# EEL 3701 – Digital Logic and Computer Systems

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## Problem Statement

The goal of the lab was to assemble the components needed to become familiar with the components, assembly and soldering of a board.  The kit came as a set of parts (components such as integrated circuits, LED arrays and resistor arrays and pre-assembled boards).  The kit was used to build up an FPGA board from Out of The Box by adding header pins that will be used in future labs.

In addition, the breadboard will be used to add circuits to that board and then tested to make sure the board works.  Integrated circuits are assembled to a full working circuit for digital logic that will be tested.  This allows the hardware assembly of the board with hand wires and LED’s / resistors.

Finally, a small circuit consisting of an AND gate was needed to show the full set of parts working.

## Design

The design consists of a board that was already built and provided in the kit that contains an FPGA.  This board is has integrated circuits and a display to show the internal operation of the board.  The board then has connectors that needed to be added to provide access to the pins on the board.

For the AND circuit, the circuit consists of ANDing together two logic inputs and provided them as an output.  The inputs of the AND gate and user inputs (switches) and the outputs are connected to an LED.

Inputs:  The inputs were from a bank of switches.  Each switch had a resistor tied to power (Vcc or 5v) that provided a default value of a logic ‘1’ to the input.  When the switch was open, it did not change. If the switch was On or closed, the input changed to a ‘0’ as the switch was connected to Ground (0 v).

Outputs:  The one output was routed to an inverter to invert the signal because the signal needed to turn on the LED was active low or ‘0’ when true.  This meant the active high output form the AND gate needed to be converted to active low.  The LED’s are a bank of LED’s and each LED had a resistor between it and power (5v) to prevent it from burning out.

## Implementation

The circuit was implemented using the breadboard from the kit.  The wiring was by following the lab instructions provided.  Each part also had to have the power and ground connections (5v and 0v) to make the part work.  The FPGA board was there too to show that it worked after soldering on the connectors.

The breadboard was wired up to connect all the power and ground long connections to the breadboard.  In addition, the power and ground pins were wired up to each integrated circuit.  The pullup resistors for the switches used the SIP resistor to connect them all in one inserted part.  This was easier than using a separate resistor foe each switch.  The LED resistors were assembled separately and near the output LED.   The IC’s were inserted with Pin 1 in the lower left hand so they looked similar.  It took a little bit longer than I anticipated to wire up the lab as I was getting familiar with new items (See picture at the end.)

## Testing

To test the FPGA board, I showed it to the PI and verified its operation.

To test the circuit, I switched the switches on and off as shown here to demonstrate the only time the LED comes on is where the AND gate is true and that is when both inputs are true (a ‘1’.)  When any other condition is present, (TF, FT or FF) the AND circuit did not light up the LED.

## Conclusions

From this lab I learned that signals can be true and have a high voltage and true and have a low voltage as needed to turn on the LED’s.  I also learned that it is easier to follow the next steps of a circuit when the wires follow the input to output as that is kind of how I see the circuit working.  In the future, I will probably spend more time studying the components and the testing to make sure I know how to test the circuit in advance.

Picture(s)

