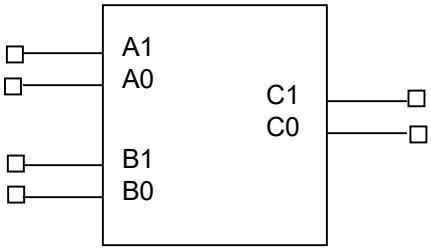
Lab 3: Combinational Design

PURPOSE

The purpose of this laboratory project is to introduce students to the synthesis of a digital device consisting exclusively of combinational functionality. In this lab, we will start with a natural language description of a device for which will then be designed, simulated, tested, and implemented. In this lab, students will implement a simple 2-bit priority selector and implement the device using a multi-level AND-OR-NOT logic implementation.

2-BIT MAXIMUM VALUE SELECTOR

Consider a simple device that takes two 2-bit binary inputs representing two values ranging from zero to three. The 2-bit value A is represented by two input variables A1 and A0. Values of A1 and A0 will be used to encode numeric values (in binary) as described below. 2-bit values for the second 2-bit input B and the 2-bit output C are encoded similarly. The 2-bit output C of the device will be the *greater* of the two values presented on the 2-bit inputs A and B.



A1A0 B1B0 C1C0	Value
00	Zero
01	One
10	Two
11	Three

Figure 1: The 2-bit priority selector and value encoding table

Consider a case in which the 2-bit value A encoded the value "One" and the 2-bit value B encoded the value "Two". In this case, the 2-bit value C should encode the greater of these two values ("Two"). At the digital level, the value A would be represented by two input variables A1 and A0 which would have the values 0 and 1, respectively. The value B would be represented by two input variables B1 and B0 which would have the values 1 and 0 respectively. The output value C would be represented by two output variables C1 and C0 which should have the values 1 and 0 respectively.

LAB 3 – TWO-LEVEL IMPLEMENTATION

The goal of this lab is to design a two-level solution for this device, simulate the device (and test your design), then to physically realize the device using AND, OR, and NOT components. Please document all of your work in your lab notebook.

Design [3 points]

- Construct a truth table that demonstrates completely functionality of this device.
- Construct a set of Boolean equations in SOP form that describe the required behavior of the output variables C1 and C0 in terms of the inputs variables A1, A0, B1, and B0. Minimize your equations using Boolean Algebra. Clearly state each step in your minimization.
- Draw a logic diagram for two-level implementation of your SOP equations.

Implement/Simulate [3 points]

- Simulate your two-level design.
- Test your design thoroughly. Include your full test results (as a truthtable or as a waveform) in your lab book.

LAB 3 – DEMONSTRATION

- **[2 points]** Demonstrate your simulation in your e-labbook. Test the device thoroughly. Make note of each test in your lab notebook. A complete test requires one test for each input assignment - your test should basically be a traversal of your truth table! Document your test cases and strategy clearly.

Integrated Writing [2 points]: Refer to "Digital System Design: Engineering Journals & Lab Policies" for details. 0.5 points each for Completeness, Clarity, Organization, and Testing.