Lab 1: Combinational Analysis & Implementation (REMOTE LAB)

PURPOSE

The purpose of this introductory laboratory project is to introduce students to basic digital devices as well as implementation and testing tools available in the laboratory. In this lab, we will implement a purely combinational device: an automatic light switch. Students will design, implement, test, and characterize a simulation of the device.

These laboratories are designed to reinforce material learned in lecture and presented in the text. Students are expected to be familiar with the course material presented to date. The laboratories may by much less useful (and more time consuming) if you are not properly prepared. For this lab, pay particular attention to the material on basic combinational devices (AND, OR, and NOT gates), the interpretation of standard symbols for combinational logic, truth tables, and basic Boolean algebra. Some students may find it helpful to review the course material as part of the lab.

SIMULATION TOOL - LOGISIM

All lab projects for Digital Systems Design require simulation using Logisim - an open source digital logic simulator. You will need to download and install Logisim on the computer where you will be doing your lab work. A one-click download may be available at: https://sourceforge.net/projects/circuit/files/latest/download
If you have any problems finding/downloading Logisim, just google "Logisim download" and look for a link from the trusted host site sourceforge.net.

LAB DUEDATES (REMOTE LAB)

You have approximately one week to complete each lab. Get started immediately! As labs trail lecture by one week, you should be introduced to all concepts necessary to complete each lab before it is released. Thus, you can (and should) begin work immediately. Ideally, you should attempt to complete the lab within 2-4 days of the assignments release. If you have any difficulties, please reach out to your lab/lecture instructors early to get any help/direction/clarification that you might need.

Labs will receive full credit if turned in anytime within one week. There are an additional two days during which the lab may be accepted 'late' with penalty. Late labs receive a penalty of 10% for each day late, for up to two days. Labs turned in more than two days late will receive no credit. You can contact the course instructor to waive late penalties if you have a documented excuse. Lab TAs cannot grant late penalty waivers.

For example: If labs are released on Pilot on Wednesday morning, then you should upload your final PDF e-labbook to the appropriate Pilot dropbox no later than midnight the following Wednesday. After that ~7.5 day period, the lab will be considered late. If it is turned in between midnight Wednesday and midnight Thursday, you will receive a 10% penalty. If it is turned in between midnight Thursday and midnight Friday, you will receive a 20% penalty. The dropbox will close and no longer accept the lab after midnight Friday.

After a lab dropbox is closed, you can still upload the e-labbook (for no credit) to the "emergency/miscellaneous" dropbox. In this case, please email your TA so that know to check that dropbox and can provide you with feedback on your late assignment when/if time allows.

AUTOMATICH LIGHT SWITCH

Consider a simple electronic device that turns on a lamp whenever there is motion in a dark room. Assume that we have a motion detector that has one output MOTION that has the value 1 when motion is detected and the value 0 otherwise. Likewise assume that we have a light detector that has one output LIGHT that has the value 1 when light is detected in the room and the value 0 when the room is dark. Finally, assume that we have an electronically controlled light with one input LAMP that turns a light on when the input has the value 1 and turns the light off when the input has the value 0.

The device that we wish to build is a detector that is capable of turning on the lamp whenever someone is moving in a dark room. Given the values of the MOTION and LIGHT sensors, the detector must control the LAMP. Thus, MOTION and LIGHT are the detector's primary inputs and LAMP is the device's primary output.

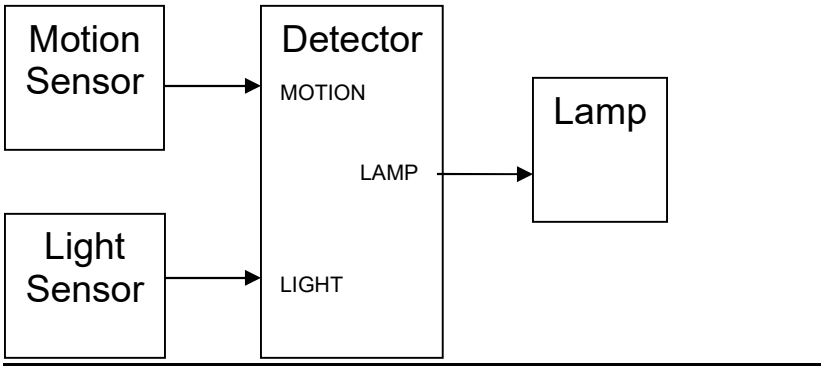

Figure 1: The automatic light switch

LAB 1 - PREPARING FOR IMPLEMENTION

The goal of this lab is to physically implement and characterize a provided solution to this combinational design problem. Please document all of your work in your lab notebook.

1) [1 point] If the detector system was implemented as a full microprocessor, it could be controlled by a computer program. Test your understanding of the device by creating high-level pseudo-code for a program capable of performing the necessary tasks. In your lab notebook, complete the following code segment:

```
while (true) {
    boolean motion = isMotionDetected();
    boolean light = isLightDetected();
   boolean lamp = // complete with a Boolean expression
  showLight(lamp);
}
```

2) [2 points] If the detector system was implemented as a simple combinational system, one solution is:

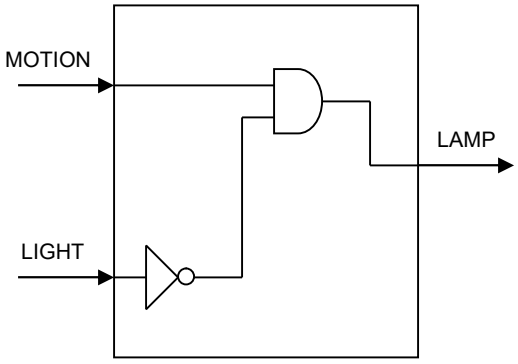

Figure 2: The automatic light switch

Provide a **truth table** for the functionality of this device.

3) [1 points] Provide a Boolean Expression for the function of this device.

LAB 1 - DEMONSTRATION

1) [2 points] Implement this device using the course simulator, Logisim. Your course instructor and/or TA will demonstrate how to use the software. There are also several tutorials available online. Include a screen capture (using snipping tool or a similar screen capture tool)
2) [2 points] Test the device thoroughly. Copy into your lab notebook the actual outputs produced for each input assignment. Verify that it matches your truth table. Your labbook should clearly demonstrate the function of your circuit to your lab instructor. Be prepared to answer additional questions about the function of the devices and the choices you faced in the implementation.

Integrated Writing [2 points]: Refer to "Digital System Design: Engineering Journals & Lab Policies" for details. 0.5 points each for Completeness, Clarity, Organization, and Testing.

LAB POLICY NOTE: If necessary, you can do your demonstration to the TA during the NEXT laboratory period. All lab book work, however, must be completed and turned into the TA (via dropbox) by 5:00 P.M. two days BEFORE your next lab period.