ELT-217, **Experiment AD-2**: DeMorgan's Theorem & Exclusive OR

EQUIPMENT NEEDED:

Analog Discovery
7400, quad 2-input NAND
7402, quad 2-input NOR
7404 Hex inverter
7408, quad 2-input AND;
7432, quad 2-input OR;
circuit diagrams for IC's

Notes:

1) **Before** wiring each circuit you must have a neat logic diagram showing pin numbers used and functional interconnections. (This circuit diagram must be included in your report.) When actually assembling the circuit make sure you are using the proper IC. Also do not forget to hook up power and ground to each IC you use.
2) For ease of typing, negation is sometimes indicated by an asterisk, an apostrophe, or a tilde.

   Thus $\overline{X}$ is the same as X* which is the same as X', which is the same as ~X, which are all ways of writing not X (or active low X).
3) If there is time at the end of doing this experiment, start on the design of Lab AD-3

A. DeMorgan's Theorem

OBJECTIVE:

To verify DeMorgan's Theorem using truth table comparison.

PROCEDURE:

For each of the four circuits producing paired outputs f and g shown in figure 1 on the next page, you are to:

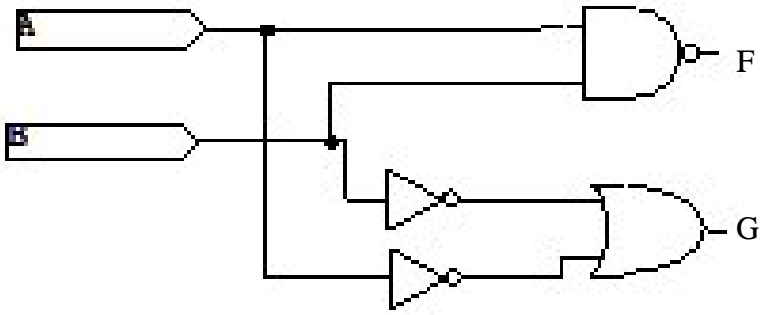
(1) Draw up the truth tables for the outputs f and g based on a theoretical analysis. Verify the equality of the two outputs from these truth tables.

(2) Wire up the circuit pairs and construct the truth table for each of the paired outputs f and g by applying all possible combinations of input signals to A and B.

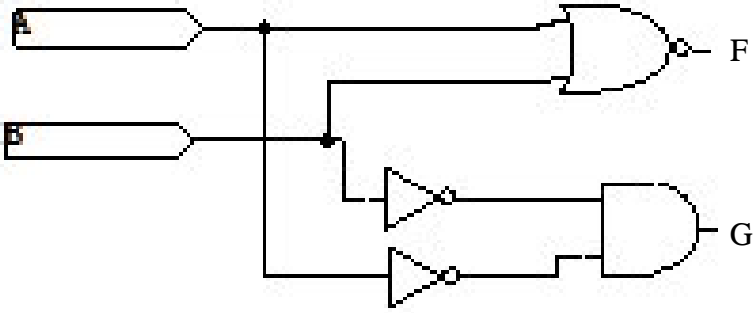
(3) State your conclusions, in the form of a Boolean expression, relating f and g, for each circuit pair.

Figure 1, Circuits for deMorgan's Theorem Evaluation

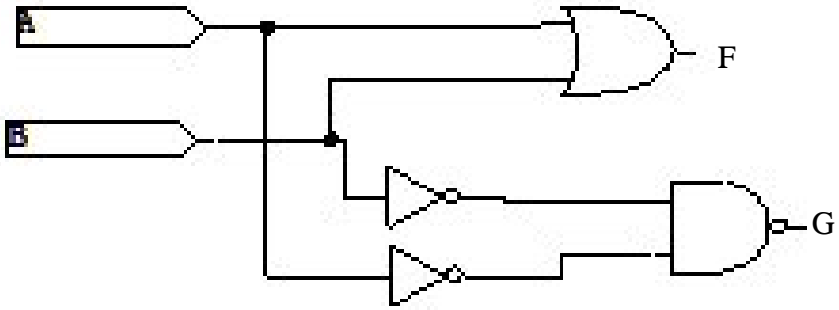
CIRCUIT #1



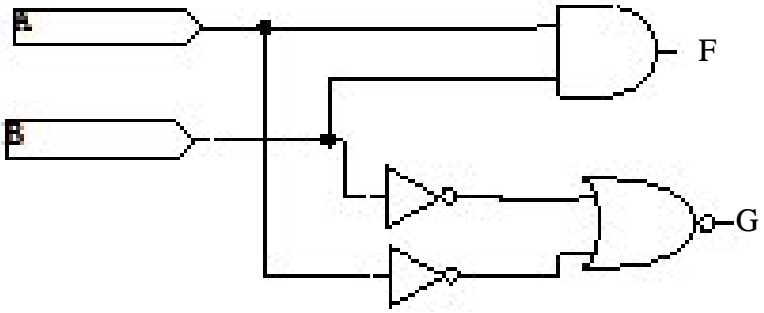
CIRCUIT #2



CIRCUIT #3



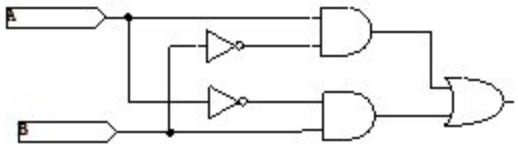
CIRCUIT #4



B. Logical Implementation of Exclusive-OR Using NAND gates.

Remembering that the equation for an EXCLUSIVE OR (XOR) is X=A*B + AB*, this can be directly implemented in SOP form using AND gates, OR gates, and inverters as shown in figure 2.

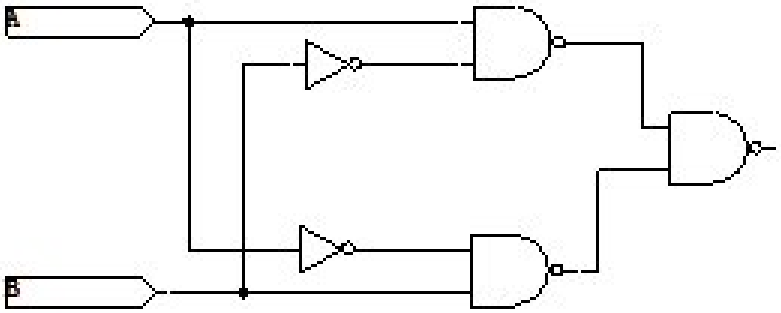
Figure 2. SOP form of XOR.



If we convert this AND-OR configuration to all NAND gates and inverters, we get Circuit #1 of Figure 3, below. Figure 3 illustrates two forms of an XOR circuit, both built using only NAND gates and inverters, one simpler (fewer gates) than the other. Verify that both circuits are identical by constructing both circuits, measuring and recording truth tables for each, and in your report writing the corresponding expression.

Figure 3, Exclusive-OR Circuits to be wired

CIRCUIT #1



CIRCUIT #2