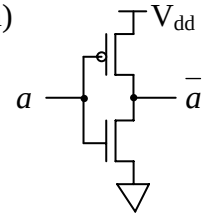
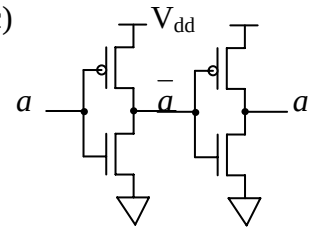
EECS 203 HW2 Solution
Spring 2008
(Solutions borrowed from Shu You Li's Solutions)

2.
(a)



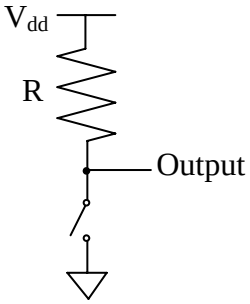
(b) NMOS is on when its gate is high; PMOS is on when its gate is low. When there is no input connected, the gates of PMOS and NMOS is floating. That means, PMOS and NMOS can be any state. There is a chance that both PMOS and NMOS are on. As a result the inverter will be shorted!

(c)



(d)
No current flowing in the circuit, because there is no status change.

3.
(a)



(b) Transistor-Transistor Logic (TTL) family
(c) Low-power Schottky type
(d) The light-emitting diode may blow out if we don't use a resistor to share voltage (limit current).
(e) Dual In-line Package
(f) Yellow
(g) The input of TTL circuit is high by default. It floats high if it isn't driven otherwise.

4.

Any Boolean that combine AND and OR should answer this question. For example a+bc. Its truth table is:

a	*b*	*c*	*f(a,b,c)*
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

5.

(a) From table below, $f(a,b,c) = \bar{a} + b\bar{c}$

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

(b) From table below, $f(a,b,c) = ac + b\bar{c}$

A \ *bc*	00	01	11	10
0	X	0	0	1
1	0	X	1	X

6.

(a) From table below, $\bar{f}(a,b,c) = \bar{a}b + b\bar{c}$, so $f(a,b,c) = \overline{\bar{a}b + b\bar{c}} = (a + \bar{b})(\bar{b} + c)$

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

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

A \ *bc*	00	01	11	10
0	0	1	X	1
1	0	X	0	1

7.

$f(a,b,c,d) = \sum(1,2,5,7,13) + d(0,6,10,15)$

(a) Truth table:

a	*b*	*c*	*d*	*f(a,b,c,d)*
0	0	0	0	X
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	X
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	X
1	0	1	1	0
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	X

(b) From the Karnaugh map below, $f(a,b,c,d) = bd + \bar{a}\bar{b}\bar{c} + \bar{a}c\bar{d}$

ab \ *cd*	00	01	11	10
00	X	1	0	1
01	0	1	1	X
11	0	1	X	0
10	0	0	0	X

(c) From the Karnaugh map below, $\bar{f}(a,b,c,d) = a\bar{b} + b\bar{d} + \bar{b}cd$, so

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

ab \ *cd*	00	01	11	10
00	X	1	0	1
01	0	1	1	X
11	0	1	X	0
10	0	0	0	X

(d)

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

(e) Just follow the equation of (d), you can draw the circuit.

8.

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

$$f(a,b,c,d) = (\bar{a} + \bar{b})(\bar{c} + \bar{d}) = (\overline{ab})(\overline{cd})$$

$$f(a,b,c,d) = \overline{ab + cd}$$