

Lab 1 – Preparation

1

Lab Room Assignments

- Labs take place in BA3145, BA3155 and BA3165
 - Lo101: Wednesdays 6-9pm.
 - Lo201: Mondays 6-9pm.
 - L5101: Tuesdays 6-9pm.
- Tentative lab assignments (might change depending on last-minute additions or drops in the class):
 - **Section Lo101 - Wednesday Labs**
 - BA3145: Angeli - Mao
 - BA3155: Marcok - Zhuang
 - **Section Lo201 - Monday Labs**
 - BA3145: Afandiyev - McKinney
 - BA3155: Memon - Zhu
 - **Section L5101 - Tuesday Labs**
 - BA3145: Abukar - Loza Vega
 - BA3155: Lu - Zhao

2

Reminders

- Rules about the labs:
 - These labs are only open and available during your dedicated lab section.
 - You must work in pairs.
 - The lab station you pick during your first lab will be yours for the entire term. You are responsible for its upkeep and maintenance.
 - **No food or drinks permitted in the labs!**
 - Please respect this to protect the lab equipment.
- A brief lab guide:
 - http://www-ug.eecg.toronto.edu/msl/handouts/labguide_DE1.html
 - Note: some parts apply mainly to engineering students.

3

Lab 1 Learning Objectives

- Learn how to build logic circuits by using chips that contain individual logic gates .
- Produce truth tables for a given design (starting either from a given logic function or from a description of the design's behaviour).
- Gain familiarity with the schematic builder tool of Quartus.

4

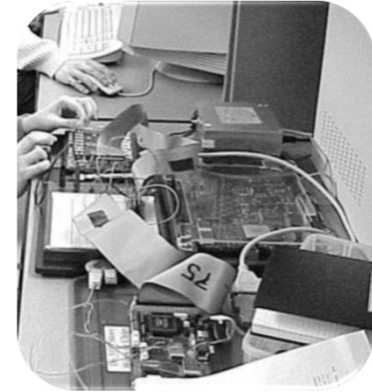
Approach to Lab 1

- Experience is the best teacher.
 - Prepare a design. → Pre-Lab
 - Implement your design. } → In-Lab
 - Debug the circuit. }
- Try to think of your prelabs as “an assignment due in the beginning of the lab”.

5

Equipment

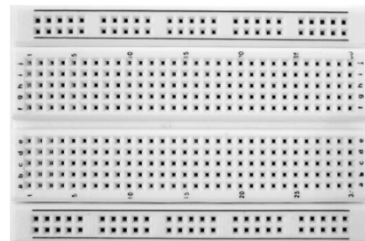
- Breadboard
- Wires
- Gates



6

Breadboard

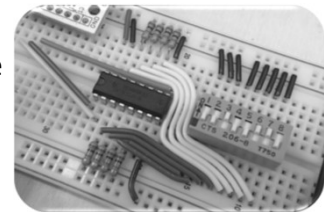
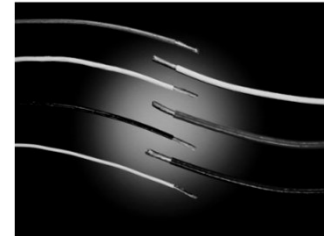
- The standard working area for connecting digital components together.
- Red and blue horizontal rows at top are connected.
- Columns in middle sections are connected.



7

Wires

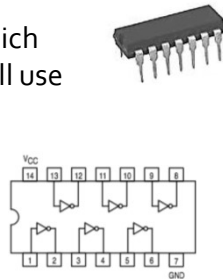
- Use this to connect different components together.
- Use the pre-cut wires whenever possible.
- Learn how to strip the coating off the end of a wire.



8

Gates

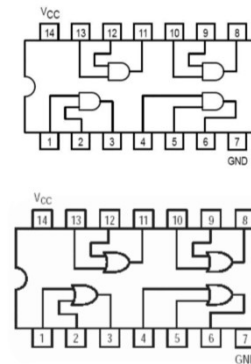
- IC chips will be supplied, which house the gates that you will use to create circuits.
- Example: 74LS04 (NOT)**
 - Notch at one end helps determine alignment.
 - Usually a dot at pin #1.
 - V_{cc} and GND always have to be connected to the power source and the ground, respectively.



9

Other Gates

- 74LS08 (AND)
- 74LS32 (OR)



10

What you're going to do

- Determine the Boolean logic equation that you need to implement.
 - Might require you to create a truth table first.
- Convert this equation into an equivalent circuit of AND, OR and NOT gates (using order of operations when necessary).
- Determine how many chips you'll need to implement all the gates for this circuit.
- For each gate in your diagram, indicate the IC pin number for each input and output.

11

Warm Up Example

- Design a circuit that implements the following logic function, using only 2-input AND and 2-input OR gates.

$$f = ab + (c + b)$$

- Write down the truth table for this design.
 - Note: This expression is common shorthand for:

$$f = a \text{ AND } b \text{ OR } (c \text{ OR } b)$$

12

Warm Up Example cont'd

- Is there a cheaper implementation (i.e., with fewer gates)?
 - $f = ab + (c + b)$



13

Pre-lab report

- Pre-lab reports are submitted online through Canvas. For Lab 1, submit a PDF of your designs for Parts I and II.
- Should include the following:
 - Lab number and title
 - Student info (last name, first name, student #)
 - Exercise parts
 - Each in its own clearly-labeled section.
 - Restate the question (summarized).
 - Provide the calculations (if applicable).
 - Illustrate the solution (including pin labels).
 - BE NEAT.

14

In-Lab Tasks

- The TAs will demonstrate how to plug the chips and wires into the breadboard, and how to connect the breadboard to the lights and switches on the side.
 - Don't be late to the first lab!!
- Helpful tips:
 - Remember to turn off the power supply when connecting/plugging in components in the breadboard.
 - Using some sort of colour convention for your wires can be helpful.
 - e.g. have all wires connected to the ground be one colour and use another colour for all V_{CC} wires.
 - Use the logic probe (provided in the lab kit) to test each connection when debugging!

15

Things to note

- This will be the easiest lab you do in the course.
- Whenever possible, use the tools and submit a printed pre-lab report (one per person).
- Try to come up with the smallest circuits possible.
 - How do you reduce a complex circuit?
 - For now, think back to boolean algebra axioms!
 - Simple reasoning helps as well ☺

16

After the lab reflect on

..how long it took you to implement even simple logic circuits on the breadboard.

- Can you imagine doing this for more complex circuits?!
 - Hardware Description Languages (HDL), like Verilog, and design tools to the rescue! ☺