Final Exam 2 hours, 30 minutes

All problems are worth 20 points. Do any 10 of the 11. Make sure it is clear which problem you do not want graded or I will grade the first 10 with anything written on them.

1. For the following function, one of the minimum sum of products expressions is shown.

$$f = w\,x\,y' + w\,y\,z' + w'\,z + x'\,z$$

Assume all inputs are available both uncomplemented and complementes. Show TWO different implementations, both equations and a block diagram, using 7 two-input NAND gates each.

BONUS (5 points): Show a third implementation using 7 two-input gates.

2. For the three functions shown, find the equations for a minimum two-level AND-OR solution. (Minimum is 8 gates/24 gate inputs) You must circle the terms on the maps and write the equations. Show the sharing in the equations. (A block diagram is NOT required.) (Two copies of the maps are there if you need them.)

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

f

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

g

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

h

3. For the following 5-variable function, find as many minimum sum of products expressions as you can. (Full credit for 4 expressions, each with 6 terms and 18 literals.) (Three copies of the maps are there if you need them.) 3 points BONUS for each additional solution.

A = 0

DE \ BC	00	01	11	10
00	1			
01	1	1	X	
11		X	1	
10	X	X		

A = 1

DE \ BC	00	01	11	10
00	X		1	X
01	1	1	X	1
11		1		
10	1	1		1

4. a) For the following function, f, find the minimum sum of products expression.

c d \ a b	00	01	11	10
00	1	1		1
01		1	1	
11		1	1	1
10		1		1

b) For the following function, g, find BOTH the minimum sum of products expression and the minimum product of sums expression. (Blank map shown for your convenience.)

y z \ w x	00	01	11	10
00	1	1	1	
01	1	1		
11		1		
10		1		

	00	01	11	10
00				
01				
11				
10				

5. Consider the following state table:

q	q^* x = 0	x = 1	z
A	A	D	0
B	A	C	0
C	E	B	1
D	E	B	0
E	A	D	0

The list of the smallest non-trivial partitions putting two states in the same block is

P_1 = (A B) (C D) (E)
P_2 = (A E) (B) (C) (D)
P_3 = (A E) (B C) (D)
P_4 = (A E) (B C D)
P_5 = (A) (B E) (C D)
P_6 = (A) (B) (C D) (E)

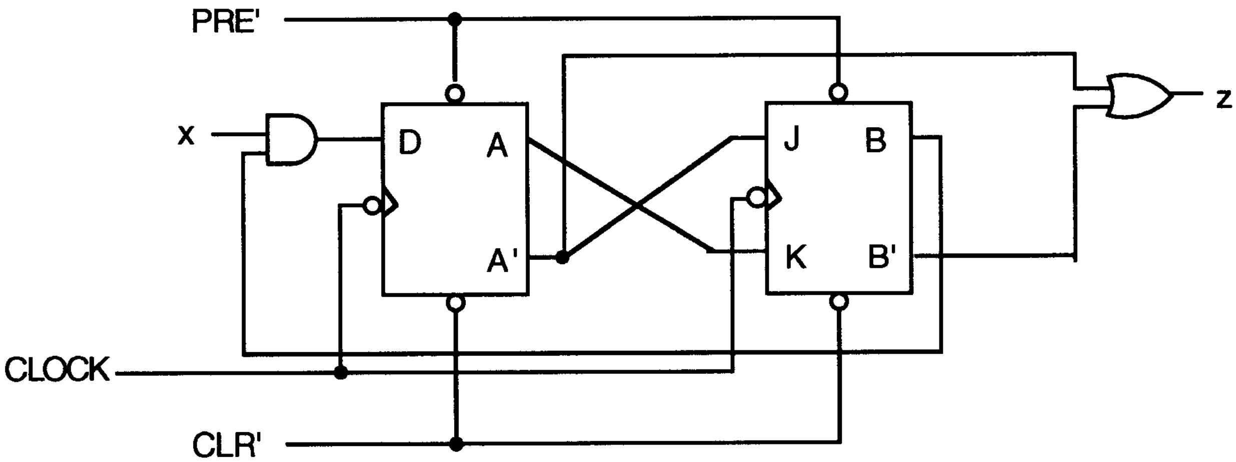
a) Find the other two non-trivial SP partitions.
b) Reduce this to the minimum number of states. Show the reduced state table.
c) Show the non-trivial SP partitions for the reduced system.

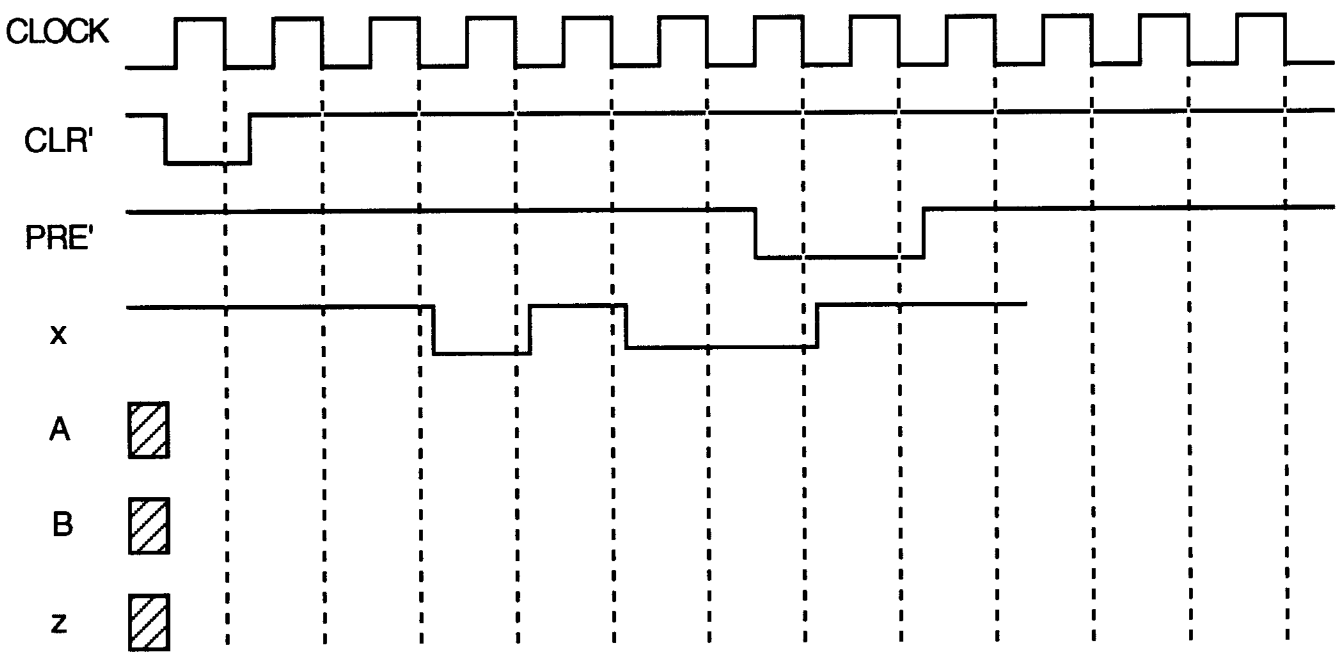
6. Show a state table or a state diagram for a Mealy system with one input, x, and one output, z, such that z = 1 if and only if the input has been exactly two 1's followed immediately by exactly two 0's followed by exactly one 1.
(Full credit for a system with 7 states.)

<u>Example</u>

x	0	1	1	0	0	1	0	1	1	0	0	0	1	0	1	1	0	0	1	1	0
z	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

7. For the following circuit, complete the timing diagram below (for A, B, and z).





8. For the following state table, show a state diagram and complete the timing trace as far as you can.

q	q* x = 0	q* x = 1	z
A	A	D	0
B	A	C	0
C	E	B	1
D	E	B	0
E	A	D	1

x	0	1	1	1	0	1	1	0
q	A							
z								

9. For the following state table

q	q* x = 0	q* x = 1	z
A	D	C	1
B	B	A	1
C	B	D	0
D	A	B	0

Design the system using JK flip flops for each of the two state assignments. You need only show the equations for J, K and z. (See the worksheet on the next page.

a)

q	q_1	q_2
A	0	0
B	0	1
C	1	0
D	1	1

b)

q	q_1	q_2
A	0	0
B	0	1
C	1	1
D	1	0

10. For the following state table

$q_1\ q_2$	$q_1^*q_2^*$		
	x = 0	x = 1	z
0 0	1 1	0 1	0
0 1	0 0	1 1	1
1 1	1 1	0 1	0

Design the system using a T flip flop for q_1 and an SR flip flop for q_2. Just show the equations for the flip flop inputs and the output.

11. Design a counter with two flip flops and one input using D flip flops that goes through the cycle for

x = 0: 0 1 2 3 and repeat
x = 1: 1 2 3 3 (and remaining there)

Just show the input equations for the two flip flops. There is no output other than the state of the flip flops.

BONUS: Show a state diagram, including what happens if x goes to 1 when the counter is in state 0. (Each path is labeled with just the inputs.)