Exam #1 for Computer Logic Design (CDA 3201)

Fall 2001

NAME: ______________________________ **SSN:** _____________________

Welcome to exam #1 in *Computer Logic Design* (CDA 3201). You have 75 minutes. Read each problem carefully. There are eight required problems (each worth 12 points - you get 4 points for "free") and one extra credit problem worth 5 points. You may have with you (on your desk, that is) a calculator, pencils, erasers, blank paper, and a lucky rabbit's foot. You will be given Table 2.2 (page 91) of your text (Boolean algebra postulates and theorems). Please start each numbered problem on a new sheet of paper and do not write on the back of the sheets (I really do not care about saving paper!). Submit everything in problem order. No sharing of calculators. Good luck and be sure to show your work!

Problem #1 (5 minutes) (a, b = 6 pts each)

a) Give the 6-bit sign-magnitude, 1's complement, and 2's complement representations for decimal 3 and –7.

b) Convert decimal 51768 into hexadecimal, octal, and binary.

Problem #2 (10 minutes)

Prove theorem T5(a) and T5(b) (from the "Table 2.2" on the last page of the exam) using the Boolean algebra postulates (and duality, if needed). Carefully show *every* (emphasis on *every*) step.

Problem #3 (10 minutes) (a, b = 6 pts each)

a) Given $f(a,b,c,d) = \sum m(0,2,5,7,8,10,13,15)$. Find the minimum POS and SOP expressions.

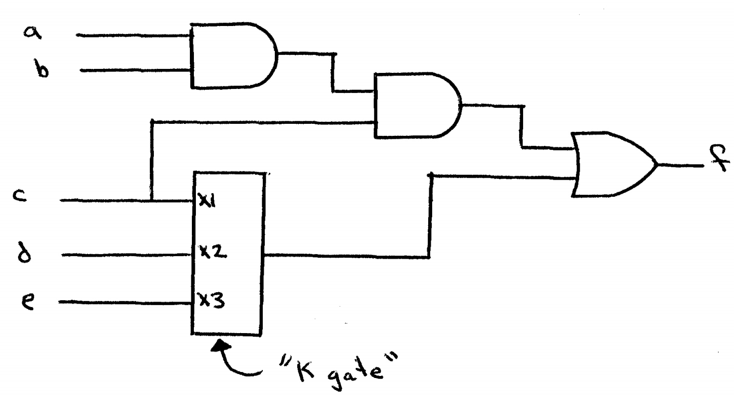
b) Given $f(a,b,c,d,e) = \sum m(0,1,6,10,12,14,16,17,26,30)$. Find the minimum SOP expression using a 5-variable K-map.

Problem #4 (15 minutes)

You are given the below circuit. The gate labeled "K gate" has the truth table given below. Your job is to analyze this circuit and come-up with the minimized two-level circuit for the same function that uses only AND and OR gates (you may assume that complementary inputs, if needed, are directly available - e.g., both A and ~A are available). Hint: THINK.

Truth table for the "K gate":

X1	X2	X3	f
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	0



Problem #5 (10 minutes)

Minimize (to POS form) $f(a,b,c,d)=\sum m(0,1,3,6,7,14,15)$ using Quine McClusky tabulation. You must show your work.

Problem #6 (5 minutes)

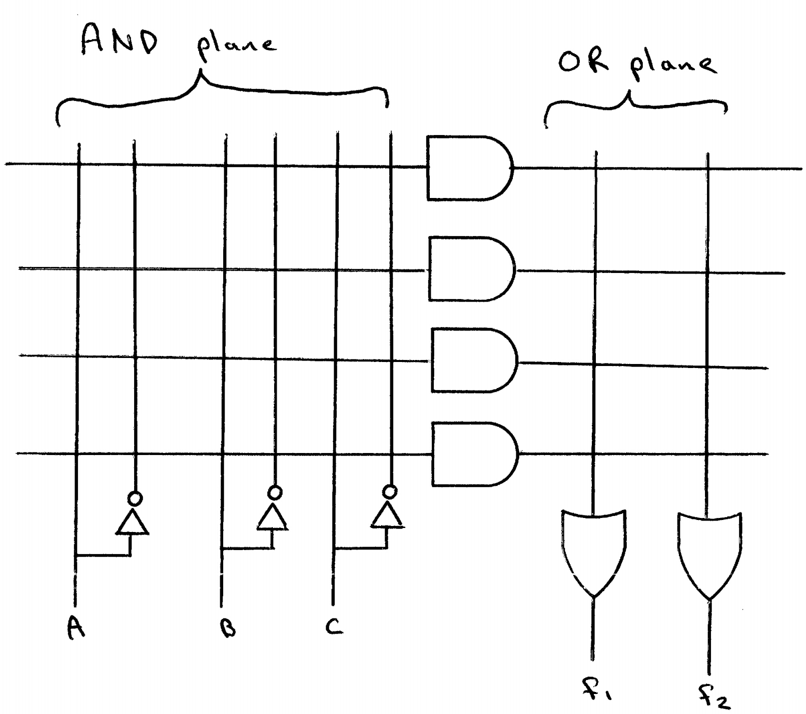
Realize $f(a,b,c)=\sum m(2,4,5,7)$ with a 4-to-1 multiplexer module (yes, you can use inverters too).

Problem #7 (15 minutes)

Here is what is in your parts bin… inverters, 2 and 3-input AND, OR, and NAND gates, multiplexers (of any size and type), decoders (of any size), and 4-bit adder units. The adder units take a carry-in and two 4-bit input values and output a single 4-bit sum value and a carry out. Design a 2's complement adder/subtractor with an overflow output using only these parts. The overflow output should be "0" if no overflow occurred and the output from the adder is valid and "1" if an overflow occurred and the output from the adder is not valid. Hint: You may not need to use all the parts in your parts bin!

Problem #8 (10 minutes)

Program the below PLA to implement $f_1(a,b,c)=\sum m(1,3,4)$ and $f_2(a,b,c)=\sum m(1,7)$



Extra Credit (a, b = 2 pts, c = 1 pts)

Answer the following questions:

a) Given a 10-milliamp current flowing through a 500 ohm resistor, what is the voltage drop across the resistor?

b) If a voltage source is wired directly to ground, and there is no fuse or circuit breaker in the circuit, what will happen? What if this short circuit is caused by a ring on your finger or a metal watch band?

c) If you touch a voltage source with your left hand, what may happen? Why should you not use your left hand when dealing with electrical circuits?

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Section 2.2 Switching Functions **91**

TABLE 2.2 BOOLEAN ALGEBRA POSTULATES AND THEOREMS

Expression	Dual
$P2(a) : a + 0 = a$	$P2(b) : a \cdot 1 = a$
$P3(a) : a + b = b + a$	$P3(b) : ab = ba$
$P4(a) : a + (b + c) = (a + b) + c$	$P4(b) : a(bc) = (ab)c$
$P5(a) : a + bc = (a + b)(a + c)$	$P5(b) : a(b + c) = ab + ac$
$P6(a) : a + \bar{a} = 1$	$P6(b) : a \cdot \bar{a} = 0$
$T1(a) : a + a = a$	$T1(b) : a \cdot a = a$
$T2(a) : a + 1 = 1$	$T2(b) : a \cdot 0 = 0$
$T3 : \quad \bar{\bar{a}} = a$	
$T4(a) : a + ab = a$	$T4(b) : a(a + b) = a$
$T5(a) : a + \bar{a}b = a + b$	$T5(b) : a(\bar{a} + b) = ab$
$T6(a) : ab + a\bar{b} = a$	$T6(b) : (a + b)(a + \bar{b}) = a$
$T7(a) : ab + a\bar{b}c = ab + ac$	$T7(b) : (a + b)(a + \bar{b} + c) = (a + b)(a + c)$
$T8(a) : \overline{a + b} = \bar{a}\bar{b}$	$T8(b) : \overline{ab} = \bar{a} + \bar{b}$
$T9(a) : ab + \bar{a}c + bc = ab + \bar{a}c$	$T9(b) : (a + b)(\bar{a} + c)(b + c) = (a + b)(\bar{a} + c)$

$T10(a) : f(x_1, x_2, \ldots, x_n) = x_1 f(1, x_2, \ldots, x_n) + \bar{x}_1 f(0, x_2, \ldots, x_n)$

$T10(b) : f(x_1, x_2, \ldots, x_n) = [x_1 + f(0, x_2, \ldots, x_n)][\bar{x}_1 + f(1, x_2, \ldots, x_n)]$