11) Given the state transition table below with state variables A and B, externally applied input X, and output F.

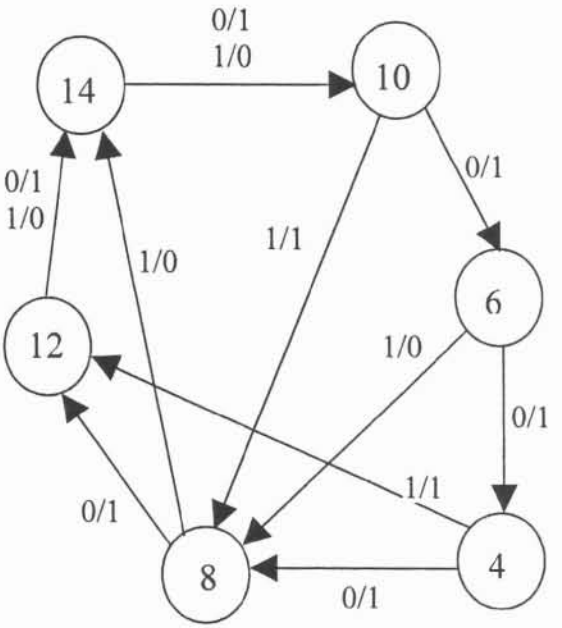
Present State		Present Input	Next State		Present Output	Flip-Flop Inputs			
A(t)	B(t)	X(t)	A(t+1)	B(t+1)	F(t)	$S_A(t)$	$R_A(t)$	$S_B(t)$	$R_B(t)$
0	0	0	0	1	0				
0	0	1	1	0	0				
0	1	0	1	1	0				
0	1	1	1	0	0				
1	0	0	1	1	1				
1	0	1	1	1	0				
1	1	0	0	1	1				
1	1	1	0	0	0				

a) (3 Points) Complete the table for the SR flip-flop inputs (S_A, R_A, S_B, R_B).

b) (6 Points) Draw the state transition diagram based on the state table above.

12) (20 points) In the Mealy diagram below, the input variable is A, and output variable is Y. The state assignments MUST take the binary version of the numerical values shown. Implement this machine using D flip flops, by using the truth table on this page, and K-maps on the next pages, to solve for the next-state and output logic. Take advantage of any don't cares that come up. Note that states 12 and 14 have only one arrow leaving them, because they go to the same next state, but they still have two different outputs for the different inputs. (Hint: Start by assessing your hardware requirements. See the next page first.)

A	$Q_3Q_2Q_1Q_0$	$D_3D_2D_1D_0$	Y
0	0000		
0	0001		
0	0010		
0	0011		
0	0100		
0	0101		
0	0110		
0	0111		
0	1000		
0	1001		
0	1010		
0	1011		
0	1100		
0	1101		
0	1110		
0	1111		
1	0000		
1	0001		
1	0010		
1	0011		
1	0100		
1	0101		
1	0110		
1	0111		
1	1000		
1	1001		
1	1010		
1	1011		
1	1100		
1	1101		
1	1110		
1	1111		



12 (continued)

Think this question through before beginning…

D0 = _____

(There's not room for D3's K-map on the next page. You can hand-draw it here if you need it, but it is optional and won't be graded. The correct equation *will* be graded.) The correct answer to this question also will be graded:

What does your equation above imply about your hardware requirements? Answer: _____

Once you've answered this, you're in a much better position to solve this problem!

12 (continued)

D3 = _____.

$Q_2\ Q_1$ / AQ_3	00	01	11	10
00				
01				
11				
10				

D2 = _____.

$Q_2\ Q_1$ / AQ_3	00	01	11	10
00				
01				
11				
10				

D1 = _____.

$Q_2\ Q_1$ / AQ_3	00	01	11	10
00				
01				
11				
10				

12 (continued)

Y = _____.

$Q_2\ Q_1$ / AQ_3	00	01	11	10
00				
01				
11				
10				

This page is scratch paper. It is ok to remove it if you don't want it considered in grading. If you put something here that should be looked at, clearly indicate it on the problem page and also refer to the problem on this page.