ENG 100 Lab 6 - Logic Circuits Introduction

The purpose of this lab exercise is to introduce basic digital logic devices and design concepts. You will use integrated circuits from the transistor-to transistor logic (TTL) family. The TTL family contains literally hundreds of different logic chips. (Look at www.fairchildsemi.com/products/logic/ to get an idea of the range of logic functions and families available.)

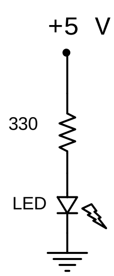
PRELAB: Design the two logic circuits for Part IV below.

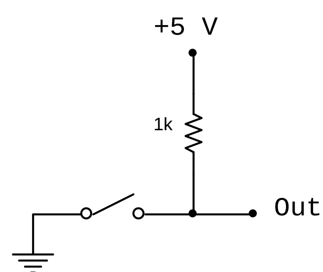
<u>I. Light Emitting Diode (LED)</u> LED's are often used to provide visible readout of a logic signal or as the illuminated segments in alpha-numeric displays. Normally these devices are made from gallium arsenide, and photons are emitted when enough current passes through the diode.

1. Connect an LED in the circuit shown below on the left. Use a red LED. (The shorter of the two leads on the LED connects to ground in this circuit.) The 330 Ω current-limiting resistor is used to protect the LED from damage. Measure the voltage drop across the LED and the resistor. How much current is flowing through the LED?

2. Repeat 1 with a 1 kΩ current limiting resistor. How much current is flowing through the LED now? What is the effect on the LED of changing the resistor?

3. For the original LED circuit shown below on the left: Disconnect the LED from ground and connect that LED lead to +5V. How much current is flowing through the LED now? Is the LED on or off?





<u>II. DIP Switch</u> Mechanical switches are sometimes used to generate logic signals. Small single-pole single-throw (SPST) switches are grouped in units of 4 or 8 switches in dual-in-line packages (DIP). The diagram above on the right shows one such switch connected to produce a logic 0 or logic 1, depending on the position of the pole. The 1 kΩ resistor is called a *pull-up resistor*, and functions to "pull" the output high when the switch is open and limit current when the switch is closed.

1. Connect two switches in a DIP switch package as shown above on the right and measure the output of one of these circuits with your DMM, when the switch is open (position ‘off’) and when it is closed (position ‘on’). These switches will generate the input signals for other parts of the lab, so leave them connected.

III. NAND Gate One of the most basic logic circuits is the NAND gate. In fact, any logic function can be generated by only NAND gates using Boolean algebra. The 74LS00 integrated circuit contains four 2-input NAND gates. Power the 74LS00 with 5V and use both of your switch and resistor circuits from part 4 as inputs to one NAND gates.

1. Using the DMM to read the gate input and output, verify the NAND gate truth table and make a table of the input and output voltages for the 4 possible input cases. Generally, for TTL gates, an input or output voltage is ‘high’ or ‘1’ if the voltage is greater than 2.0V. An input or output voltage is ‘low’ or ‘0’ if the voltage is less than 0.8V.

2. Connect an LED with 330 Ω current-limiting resistor to the NAND gate output (that is, build the LED circuit on the previous page, but disconnect the shorter LED lead from ground and connect that LED lead to the NAND gate output) . Apply all 4 possible input combinations to the NAND gate. What happens to the LED? Why?

IV. OTHER LOGIC FUNCTIONS USING NAND GATES.

1. Wire the 2-input NAND gate to act as an inverter (an inverter has only one input). Connect an LED with 330 Ω current-limiting resistor to the NAND gate output. Apply the two possible input values to the inverter gate using a DIP switch circuit. Record the truth table by observing the LED.

2. Using DeMorgan's theorem, design and build a circuit with 2-input NAND gates that implements an OR operation (i.e., output = A + B). Use the DIP switch circuits as the inputs and an LED for the output display, and verify the truth table.

Report:

Turn in your logic circuit schematics (Part IV), measured truth tables (Parts III and IV), any measured voltages and currents. Also include answers to any questions above.

7400 and 74LS00 pin information:

PIN ASSIGNMENTS (TOP VIEWS)

QUADRUPLE 2-INPUT POSITIVE-NAND GATES

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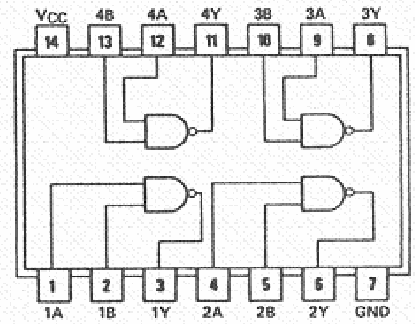
positive logic:

$Y = \overline{AB}$

See page 6-2



SN5400 (J)	SN7400 (J, N)
SN54H00 (J)	SN74H00 (J, N)
SN54L00 (J)	SN74L00 (J, N)
SN54LS00 (J, W)	SN74LS00 (J, N)
SN54S00 (J, W)	SN74S00 (J, N)

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