CSCI 255 – Fall 2011 Name ___________________________
Lab #2
Circuits
DUE: Start of lab Mon 9/19/11

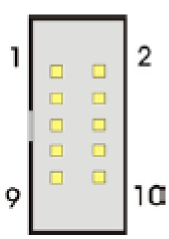
We will be building several simple circuits on the breadboard of the 8051 educational board. You will also build a more complicated circuit using the Logisim simulation software.

Initial setup

The 8051 board does not need to be connected to the computer for this lab. Connect the negative bus on the left side of the breadboard to one of the GND connections at the top of the 8051 board. Connect the positive bus on the right side to one of the +5V connections at the top of the 8051 board. You will be plugging various gate ICs which will span between column e and f on the breadboard.

Input to your circuits

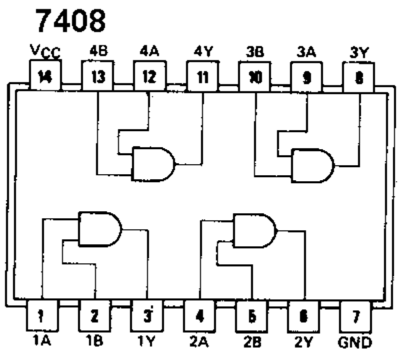
For input to your circuits, we will use port 2 on the 8051 board. The pins on this port will sink current when one of the four push buttons (P2.0, P2.1, P2.2, P2.3) are pressed, or when the dip switches are switched to the ON position. Dip switch 8 is P2.0, 7 is P2.1, and so on. You can connect the pins of port 2 to the breadboard using a ribbon cable which has had its wires separated and stripped. The Amtel AT89S8253 can only sink 10 mA per pin, 15 mA per port, or 70mA total. So you must use a resistor or a gate IC in any circuit connecting to P2. The pin wiring and functions of port 2 are:



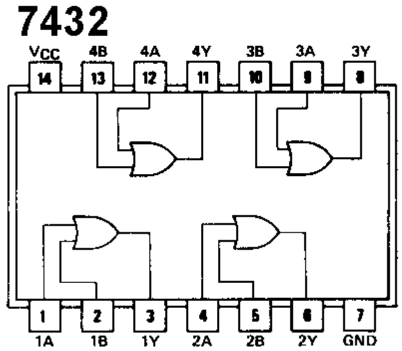
PIN	NEME	Function connected with CPU
1	P2.0	P2.0/A8 I/O Port
2	P2.1	P2.1/A9 I/O Port
3	P2.2	P2.2/A10 I/O Port
4	P2.3	P2.3/A11 I/O Port
5	P2.4	P2.4/A12 I/O Port
6	P2.5	P2.5/A13 I/O Port
7	P2.6	P2.6/A14 I/O Port
8	P2.7	P2.7/A15 I/O Port
9	VCC	+VCC
10	GND	GND

Gates

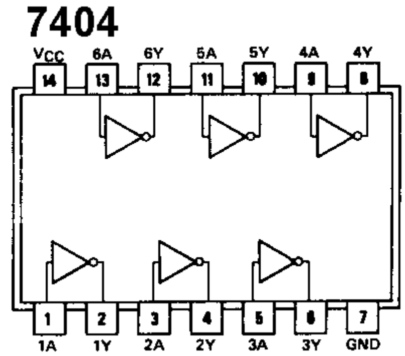
We have 6 different ICs each containing a number of AND, OR, NOT, NAND, NOR, or XOR gates. Here are the schematics for each:



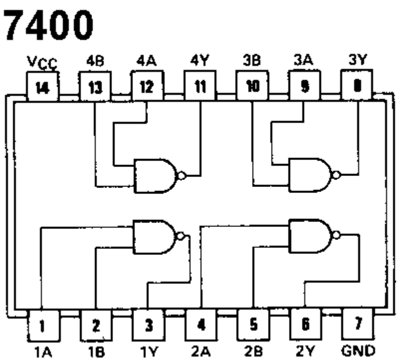
AND



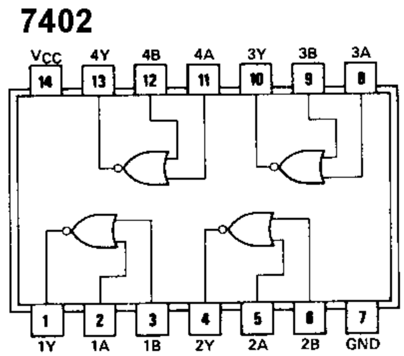
OR



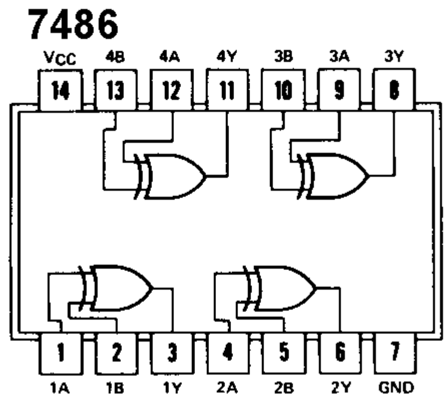
NOT



NAND



NOR



XOR

NOTE: each IC needs to be connected to power on pin 14 and ground on pin 7.

We recommend you first experiment with a gate of your choice before messing with P2 and a more complicated circuit. Hook up the gate input(s) to the 5V bus (binary 1) or to the ground bus (binary 0). Note that a binary 0 needs to be ground and not floating (a wire not connected to anything). The see the output of a gate, connect the output to an LED and then connect the LED to ground. Be sure to connect the LED in the right direction, otherwise it won't light up.

Circuit #1 – Two-bit equality

Design a two-bit equality function. The function should return true only when the two input bits are the same value (both 0 or both 1). Build a circuit that lights an LED if the dip switches 7 and 8 are in the same position

1a) Show the truth table.

1b) Give the Boolean expression for the circuit you intend to build.

1c) Draw a diagram of the circuit you intend to build (using normal gate notation).

1d) Build your circuit. Show your working circuit to Zach or Keith.

Circuit #2 – Three-bit majority

Design a three-bit majority function. The function returns true whenever the majority of its bits are 1. Build a circuit that lights up an LED if two or more of the dip switches 6, 7, and 8 are in the OFF position.

2a) Show the truth table.

2b) Give the unminimized sum-of-products expression.

2c) Show how you minimized the sum-of-products expression including the final expression for your intended circuit.

2d) Draw a diagram of the circuit you intend to build (using normal gate notation).

2e) Build your circuit. Show your working circuit to Zach or Keith.

Circuit #3 – Rock, paper, scissors (Logisim only)

Design a circuit that has three binary inputs for player A: A_r, A_p, A_s corresponding to player A playing rock, paper or scissors respectively. Similarly, there are three binary inputs for player B: B_r, B_p, B_s. The winner is determined by the rules: rock smashes scissors, paper covers rock, scissors cuts paper.

Your Logisim circuit should light up an LED labeled "A wins" if player A won the game or light up an LED labeled "B wins" if player B won. If there is a tie, neither of the LEDs should light up. If more than one of the inputs for a player is set to 1, any LED result is acceptable (the input is considered invalid).

3a) Find the minimal Boolean expression for the circuit.

3b) Implement and test your circuit in Logisim. Attach a printout of your Logisim circuit. Submit an electronic copy of your Logisim file via Moodle by the due date.

Extra-credit: implement the circuit in hardware. Show Zach or Keith your working circuit.