EECS 281:	Sample Test 3 (5 pages)	Due: Tuesday, November 2, 2004
Name:	Email:	$\qquad \qquad $

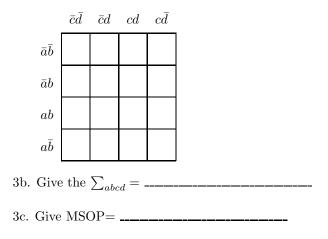
1. (10 points) Please answer the following True or False in the context of Boolean Algebra:

Т	F	$\overline{a} + b = \overline{a}\overline{b} + b$	(hint: k-map or truth table)
Т	F	$a\overline{a} = a \oplus a$	(Wakerly section $5.8.1$ page $410-413$)
Т	F	$\sum_{ab}(1,2) = a \oplus b$	(hint: use truth table)
Т	F	$a = ab + \overline{b}a$	
Т	F	$\sum_{abc} (0, 2, 4, 5, 6) = a\overline{b} + \overline{c}$	(hint: use k-map)
Т	F	$b + \overline{b} = \overline{a}\overline{a}$	
Т	F	$\sum_{abc}(1,3,5,7) = \prod_{abc}(2,4,6)$	
Т	F	$a + \overline{a}b = a + b$	
Т	F	$\overline{a+\overline{a}} = \overline{c}c$	(see MIT problem set 1 $\#22$)
Т	F	$\prod_{abc}(1,2,5) = (a+b+\overline{c})(a+\overline{b}+c)(\overline{a}+b+\overline{c})$	(Wakerly, pg 208)

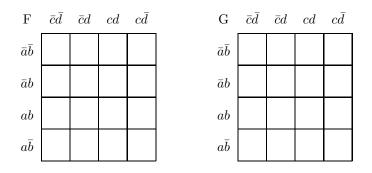
2. (10 points) Use Boolean Algebra to establish the identity. Show the Theorem numbers (i.e. T1-T13) for each step of your proof:

Theorem	Expression
	$c = \overline{(b+\overline{c})(a+\overline{c})} + cb + c\overline{b}$

3a. (15 points) Show the optimal minimal circling in the k-map in minterm function $f(a, b, c, d) = (\overline{a} \oplus b) + \overline{a}cd + bcd$ (hint: replace xor as $a \oplus b$ with $a\overline{b} + \overline{a}b$):



4a. (20 points) Show the optimal multi-output minimal circling the terms and in the k-map in minterm function $F = \sum_{abcd} = (4, 12, 13, 15)$ and $G = \sum_{abcd} = (6, 13, 14, 15)$. Indicate which circle belongs to what function.



4b. Give the common term of multi-output MSOP = _____

4c. Give the multi-output MSOP of F= _____

4d. Give the multi-output MSOP of G= _____

4e. Fill in the PLA

Group	Minterms	0-cubes	Minterms	1-cubes	Minterms	2-cubes
G_0						
G_1						
G_2						
G_3						
G_4						

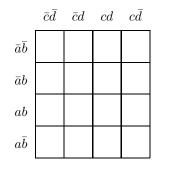
5a. (20 points). Do the Quine-McCluskey Algorithm of $\sum_{a,b,c,d} (0, 1, 6, 7, 14, 15)$.

5b. Fill in the covering table

EPI?	Needed?	PI-cubes				
		Covered?				

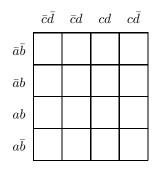
5c. Give the MSOP= _____

5d. Show the optimal k-map:



5e. Give the MSOP of the k-map: _____

6a. (10 points) Given $\sum_{a,b,c,d} (0, 1, 6, 7, 14, 15)$ and the don't cares (2, 8, 10), show the optimal k-map:



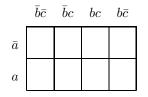
6b. Give the MSOP of the k-map: _____

7. (15 points) A programmer as written the following C code fragment:

f=0; if (a ^ b) { if (c) { f=1; } } else if (b | c) { f=1; } else if (~ b) { f=1; }

7a. Give the truth table for the variable f (assume that a, b, c are boolean values only):

7b. Give the optimal k-map of 7a.



7c. Give the MSOP of the k-map: _____

7d. Re-write as optimal C code:

x1. (Extra credit 10 points) Using C++ data types for a machine that uses a char of 4-bits, convert the following into one's complement big-endian binary and if not, then show why not?: where signed char s, a=6, b=-3; For addition and indicate if end-around-carry, overflow and/or carry has occurred. Show work.

Give unsigned char range:	
Give signed char range:	Wakerly Table 2-6, page 40
unsigned char $x = 2;$	Wakerly section 2.5.6 page 38
signed char $x = -2;$	Wakerly section 2.5.6 page 38
$\mathbf{s} = (\sim \mathbf{a}) + 1;$	
$s = \sim a;$	
s = -b;	Hint: one's complement, not two's complement
s = a & b;	bitwise operation
$\mathbf{s} = \mathbf{a} + \mathbf{b};$	end-around-carry occurs here! Given in Wakerly section 2.7, page 44
s = a - b;	Hint: complement and then add

Theorem	Relationship	Dual	XOR	Property
T1	a1 = a	a + 0 = a	$a \oplus 0 = a$	Identity
T2	a0 = 0	a + 1 = 1	$a \oplus 1 = \overline{a}$	Domination
Т3	aa = a	a + a = a	$\begin{array}{c} a \oplus a = 0\\ a \oplus a \oplus a = a \end{array}$	Idempotency
Τ4	$\overline{\overline{a}}$			Involution
T5	$a\overline{a} = 0$	$a + \overline{a} = 1$	$a \oplus \overline{a} = 1$	Complement
Т6	ab = ba	a+b=b+a	$a\oplus b=b\oplus a$	Commutative
Τ7	(ab)c = a(bc)	(a+b) + c = a + (b+c)	$(a \oplus b) \oplus c = a \oplus (b \oplus c)$	Associative
Т8	(a+b)(a+c) = a+bc	a(b+c) = ab + ac	$a(b\oplus c)=ab\oplus ac$	Distributive
Т9	a(a+b) = a	a + ab = a	$a\oplus ab=a\overline{b}$	Absorption Covering
T10	$(a+b)(a+\overline{b}) = a$	$ab + a\overline{b} = a$	$ab\oplus a\overline{b}=a$	Combining
T11	$(a+b)(\overline{a}+c)(b+c) = (a+b)(\overline{a}+c)$	$ab + \overline{a}c + bc = ab + \overline{a}c$		Consensus Proof by k-map
T12	$a + a + \dots + a = a$	$aa\cdots a=a$	$\begin{array}{c} a \oplus a \oplus \cdots \oplus a_{odd} = a \\ a \oplus a \oplus \cdots \oplus a_{even} = 0 \end{array}$	Generalized Idempotency
T13	$\overline{a+b} = \overline{a}\overline{b}$	$\overline{ab} = \overline{a} + \overline{b}$	$\overline{ab} = \overline{a} \oplus \overline{b} \oplus \overline{a}\overline{b}$	DeMorgan
XOR	$ab=a\oplus \overline{b}\oplus \overline{a}\overline{b}$	$a + b = a \oplus b \oplus ab$	$a \oplus b = \overline{a} \oplus \overline{b} = a\overline{b} + \overline{a}b$	Definition