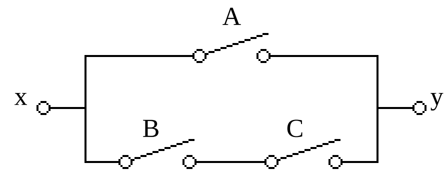
ECE 1250 homework # D1 Combinatorial Logic

b

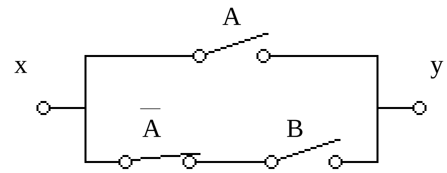
1. Look at the network of switches to the right. $A = 1$ means that switch A is closed (making contact). $A = 0$ means that switch A is open (not making contact). Same for the other two switches, B, and C. If there is a path of connection between terminals x and y then consider $P = 1$, otherwise $P = 0$.



   a) Create a truth table showing A, B, and C as inputs and P as the output

   b) Write a Boolean expression for P in terms of A, B, and C.

2. Repeat problem 1 for the next network shown. The $\overline{A}$ switch is closed when $A = 0$ and open when $A = 1$. Also simplify the Boolean expression you get in part b).



3. Find the simplest SOP form for the following Boolean expressions. You may wish to refer to the table of Logic Identities shown on page 645 of you textbook.

   a) $(A+B)+\left(\overline{B}+C\right)$

   b) $A\cdot B+B\cdot\overline{A}$

   c) $A\cdot(A\cdot B+C)$

   d) $\left(A+\overline{B}\right)\cdot(B+C)$

   e) $A\cdot\left(\overline{A}\cdot B+C\right)$

   f) $\left(\overline{A}+B\right)\cdot(B+C)$

   g) $A\cdot B\cdot C+A\cdot B\cdot\overline{C} \;=\; A\cdot B\cdot\left(C+\overline{C}\right)$

   h) $\overline{A}\cdot B\cdot C+\overline{A}\cdot\overline{B}\cdot C$

   i) $\overline{A}\cdot B\cdot C+A\cdot\overline{B}\cdot C+A\cdot B\cdot\overline{C}+A\cdot B\cdot C$

   j) $A\cdot B\cdot C+\overline{B}\cdot C \;=\; A\cdot B\cdot C+A\cdot\overline{B}\cdot C+\overline{A}\cdot\overline{B}\cdot C$

   k) $\overline{A}\cdot B+\overline{A}\cdot C+\overline{A}\cdot\overline{B}\cdot\overline{C}+\overline{A}\cdot B\cdot\overline{C}+A\cdot B\cdot\overline{C}$

   l) $\overline{A}\cdot\overline{B}\cdot C+\overline{A}\cdot B\cdot\overline{C}+A\cdot\overline{B}\cdot\overline{C}+A\cdot B\cdot C$

   m) Simplify l) with one or more exclusive-OR gates.

4. The truth table at right shows both the exclusive-OR function and the exclusive-NOR (equivalence) functions.

   a) Express the XOR in a sum-of-products (SOP) form.

   b) Manipulate the following product-of-sums (POS) form to show that it is the same.
   $$(A+B)\cdot\left(\overline{A}+\overline{B}\right)$$

   c) Express the XNOR in a sum-of-products (SOP) form.

   d) Manipulate the following product-of-sums (POS) form to show that it is the same.
   $$\left(A+\overline{B}\right)\cdot\left(\overline{A}+B\right)$$

A	B	XOR $A \oplus B$	XNOR $A \odot B$
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

5. Simplify the following. Hint: You'll need DeMorgan's theorem

   a) $\overline{X}\cdot\overline{Y}\cdot\overline{Z}+\overline{X}\cdot Y\cdot Z+X\cdot\overline{(Y+Z)}$

   b) $\overline{\left(\overline{\left(A\cdot\overline{B}+\overline{A}\cdot B\right)}\cdot\overline{A}\cdot B\right)}$

6. For the given truth table, find the expression for F.

A	B	C	F
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

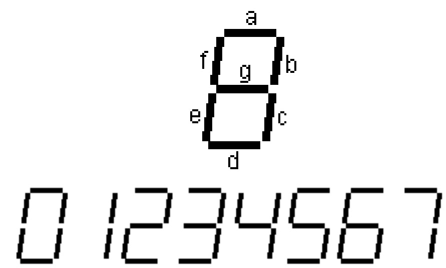
7. A 3-member town council votes on resolutions by pressing a button to indicate "yes".
   a) Create a logic circuit which will indicate if a resolution passes with a majority vote.

   b) Add more to your circuit so the the Mayor could veto the resolution by pushing a button.

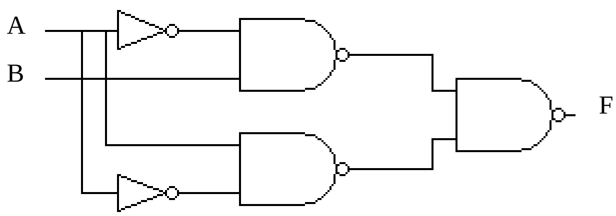
   c) Add more to your circuit so the the Mayor's veto could be overridden by a unanimous vote of the council.

8. 7-segment display problem.

   Make a truth table for 8 possible inputs (0 through 7). Look at the 7-segment display at right and determine the outputs necessary to operate segments b and d for input binary numbers 0 through 7. Find logical expressions and the logic circuits for segments b and d.

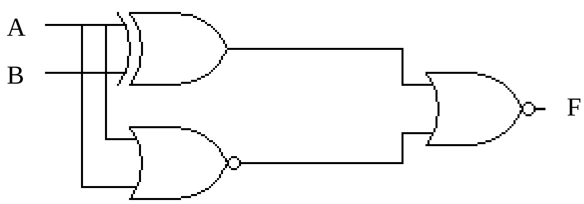


9. a) Use a multi-column truth table or Boolean algebra to find the function, F of the logic circuit shown.



   b) Does this perform some commonly known operation?

10. a) Use a multi-column truth table or Boolean algebra to find the function, F of the logic circuit shown.



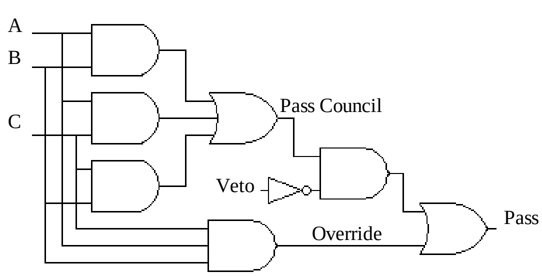
   b) Does this perform some commonly known operation?

Answers

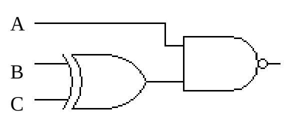
1. $A + B\cdot C$ 2. $A + B$ 3. a) 1 b) B c) $A\cdot B + A\cdot C$ d) $A\cdot B + A\cdot C + \overline{B}\cdot C$ e) $A\cdot C$ f) $\overline{A}\cdot C + B$ g) $A\cdot B$
   h) $\overline{A}\cdot C$ i) $B\cdot C + A\cdot C + A\cdot B$ j) $A\cdot C + \overline{B}\cdot C$ k) $\overline{A} + B\cdot\overline{C}$ l) IS the simplest SOP form m) $A \oplus (C \oplus D)$

5. a) $\overline{X}\cdot Y\cdot Z + \overline{Y}\cdot\overline{Z}$ b) 1 6. $A + C$

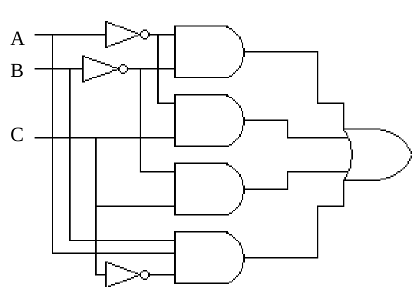
7.



8.



$b = \overline{A\,(B \oplus C)}$



$d = \overline{A}\cdot\overline{C} + \overline{A}\cdot B + B\cdot\overline{C} + A\cdot\overline{B}\cdot C$

9. a) $A\cdot\overline{B} + \overline{A}\cdot B$ b) XOR

10. a) $A\cdot B$ b) AND