ECE 124 digital circuits and systems
Assignment #2

Q1: Design the simplest circuit that has 3 inputs, x_1, x_2 and x_3, which produces an output of 1 whenever exactly one or two of the inputs have the value of 1; otherwise, the output is 0.

Q2: Consider a circuit with one output f and four inputs a_1, a_0, b_1 and b_0. Let $A = a_1a_0$ be a binary representation of a number where the four possible values of A (00, 01, 10, and 11) represent the four unsigned integer values 0, 1, 2 and 3, respectively. Similarly, let $B = b_1b_0$ represent another number with the same four values. Assume that f should be 1 if the numbers represented by A and B are equal, otherwise f should be 0.

(a) Provide the truth table for f;

(b) Determine the simplest product-of-sums expression for f.

Q3: Consider a circuit with one output f and four inputs a_1, a_0, b_1 and b_0. Let $A = a_1a_0$ be a binary representation of a number where the four possible values of A (00, 01, 10, and 11) represent the four unsigned integer values 0, 1, 2 and 3, respectively. Similarly, let $B = b_1b_0$ represent another number with the same four values. Assume that f should be 1 if $A \geq B$, otherwise f should be 0.

(a) Provide the truth table for f;

(b) Determine the simplest sum-of-products expression for f.

Q4: Consider the following sum-of-products expression $f = x_1'x_2'x_3 + x_1'x_2x_3' + x_1x_2'x_3' + x_1x_2x_3$. Implement f as a 2-level circuit using only NAND gates.

Q5: Consider the following product-of-sums expression $f = (x_1 + x_2' + x_3')(x_1' + x_2 + x_3')(x_1' + x_2' + x_3)(x_1 + x_2 + x_3)$. Implement f as a 2-level circuit using only NOR gates.

Q6: Consider the logic function $f = (((x_1x_2') + (x_1'x_2))x_3) + (((x_1x_2') + (x_1'x_2))'x_4)$ which is shown below (note that inverters are shown explicitly) in Figure 1.

(a) Implement/convert this circuit to one that uses only NAND gates and NOT gates.

(b) Implement/convert this circuit to one that uses only NOR gates and NOT gates.

Q7: Consider the logic function $f = (AB' + CD')E + BC(A + B)$.

(a) Draw this multi-level circuit using AND, OR and NOT gates.

(b) Convert and draw a multi-level circuit implementation that uses only NAND gates and NOT gates.

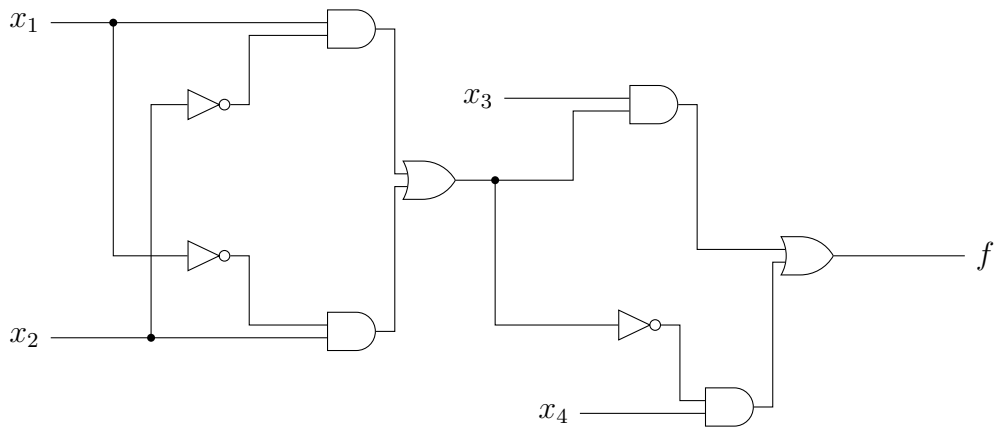

Figure 1: Circuit for Q6.

Q8: Consider the logic function $f = w(x + y + z) + xyz$.

(a) Draw this multi-level circuit using AND, OR and NOT gates.

(b) Convert and draw a multi-level circuit implementation that uses only NOR gates and NOT gates.