CS 312: Computer Architecture II

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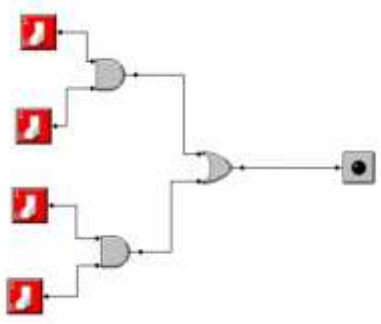
Lab 1. The AND, OR, NAND and NOR logic gates.

Use the MultimediaLogic (MMLogic) system to set up the following circuit: **F = AB + CD**
Use four switches for controlling the inputs and an LED to show the value of F.

Part 1. a). Simulate the circuit for all combinations of A, B, C, and D and record the results. Use a truth table to show these results.

A	B	C	D	AB	CD	F = AB + CD
0	0	0	0	0	0	0
0	0	0	1	0	0	0
0	0	1	0	0	0	0
0	0	1	1	0	1	1
0	1	0	0	0	0	0
0	1	0	1	0	0	0
0	1	1	0	0	0	0
0	1	1	1	0	1	1
1	0	0	0	0	0	0
1	0	0	1	0	0	0
1	0	1	0	0	0	0
1	0	1	1	0	1	1
1	1	0	0	1	0	1
1	1	0	1	1	0	1
1	1	1	0	1	0	1
1	1	1	1	1	1	1

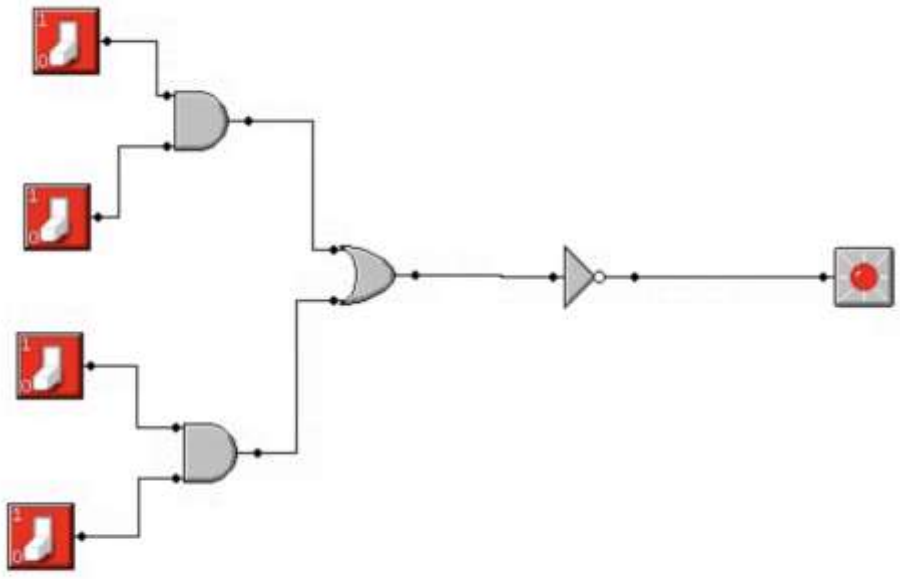
Part 1. b) Sketch or copy/paste screenshot of your circuit that you make in MM logic circuit here.



Part 2. a) Change the OR gate to a NOR gate. Simulate the circuit and record the results in a truth table.

A	B	C	D	AB	CD	F = AB NOR CD
0	0	0	0	0	0	1
0	0	0	1	0	0	1
0	0	1	0	0	0	1
0	0	1	1	0	1	0
0	1	0	0	0	0	1
0	1	0	1	0	0	1
0	1	1	0	0	0	1
0	1	1	1	0	1	0
1	0	0	0	0	0	1
1	0	0	1	0	0	1
1	0	1	0	0	0	1
1	0	1	1	0	1	0
1	1	0	0	1	0	0
1	1	0	1	1	0	0
1	1	1	0	1	0	0
1	1	1	1	1	1	0

Part 2. b) Draw the circuit (in all tasks copy a screenshot of your circuit that you make in MM logic). For the part2, the OR gate is changed to a new NOR gate.



Part 2. c) Write the equation for this new circuit, forming the equation based on the circuit diagram and not on the Truth Table. Apply **DeMorgan's Theorem** to this equation and apply again until you get a product of sums. Expand the product of sums to get the sum of products equation.

1. Original NOR circuit: F = (AB+CD)′
2. Now, apply DeMorgan's Theorem again to each negated product, since $(X \cdot Y)' = X' + Y'$:
   - F = (AB)′ · (CD)′ = (A′+B′) · (C′+D′)
3. Expand to Sum of Products:
   - F = (A′+B′) · (C′+D′) = A′C′ + A′D′ + B′C′ + B′D′

(SOP) form is: $F = A'C' + A'D' + B'C' + B'D'$

Part 3.a) Product of sums:
Base on the truth table from 2a, applying that the output is 1 if none of the input combinations that produce 0 is true, write out the equation. Apply the DeMorgan's Theorem to it and convert it into the POS form:

Answer:
F=(A+B+C′+D′)(A+B′+C′+D′)(A′+B+C′+D′)(A′+B′+C+D)(A′+B′+C+D′)(A′+B′+C′+D)(A′+B′+C′+D′)

Part 3.b) Sum of products:
Base on the truth table from 2a, applying that the output F is 1 if any of the input combinations that produces 1 is true, write the equation in an SOP form:

Answer:
F=A′B′C′D′+A′B′C′D+A′B′CD′+A′BC′D′+A′BC′D+A′BCD′+AB′C′D′+AB′C′D+AB′CD′

Show that the SOP form is equivalent to the equation in 2c:

Answer:
$F = A'C' + A'D' + B'C' + B'D'$ = (A′ + B′)(C′ + D′)

Grading rubric:

Parts	Points
Part 1.a	5
Part 1.b	5
Part 2.a	5
Part 2.b	5
Part 2.c	5
Part 3.a	5

Part 3.b	5

Submission:

This file must be submitted through Canvas.