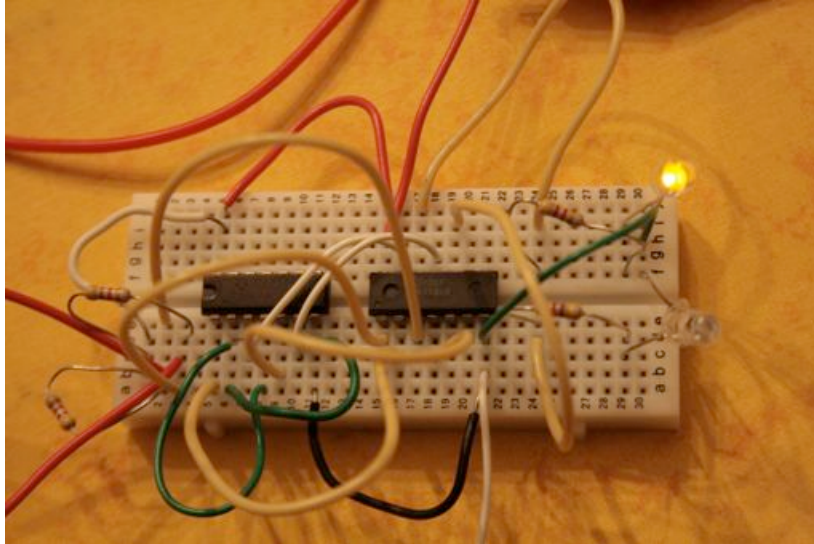


Engr003
Mission College

Digital Logic Circuits

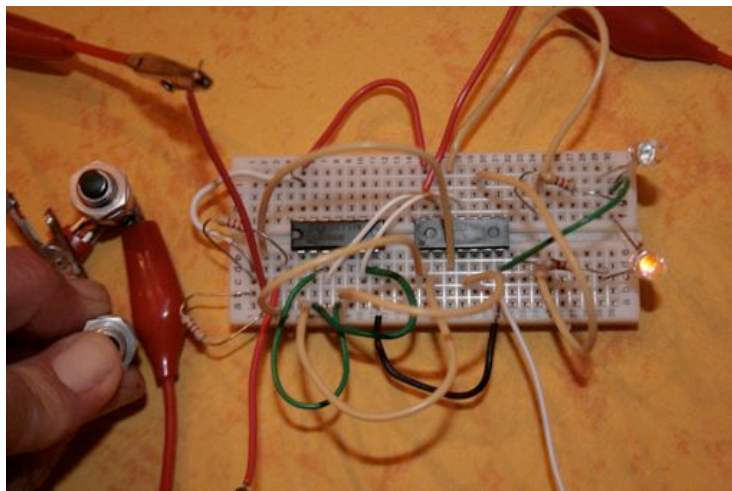
"THE JEOPARDY CIRCUIT"



Introduction:

In this lab you will build a circuit that determines which team player pushes his/her button first. This can be thought of as a first responder discriminator circuit for two players.

Your circuit will have two push buttons. When one is pushed first the other button is "locked out" and the LED corresponding to the first button is turned on.

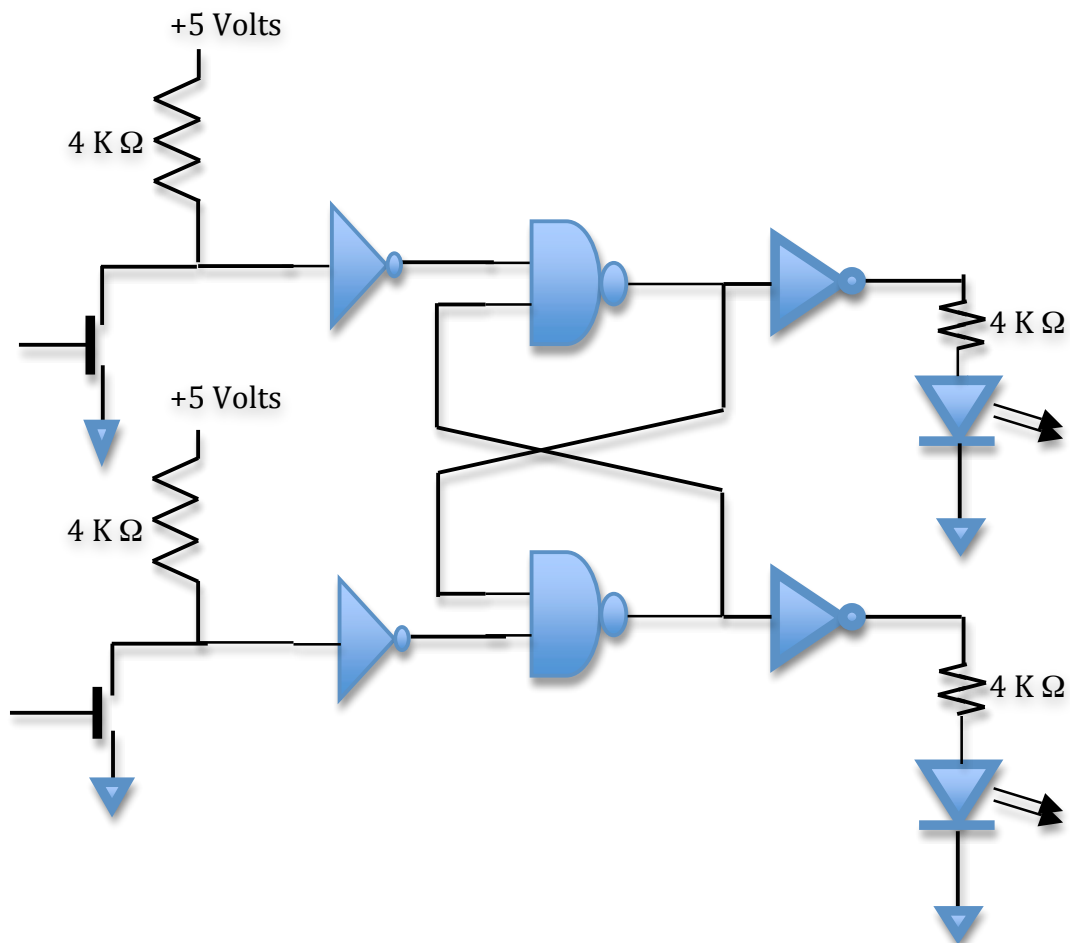


Parts:

DM7404N Hex Inverter IC
SN7400N Quad 2-input NAND IC
4K Ω resistor (need four) *yellow-black-red*
Two push button switches (SPSP N/O)
Two LEDs
5 Volt Power Supply
Solderless Breadboard
Alligator Wires
18 gauge solid insulated wire

Circuit Schematic:

Below in the complete circuit. Once a player presses his/her button the other player is "locked" out. The button must stay pressed for the LED to remain on. Releasing the button resets the gates.

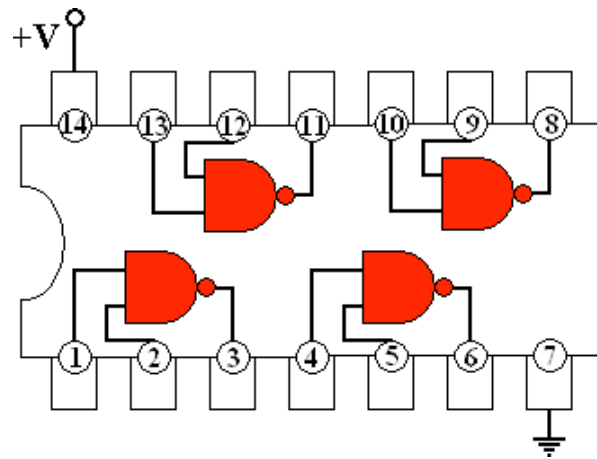


Logic Truth Table:

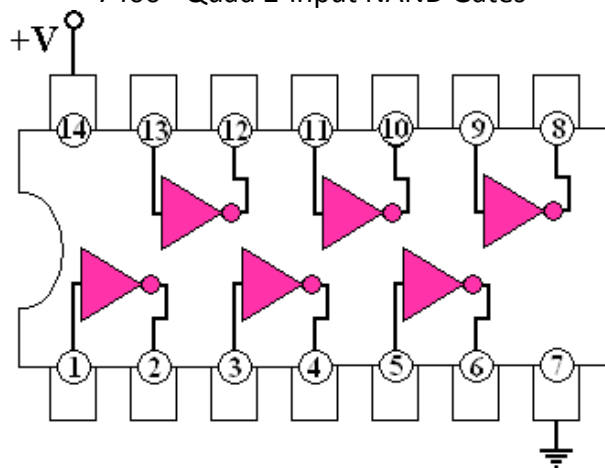
NAND Gate

| In ₁ | In ₂ | NAND Out | $\overline{\text{Out}}$ | LED |
|-----------------|-----------------|----------|-------------------------|-----|
| 0 | 0 | 1 | 0 | Off |
| 0 | 1 | 1 | 0 | Off |
| 1 | 0 | 1 | 0 | Off |
| 1 | 1 | 0 | 1 | On |

Pin Lay-Out and Internal Gate Connections for ICs:



7400 - Quad 2-input NAND Gates



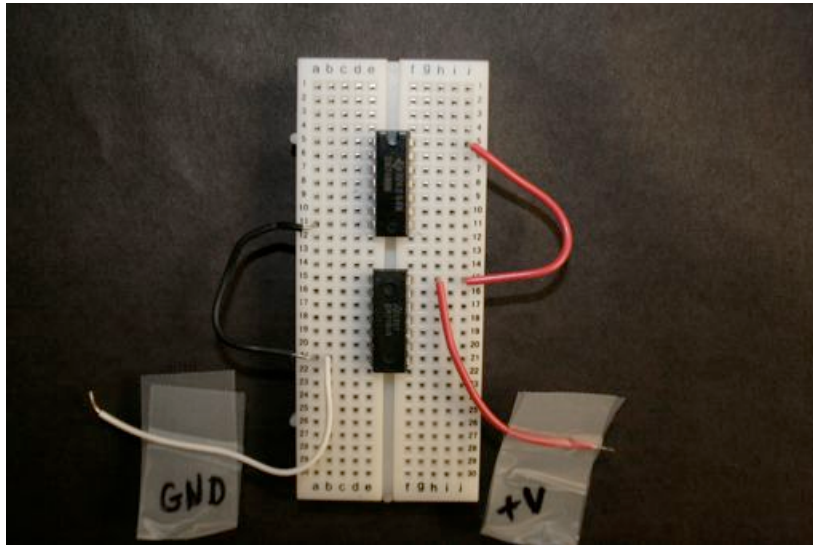
7404 - Hex Inverter Gates

Construction Steps:

Step 1:

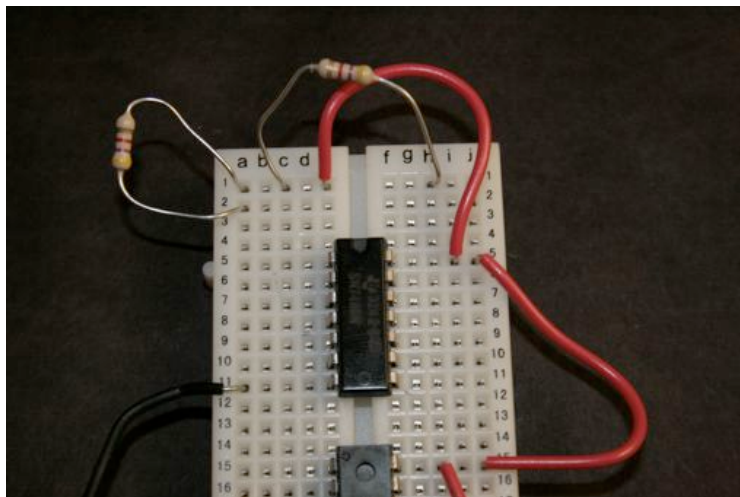
Insert both ICs into the breadboard. Make sure all pins are straight and go into the board's holes. Put the NAND chip (7400) with pin-1 in node #5 (approximately), and put the inverter chip (7404) four to five nodes below it as shown in the picture.

Add the ground and +V wires to pins 7 and pins 14 respectively on the chips.



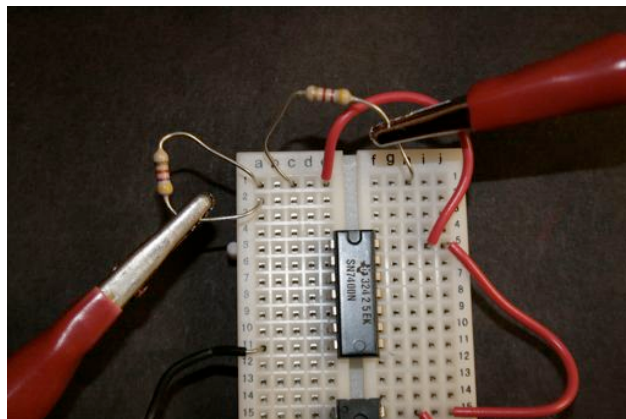
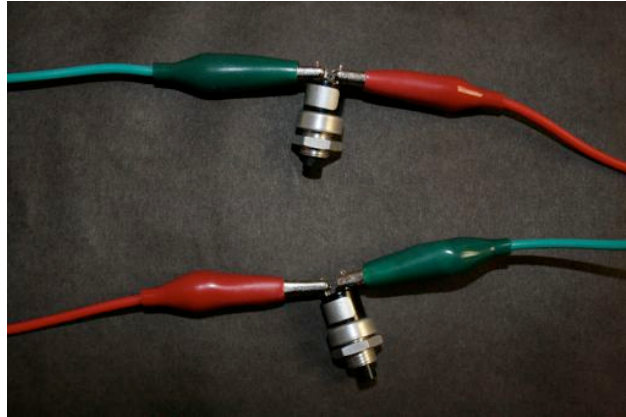
Step 2:

Add a jumper wire from any +V node to node 1a. This makes node 1a +V as well. Add the two 4K Ω resistors as shown by running them from node 1a to any two nearby unused nodes. These new nodes will be where the two push buttons connect to.



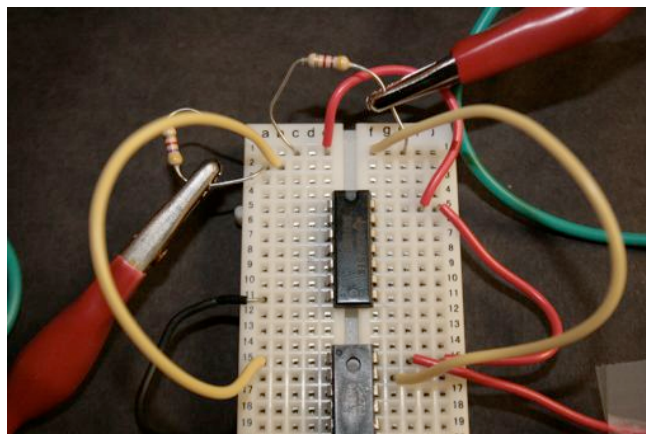
Step 3:

Connect alligator wires to the two leads of the push-button switch. Do this for both switches. One end of each switch will connect to one of the $4\text{K}\Omega$ resistors. The other end of the switches will connect to ground.



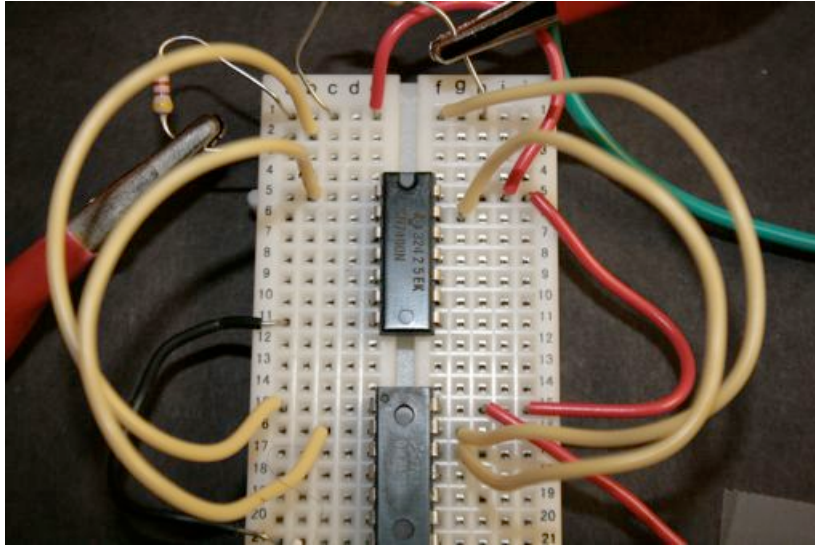
Step 4:

Next insert a wire connecting one of the $4\text{K}\Omega$ resistors to one of the inverters in the 7404 chip. Repeat this for the other $4\text{K}\Omega$ resistor.



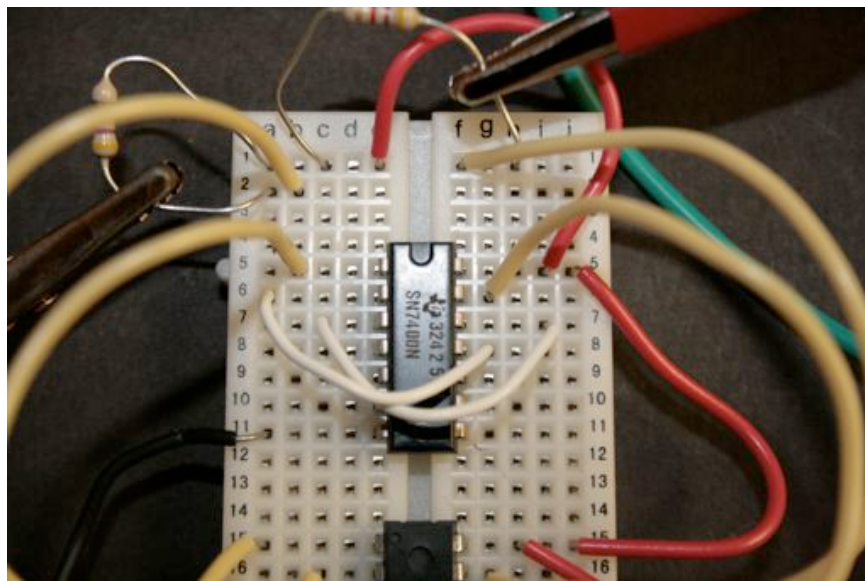
Step 5:

Insert wires from the outputs of the two inverters used in step-4 to a NAND input in the 7400 chip. Do not use the same NAND gate for both wires. See the schematic for clarity.



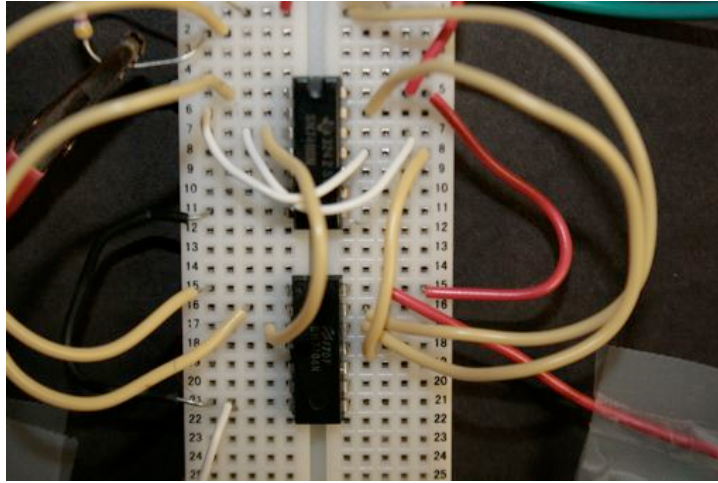
Step 6:

Next insert the cross over wires. The output of one NAND will be an input to the other, and vice versa.



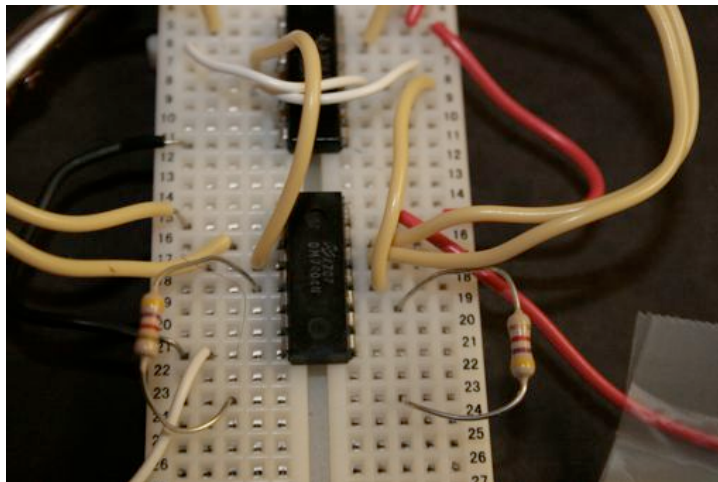
Step 7:

Wire the two NAND outputs each to an inverter.



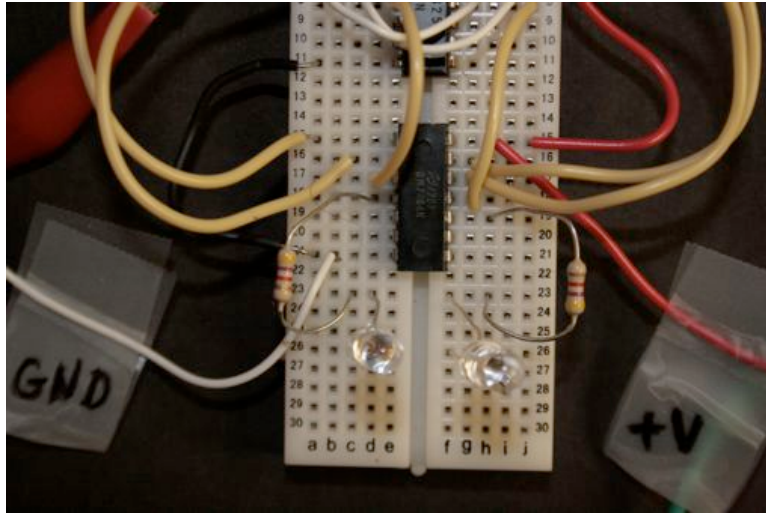
Step 8:

Connect 4K Ω resistors to the outputs of the inverters used in step-7. The other terminals of the resistors should go to unused nodes towards the bottom of the board.



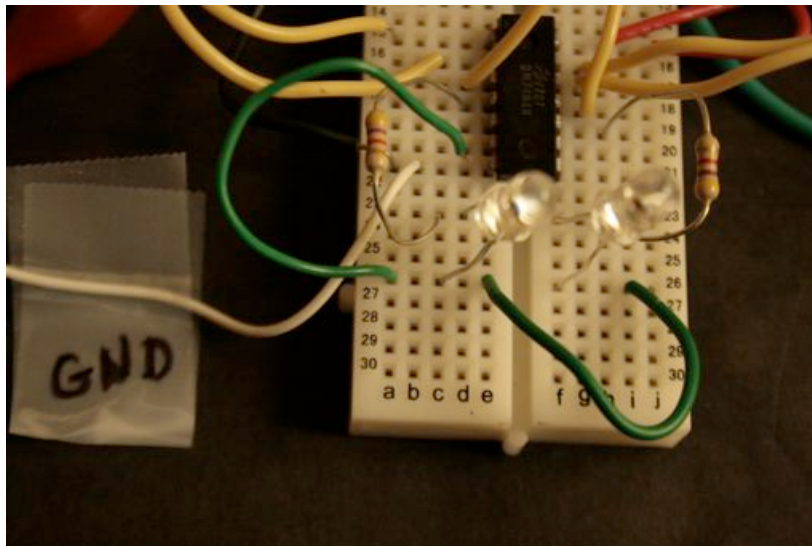
Step 9:

Insert the long lead of the LEDs into the nodes created in step-8. Remember the LED must be forward biased in order to turn on.



Step 10:

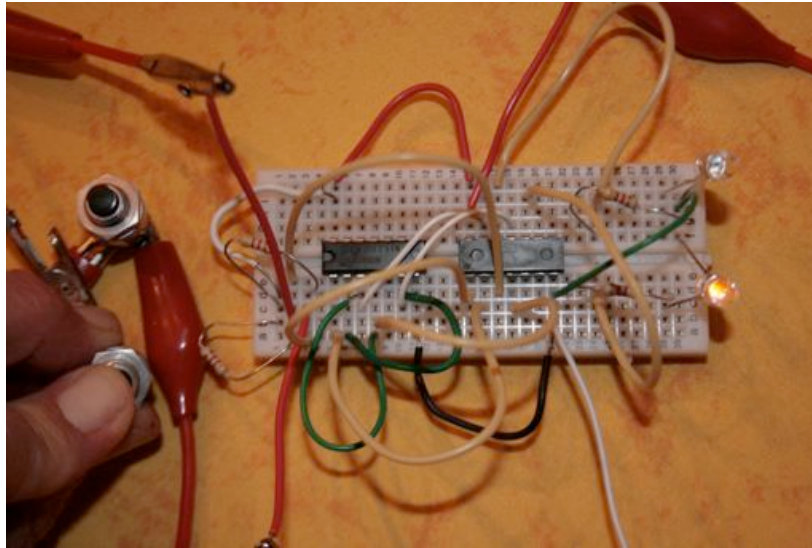
Connect ground to the other end of each LED.



Step 11:

Connect 5 volts to +V and ground to the ground node. You are now ready to test the circuit.

Your circuit has two push buttons external to the board. When one is pushed first the other button is “locked out” and the LED corresponding to the first button is turned on as shown below. Releasing the buttons resets the circuit.



Questions:

These questions can be asked in-class using the Jeopardy Circuit and the Jeopardy Game rules.

1. Using the internet, find out what the circuitry is inside the 7400 chip. How many transistors approximately does the 7400 chip have? See:

<http://hyperphysics.phy-astr.gsu.edu/HBASE/electronic/nand2.html>

2. What is the difference between analog and digital technology?
3. Is it possible to build NAND gates and Inverters with FET transistors (FET stands for Field Effect Transistor)?
4. Explain how the Jeopardy Circuit you built works. How does the first responder “lock-out” the other player?
5. Do you think after doing some extra study you could scale this circuit to accommodate more players?

Resources:

<http://members.shaw.ca/roma/twenty-two.html>