Embedded Real-Time Systems (AME 3623)
Homework 2 Solutions

February 9, 2006

Question 1

Consider the following function:

A	B	C	D	f
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

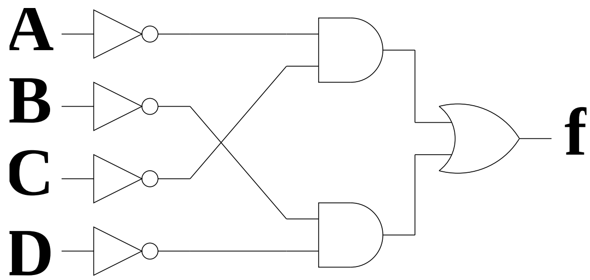
1. (10pts) Show the corresponding Karnaugh map and a good set of covering clusters.

					A
	AB		B		
CD		00	01	11	10
	00	1	1	0	1
	01	1	1	0	0
D	11	0	0	0	0
C	10	1	0	0	1

2. (10pts) What is the algebraic description of the reduced circuit?

   $f = \bar{A}\bar{C} + \bar{B}\bar{D}$

3. (10pts) Show the reduced circuit.



Question 2

Consider the following function:

A	B	C	D	f
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

1. (10pts) Show the corresponding Karnaugh map and a good set of covering clusters.

A (over AB = 11, 10); B (over AB = 01, 11); D (beside CD = 01, 11); C (beside CD = 11, 10)

CD \ AB	00	01	11	10
00	1	1	1	0
01	1	0	1	1
11	1	1	1	1
10	1	1	0	1

2. (10pts) What is the algebraic description of the corresponding circuit?

   $f = \bar{A}\bar{B} + B\bar{C}\bar{D} + AD + \bar{A}C + \bar{B}C$

3. (10pts) What is the algebraic description of the simplest circuit (in terms of the number of logic gates)?

   1's and 0's don't have a special status relative to one-another. So - our choice to circle clusters of 1's is somewhat arbitrary. Instead, we can focus on the 0's. One way to think about this approach is that we are inverting the original function, finding the appropriate clusters, and then designing the circuit. However, we have to remember to invert the final result. The result is:

   $f = \overline{A\bar{B}\bar{C}\bar{D} + \bar{A}B\bar{C}D + ABC\bar{D}}$

   Note that through algebraic manipulation, you can get between these two solutions (this requires multiple applications of DeMorgan's Laws).

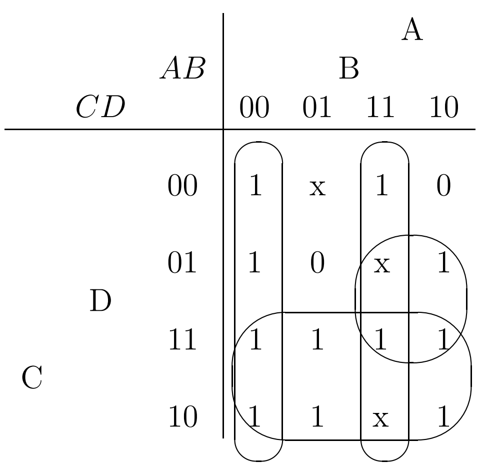
Question 3

Consider the following function:

A	B	C	D	f
0	0	0	0	1
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	x
0	1	0	1	0
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	x
1	1	1	0	x
1	1	1	1	1

Where “x” is a don’t care case.

1. (10pts) Show the corresponding Karnaugh map and a good set of covering clusters.



(note that this is one of two best coverings)

2. (10pts) What is the corresponding algebraic description of the reduced circuit?

   $f = \bar{A}\bar{B} + AB + AD + C$

   or

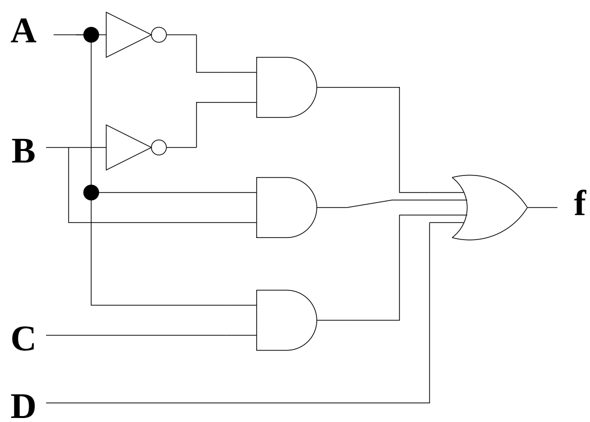
   $f = \bar{A} \bigoplus B + AD + C = \overline{A \bigoplus B} + AD + C$

   or

   $f = \bar{A}\bar{B} + AB + \bar{B}D + C$

3. (10pts) Show the reduced circuit.

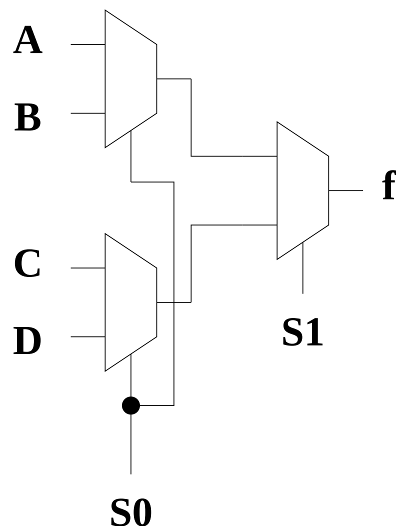
   Here is one of the solutions:



Question 4

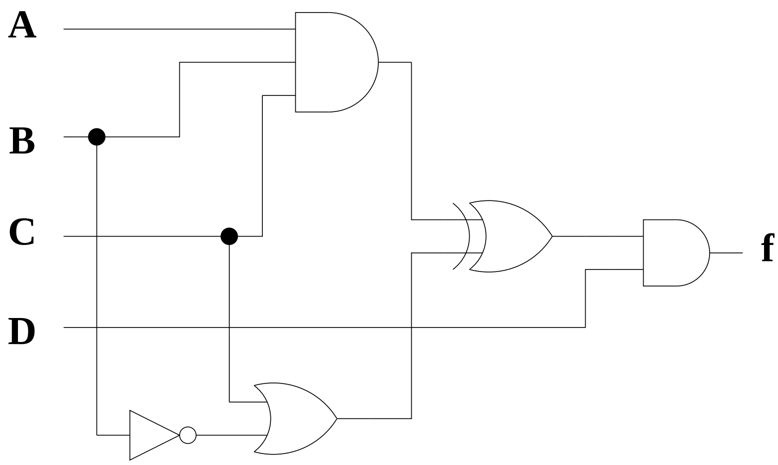
In class we designed a 2-input multiplexer (with one *select* input).

(10 pts) Using this component as a building block, show the design for a 4-input multiplexer. By *building block*, we mean that you should use the multiplexer symbol in your design (as opposed to the AND, OR, and NOT gates that make up the multiplexer).



Question 5

Consider the following circuit (note its relationship to the one in homework 1).



1. (10 pts) What is the corresponding truth table?

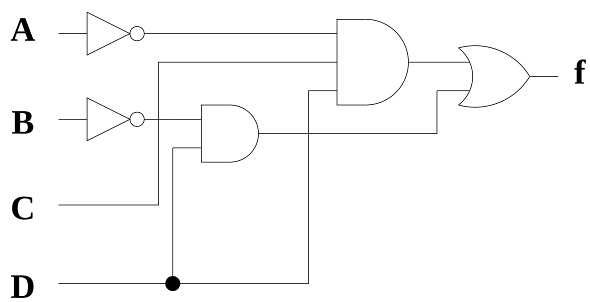
A	B	C	D	f
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

2. (10 pts) Show the Karnaugh map, the clusters, and the reduced algebraic representation.

CD \ AB	00	01 (B)	11 (A, B)	10 (A)
00	0	0	0	0
01 (D)	1	0	0	1
11 (C, D)	1	1	0	1
10 (C)	0	0	0	0

$f = \bar{B}D + \bar{A}CD$

3. (10 pts) Show the simplified circuit.



Question 6

How much time did you spend on this homework assignment?