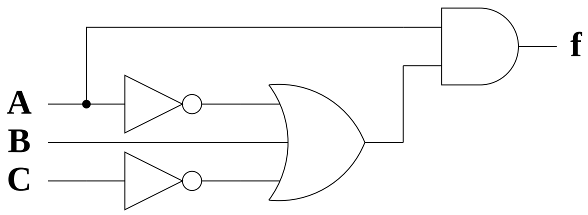
Embedded Real-Time Systems (AME 3623)
Homework 1 Solutions

February 5, 2007

Question 1

Consider the following circuit.



(10 pts) What is the corresponding truth table?

Shortcut: A must be 1 in order for f to be 1.

A	B	C	f
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

Question 2

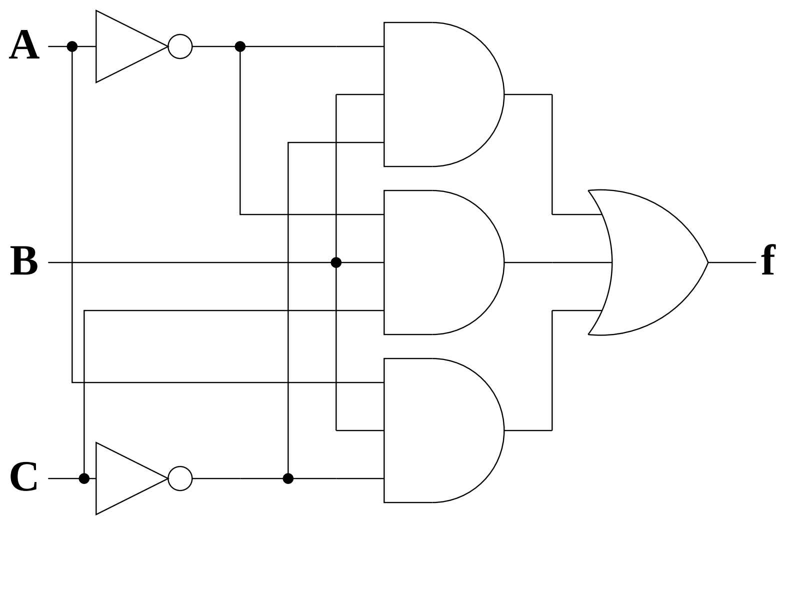
Consider the following function:

A	B	C	f
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	0

1. (10pts) Show the algebraic expression for the "minterm" form of the circuit (set of 3-term ANDs that are then ORed together).

   $f = \bar{A}B\bar{C} + \bar{A}BC + AB\bar{C}$

2. (10pts) Show the corresponding circuit

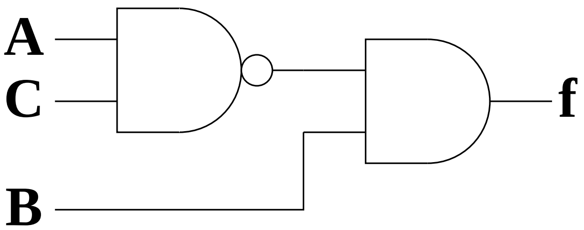


3. (10pts) Reduce this algebraic expression to a minimal form (note that there may be more than one correct answer). Show each step, showing the name of the rule that you use.

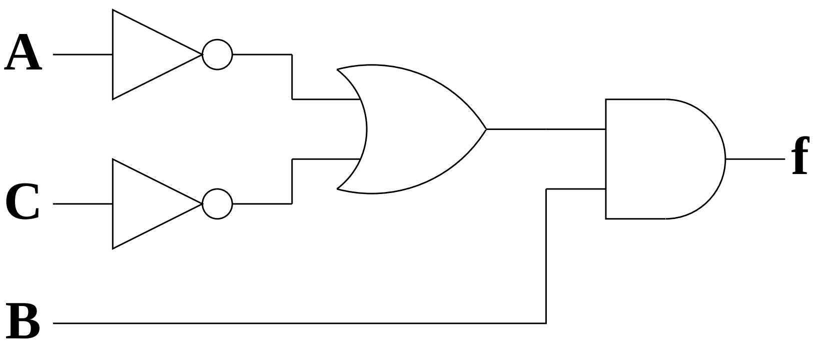
$$\begin{array}{rl}
\bar{A}B\bar{C} + \bar{A}BC + AB\bar{C} & \\
\bar{A}B\bar{C} + \bar{A}B\bar{C} + \bar{A}BC + AB\bar{C} & X = X + X \\
\bar{A}B\bar{C} + \bar{A}BC + \bar{A}B\bar{C} + AB\bar{C} & Commutative \\
\bar{A}B(\bar{C} + C) + (\bar{A} + A)B\bar{C} & Distributive \\
\bar{A}B(1) + (1)B\bar{C} & X + \bar{X} = 1 \\
\bar{A}B + B\bar{C} & X * 1 = X \\
B(\bar{A} + \bar{C}) & Commutative\ and\ Distributive \\
B\overline{AC} & DeMorgan's\ Law
\end{array}$$

Note: the last step is not required for full credit.

4. (10pts) Show the corresponding circuit



OR



Question 3

Consider the following function:

A	B	C	f
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

1. (10pts) Show the algebraic expression for the "minterm" form of the circuit.

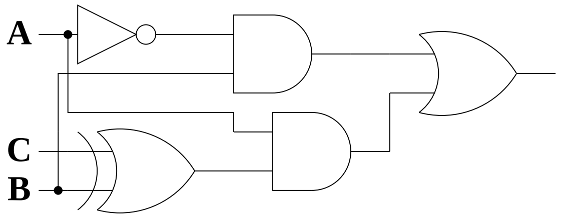
   $\bar{A}\bar{B}C + \bar{A}BC + A\bar{B}C + AB\bar{C}$

2. (10pts) Reduce this algebraic expression to a minimal form. Show each step, showing the name of the rule that you use.

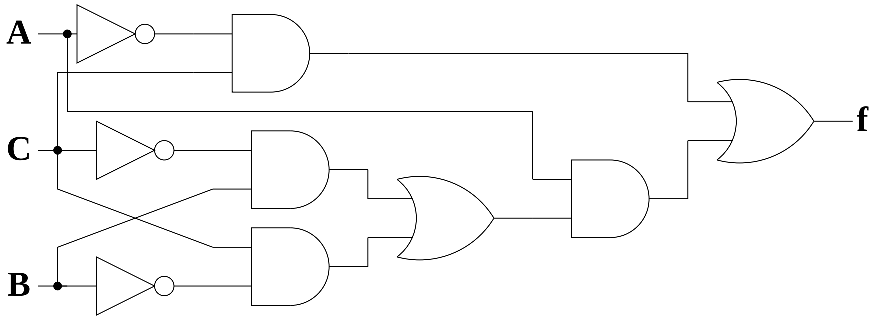
$$\begin{array}{rl}
\bar{A}\bar{B}C + \bar{A}BC + A\bar{B}C + AB\bar{C} & \\
\bar{A}C(\bar{B} + B) + A(\bar{B}C + B\bar{C}) & \quad Commutative\ and\ Distributive \\
\bar{A}C(1) + A(\bar{B}C + B\bar{C}) & \quad X + \bar{X} = 1 \\
\bar{A}C + A(\bar{B}C + B\bar{C}) & \quad X * 1 = X \\
\bar{A}C + A(B \oplus C) & \quad Definition\ of\ XOR
\end{array}$$

   Note: the last step is not necessary for full credit.

3. (10pts) Show the reduced circuit.



OR



Question 4

Suppose you need a circuit to perform an inversion (i.e., implement the NOT operator), but that you only have NOR gates.

(10 pts) How is this circuit wired (give a circuit diagram)?

If we wire the other input such that it is a constant **0**, then f will always be the inverse of A.