**Experiment 7: Introduction to LabVIEW and Digital Circuits**

**Week One Objectives:**
- As you complete Part A you will become familiar with LabVIEW graphical programming language.
- In Part B you will demonstrate your ability to simulate logic circuits using LabVIEW.

**Week Two Objectives:**
- Construct logic circuits using a standard breadboard, integrated circuits, and a light emitting diode.

**Week 1 Pre Lab:**
- Bring a 3.5” diskette to lab. You will need it to save your files.
- Read and understand Section 9.4 in Hambley.
- Read and understand Sections 7.1 and 7.3 in Hambley.
- Examine the circuit of Part B. Create a truth table for this circuit.

**Week 2 Pre Lab:**
- Bring a 3.5” diskette to lab. You will need it to save your files.
- Using the attached breadboard diagram (Prelab Part C), draw the physical circuit layout. Draw the chips in the approximate final locations, wires that will connect power, ground, all input signals and all interconnects. You will use this diagram to wire up your circuit in class.

**Part A: Become Familiar with LabVIEW**

Work your way through the LabVIEW example starting on page 429 of Hambley. If you have difficulties ask the lab instructor for help. When you have completed the virtual instrument shown in Figures 9.24 and 9.25 have your lab instructor verify its operation.

**Part B: Constructing Combinatorial Logic Systems with LabVIEW**

1. Construct the logic circuit of Figure 1 using LabVIEW. Use Boolean toggle switches for the A and B inputs. Connect X to a light-emitting diode (LED). Your front panel should look like Figure 2 and the diagram should look like Figure 3. The switches and LED can be found on the Boolean menu of the Controls Palette. The logic gates and inverter can be found on the Boolean menu of the Functions Palette. Input A is high when the switch is up and low when the switch is down. The LED lights when X is high.

![Figure 1 Digital Schematic](image-url)
2. Turn on the circuit by clicking on the run continuously button. Change switch states to test all possible combinations of input logic states. Examine the output for each input state combination and create a truth table to describe the results.

3. Does this truth table agree with the results from the Pre Lab?

**Part C: Constructing Combinatorial Logic Systems**

1. Construct the digital circuit described by the digital schematic of Figure 1 using the breadboard, integrated circuits (chips) provided. Verify the correct output of the combinatorial circuit by using a light emitting diode. Follow the simple steps provided.
a. Examine the photograph of the breadboard in Figure 4 below. Notice the array of holes in the board. There are two thin strips of holes along the top and bottom edge of the breadboard. These are connected electrically lengthwise along the edge of the board. The voltage applied to any pinhole along the top row appears at every pinhole along the row. Likewise, the next row inboard is electrically connected. The twin rows at the bottom of the image are similarly connected. These strips are often used to provide voltage that is common to all the components in the circuit, such as power, or ground. You’ll notice that there is a connection from the top row to both of the chips in this picture. Notice that they are from the same row on the top but where they are placed in the column doesn’t matter.

b. Notice the twin strips of five rows each down the center of the image. These strips are electrically connected VERTICALLY. Each column of holes is connected together, but is insulated from the adjacent columns. This enables a single pin on one of the chips to be connected to more that one wire. By placing the IC (chip) so that it bridges the gap between the two strips, you can make connection to pins using 26-gauge wire and construct your circuit. The holes on the breadboard are spaced so that a standard integrated circuit will fit easily into the holes. A small amount of pressure seats them into the holes and makes a good electrical contact.
c. Notice that each chip has a small depression formed into its top surface near the lower left corner of the case. This is an index mark. It tells you where Pin 1 is located. You can see the diagrams that describe the connections, also known as “pin outs,” to the chips you’ll be using below. These diagrams are extracted from a manufacturer’s databook that describes the operation of the chips in more detail than is needed for this exercise.

d. There are two input variables to the combinatorial circuit in Figure 1. They are A and B. There are three Boolean functions required and each is implemented on a separate CMOS (Complementary Metal Oxide Silicon) integrated circuit. The two input AND gate is the 74LS08, the two input OR gate is the 74LS32 and the INVERTER is the 74LS04.

e. Place the three chips on the breadboard the way you see them placed in the picture above, so that they bridge the gap down the center of the breadboard, and with the index mark in the lower left corner of the chip. One way to layout the chips is to follow the logical flow of the circuit. Try putting the INVERTER on the left, the OR gate in the middle and the AND gate on the right. Leave an inch or so between each
f. The next step is to apply the power supply voltage to the breadboard. Using the Power One regulated power supply, adjust the voltage output so it shows 5V. Double check the voltage using the FLUKE45 Multimeter. Then connect V+ to the very top and V- to the very bottom rows on the breadboard.

g. Each chip needs to be energized before it will function, connect a 5V power supply wire from the top row of the bread board to pin 14(Vcc) of each chip and Ground to pin 7 (Gnd) of each chip. If you put the index mark in the lower left corner, then pin 14 will be at the upper left corner, and pin 7 will be at the lower right corner.

h. Using the index mark as a reference, connect **input A** to **pin 1** (A1) of the inverter. The output of the inverter will be at **pin 2** (Y1). Connect **pin 2** (Y1) of the inverter to **pin 1** of the OR gate and **input B** to **pin 2** of the OR gate. Remember that integrated circuits look at voltage levels as inputs. Most logic circuit manufacturers guarantee that their chip will acknowledge an input voltage of 4.3 V or higher as a logical ONE, and any voltage below 0.3 V as a logical ZERO. For this exercise, you'll set Vcc at 5V dc so you can connect a wire from the power supply or ground as your inputs A and B. When you connect Vcc as an input, it will be recognized as a logic ONE. When you connect ground to any input it will be a logic ZERO. As a general rule its considered poor design to leave pins “floating.” Ambient noise or stray capacitance can provide unintended inputs to the circuit and cause unanticipated outputs. Set the unused AND gate inputs to a logic ONE and OR gate inputs to logic ZERO.

*Pin assignment & logic diagram for the 74LS04 Hex Inverter:

![Pin assignment & logic diagram](image)

**Fig. 3**
Pin assignment & logic diagram for the 74LS08 Two Input AND gate

The output of the OR gate will be its pin 3; connect that, and input A, (connect a "jumper" from the input pin of the inverter where you first applied input A so that if your input changes it automatically is applied everywhere simultaneously) to the two input AND gate. The output of the AND gate will have to be connected to the anode of the LED, it will illuminate when it is at
the ‘1’ state and is off when the AND gate goes to the ‘0’ state. Notice that the LED has a long lead and a short one. The long lead is the anode. Connect the cathode (short lead) to ground to complete the circuit.

1. Ask your TA to verify your circuit before energizing it.

2. Create a truth table for this circuit that describes the behavior that you observe. Order the rows of the truth table by counting up in binary to account for all combinations of input states. Determine the output state for every possible combination of input states.

3. Does this truth table agree with that of the Pre Lab?

4. Examine the truth table outputs. Is there a simpler circuit that would perform the same function?
   Use Boolean algebra, truth tables, and Karnaugh maps to verify.
Prelab Part C
Name __________________________

Draw the pin diagram of the circuit of Lab 7 on the breadboard below. Include all chips, pins and wires. Don’t forget “pullup” and “pulldown” connections for unused inputs.