EECS 203: Intro to Computer Engineering
Spring Quarter 2008
Homework #1

2.

f(a,b,c,d)	Reason
$\bar{a}b\bar{c}d + a\bar{b}\bar{c}d + a\bar{b}cd + ab\bar{c}d + abcd$	Given
$(\bar{a}b\bar{c} + a\bar{b}\bar{c} + a\bar{b}c + ab\bar{c} + abc)d$	$x(y+z)=xy+xz$
$((a + \bar{a})b\bar{c} + a\bar{b}\bar{c} + ac(\bar{b} + b))d$	$x(y+z)=xy+xz$
$(b\bar{c} + a\bar{b}\bar{c} + ac)d$	$x + \bar{x} = 1$
$((b + a\bar{b})\bar{c} + ac)d$	$x(y+z)=xy+xz$
$((b + a)\bar{c} + ac)d$	$x + \bar{x}y = (x + \bar{x})(x + y) = x + y$
$(b\bar{c} + a\bar{c} + ac)d$	$x(y+z)=xy+xz$
$(b\bar{c} + a(\bar{c} + c))d$	$x(y+z)=xy+xz$
$(b\bar{c} + a)d$	$x + \bar{x} = 1$

Minimum Literal Count = 4

3.

Show $f(a,b,c,d) = b + \bar{c}d$	Reason
$ab\bar{c} + b\bar{c}\bar{d} + bc + \bar{c}d$	Given
$(ab + b\bar{d} + d)\bar{c} + bc$	$x(y+z)=xy+xz$
$(ab + b + d)\bar{c} + bc$	$x + \bar{x}y = (x + \bar{x})(x + y) = x + y$
$ab\bar{c} + b\bar{c} + \bar{c}d + bc$	$x(y+z)=xy+xz$
$b(a\bar{c} + \bar{c} + c) + \bar{c}d$	$x(y+z)=xy+xz$
$b + \bar{c}d$	$x + \bar{x} = 1,\ x + 1 = 1,\ x \cdot 1 = x$

Desired result is obtained, therefore QED.

4.

Show $f(a,b,c,d) = bc$	Reason
$(a+c)(\bar{a}+b)(b+c)$, $ab=0$, $a+b=1$	Given
$(a+c)(b+\bar{a}c)$	$x+yz = (x+y)(x+z)$
$ab+a\bar{a}c+\bar{a}cc+bc$	$(w+x)(y+z)=wy+wz+xy+xz$
$\bar{a}c+bc$	$x\bar{x}=0$, $x\cdot 0=0$, $ab=0$
$(a+b)(\bar{a}+b)c$	$a+b=1$, $x\cdot 1=x$
$(a\bar{a}+b)c$	$x+yz = (x+y)(x+z)$
bc	$x\bar{x}=0$, $x+0=x$

Desired result is obtained, therefore QED.

5.a)

$$f(a,b,c) = \bar{a}bc + \bar{b}\bar{c} + a\bar{b}$$
$$f(a,b,c) = \overline{(a+\bar{b}+\bar{c})} + \overline{(b+c)} + \overline{(\bar{a}+b)}$$

5. b)

$$f(a,b,c) = \bar{a}bc + \bar{b}\bar{c} + a\bar{b}$$
$$\overline{f(a,b,c)} = \overline{\bar{a}bc + \bar{b}\bar{c} + a\bar{b}}$$
$$f(a,b,c) = \overline{(\bar{a}bc)}\,\overline{(\bar{b}\bar{c})}\,\overline{(a\bar{b})}$$

6.a,b)

a	b	c	$\bar{a}$	$\bar{b}$	$\bar{c}$	$f_p(a,b,c)$	$f_n(a,b,c)$	$f(a,b,c)$
0	0	0	1	1	1	z	0	0
0	0	1	1	1	0	1	z	1
0	1	0	1	0	1	z	0	0
0	1	1	1	0	0	1	z	1
1	0	0	0	1	1	z	0	0
1	0	1	0	1	0	1	z	1
1	1	0	0	0	1	1	z	1
1	1	1	0	0	0	1	z	1

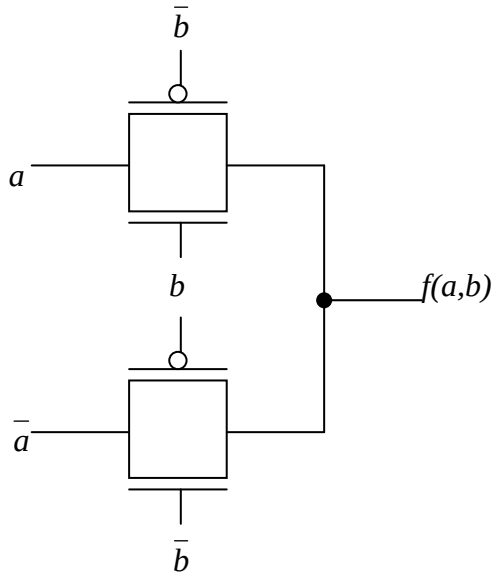
c)

a\bc	00	01	11	10
0	0	1	1	0
1	0	1	1	1

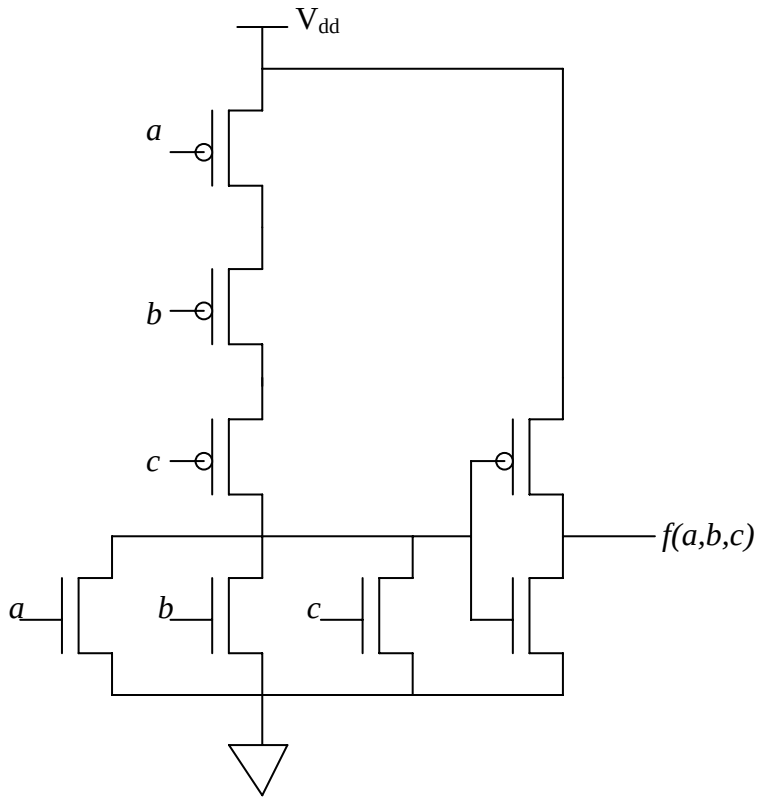
$f(a,b,c) = ab+c$

7.

$f(a,b) = ab + \bar{a}\bar{b}$



8.



Requires 8 transistors (4 NMOS, and 4 PMOS) because you can only obtain a NOR using 3 NMOS and 3 PMOS. Therefore you need to add the inverter to obtain the OR gate.