OBJECTIVES

- Understand what is expected of you in this course.
- Get to know your (**U**ndergraduate) **P**eer **I**nstructor (**UPI** or **PI**).
- Complete the construction of your lab kit PCBs.

Two of the three main objectives of this lab are to become familiar with the lab policies and to meet one of the course PI (but perhaps not your normal lab PI). The final objective is for you start the construction of your PCBs (i.e., assembling and soldering various parts to several PCBs). The construction must be completed prior to the Lab 1 due date. If you don't finish soldering in lab, use only a temperature regulated soldering iron, i.e., do **not** use the soldering iron from EEL3000).

INTRODUCTION

Welcome to EEL4744C (otherwise known as *4744* and *µP*, pronounced micro-P)! In this course, a vast amount of fundamental microprocessor and microcontroller application concepts will be explored. Just as in any other course, the amount of knowledge received will be very positively correlated with the amount of effort put into learning the material. However, unlike many other courses, it is likely that *4744* shall prove to be challenging for all that are enrolled.

In general, this course is lab-driven. Primarily, course lectures will aim to provide a broad understanding of general concepts pertaining to a wide variety of microprocessors and microcontrollers, rather than provide specific details related to the lab material. We will present a few example applications in lectures, but we will not walk you through the labs. It is therefore the intention that labs will require students to explore material beyond what is discussed in lecture, just as you will be expected to accomplish when you are a practicing engineer/computer scientist. With an appropriate understanding of the above, along with motivation and consistent effort, most individuals can succeed in this course, as well as *gain superpowers in the realm of microprocessor applications* during the process.

LAB STRUCTURE

In this first lab, you will become familiar with what is expected of you, as well as begin to construct your lab kit. Before attending your assigned lab session, you will explore, understand, and agree to all lab rules and policies (in the Homework 0 Quiz). Then, within the lab, you will become formally introduced to your **U**ndergraduate **P**eer **I**nstructor, the individual responsible for hosting your lab session. Beyond introductions, your Peer Instructor[1] will identify if anything additional is expected of you throughout the semester. You will also begin to construct your lab kit for the semester by soldering and assembling several **p**rinted **c**ircuit **b**oards (**PCB**s).

REQUIRED MATERIALS

- *Lab Rules and Policies*
- *Out of the Box (OOTB) µPAD 1.4 Assembly Guide*
- *Hardware Assembly Video Tutorial*
- *µPAD v2.0 Parts List* (*Excel* or *PDF*)
- *Electronic Assembly Technique Handout*
- *Pre-lab Report Submission Templ*ate *(Word or PDF)*

SUPPLEMENTAL MATERIALS

- Temperature regulated soldering iron, solder, flux, desoldering braid (aka solder wick), safety glasses.
- Multimeter. (Toolbox is advisable.)
- **D**igital **A**nalog **D**iscovery (**DAD**) and *WaveForms* software installed on your computer.
  - If you don't have a DAD, you will be able to borrow a DAD-3. Details will be provide elsewhere.
- Later in the semester, you'll need the following 3701 items:
  - PLD PCB, the necessary USB cables, large prototyping bread board, wire kit, 8 element switch DIP, 8 element LED DIP, two SIP resistors (one for each of the switch and LED DIPs).
    - Note that the DE10-lite PCB or the 3701 PLD PCB (from semesters prior to fall 2023) can be used.
      - If you were in 3701 during fall 2023, you will be able to borrow a DE10-lite and the other required hardware specified above. Details will be provide elsewhere.
    - If you do not have these items, try to borrow them from a friend not presently taking 4744 or 3701 or **buy them** from sales@ootbrobotics.com.
  - Quartus installed on your computer.

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[1] You may see or hear the term *Peer Instructor*, *PI,* or *UPI* (an abbreviation for *Undergraduate Peer Instructor*).

PRE-LAB PROCEDURE

First and foremost, you must become fully aware of, as well as agree to, the lab rules and policies for this course.

1. As part of the Homework 0 Quiz, you should have already read, understood, and agreed to abide by all the items presented within in the *Lab Rules and Policies* document.

PRE-LAB EXERCISES

i. Other than Labs 0 and 8, when are your pre-lab submissions due to Canvas, with respect to the earliest lab demo dates, i.e., how many days before or after the earliest lab demo date? Be specific.
ii. What can I do if I miss my lab appointment, but I already submitted the lab document? What is the grade penalty?
iii. You **cannot** be late to your lab appointment time, but you can turn in your lab submissions late. How late, what are the penalties, and if so, how many times.
iv. Can you drop any (single) lab if you would rather go to the beach? How about if a project for another class is due?
v. Describe the lab makeup policy for a first missed (i.e., not submitted) lab.
vi. In your pre-lab report, what should be included with every measurement, screenshot, etc.?
vii. What is the minimum combined weighted lab average and lab quiz average required for you to be *eligible* to pass the course?
viii. In which section of your pre-lab report should any required screenshot be included?
ix. Describe the process of taking measurements with a system such as an oscilloscope or logic analyzer. Additionally, include details regarding when precise frequency measurements are of interest.

As mentioned above, during the first lab session, you will begin to solder and assemble a lab kit containing several printed circuit boards. Overall, this lab kit will contain several printed circuit boards (PCBs), with the main processor PCB referred to as the ***µPAD*** (pronounced *micro-pad*). This PCB has a *Microchip/Atmel ATxmega128A1U* microcontroller. Several accompanying PCBs called either **backpacks** or **baseboards**, depending on where they are located with respect to the *µPAD*, extend the functionality of the microcontroller. (Backpacks are accompanying PCBs mounted on top of the *µPAD* and baseboards are PCBs mounted beneath the *µPAD*.)

Before constructing the kit in lab, it is first necessary to review how to properly solder an electrical component, as well as understand how the lab kit should be assembled.

Soldering is an important skill, especially for electrical and computer engineers. Since many of you did may not have soldered anything in 3701, a review is warranted of how to properly solder an electrical component, as well as to understand how the lab kit was to be assembled.

NOTE: Prior to the last few years, wire wrapping was performed in *4744*. Wire wrapping is an alternative to soldering and is used to make an electrical and mechanical connection between two parts by wrapping wires around pins. Wire wrapping is no longer performed in this course in order to save students many hours and frustration. However, later in this course, electrical connections will also be made with a breadboard, as in EEL3701C. Wire wrapping is still done in EEE4511C: *Real-time DSP Applications*.

2. Read and understand the *Electronic Assembly Handout* given on the course website. Prepare to assemble the lab kit by watching the *Hardware Assembly Video Tutorial*. Although a few of you will not need to complete the construction of your lab kit, since it will be given to you already complete, everyone should still *Out of the Box (OOTB) µPAD 1.3 Assembly Guide* in order to become familiar with the components used in the course.

PRE-LAB EXERCISES

x. In general, when soldering a wire to a pin, what should the soldering iron touch? What should the soldering iron not touch?

3. Create your *Pre-Lab Report* using something like MS Word. Use the format specified in the *Pre-lab Report Submission Template*. The report must be computer-generated (even if parts of it are from clean and easy to read scans). Ultimately, you will save this file as *Lab0.pdf* for submission on Canvas. You will have a *Pre-Lab Report* for **every** lab. In this lab, from part 5, only parts 5. i. a) – e) from the *Lab Rules and Policies* are relevant.

PRE-LAB PROCEDURE SUMMARY

1) Read and understand the *Lab Rules and Policies* document (as required in the Homework 0 Quiz).
2) Answer all pre-lab exercises.
3) Further prepare for your first lab session by reviewing how to properly solder an electrical component, as well how to assemble the relevant lab kit.
4) Read the *Out of the Box (OOTB) µPAD 1.3 Assembly Guide* and watch the *Hardware Assembly Video Tutorial*.
5) Upload your lab report to the proper Canvas assignment. (This is **ALWAYS** required and will not be explicitly listed again.)
6) In all labs **EXCEPT** this one, you will also upload your zip file (with all of your Microchip Studio project folders for the lab) to the proper Canvas assignment. (This is **ALWAYS** required and will not be explicitly listed again.)

IN-LAB PROCEDURE

In your first lab session, you will do several things in preparation for the remainder of the semester. Initially, you will meet your Peer Instructor (PI), the individual in charge of hosting your lab session.

Then, as an additional resource, your PI will provide a short demonstration of how to properly solder. For the purposes of this course, when soldering any component with more than two pins, it is required that two pins on opposite corners of the component be connected first before soldering the remainder of the pins. Then, before proceeding with the soldering, verify that the component is appropriately placed (by looking at an image or a properly soldered PCB). When placing components or when unsure about anything, consult your PI! Failure to follow any of the above procedure may result in unnecessary errors that cost significant *time*, *money*, and *lab points*.

After this, your PI will provide you with your lab kit. Upon receiving this kit, you will be required to verify that it contains all the parts listed on the *µPAD v2.0 Parts List* (*Excel* or *PDF*), immediately notifying the PI if any components are missing. For documentation purposes (and before any assembly), take picture of all of the parts in your kit (each of the PCBs, the chips, etc.) and include these images in your **Lab 1** *Pre-Lab Report*. Your Lab 1 report should also include images of all of your complete constructed PCBs.

NOTE: After receiving the lab kit in this lab, verify that it is complete. After this lab, you will be responsible for any missing components.

Next, after verifying that you have received all of the required components, you must ask your PI to either practice soldering on some component available in the lab or ask to begin assembling your kit.

When assembling the kit, regularly refer to the *Out of the Box (OOTB) µPAD 1.3 Assembly Guide*, the *Hardware Assembly Video Tutorial*, and your PI. You must remain in lab until you have done at least enough soldering to assure your PI that you know the proper procedure. If you do not finish the assembly, **you must finish it before your next lab session** (either during lab office hours or at home). Additionally, if you plan to solder any of the remainder of the kit at home, first verify with either a PI or Dr. Schwartz that your soldering iron and solder are appropriate. Do **not** use a soldering iron from EEL3000!

IN-LAB PROCEDURE SUMMARY

1) Meet your PI and become familiar with their style of teaching.
2) If possible, watch your PI perform a demonstration of how to properly solder.
3) Receive your lab kit and verify that all components are accounted for. If any parts are missing, immediately notify your PI.
4) Ask your PI to allow you to either practice soldering on a component available in lab or to begin assembling your lab kit.
5) Continue constructing your lab kit until either it is complete or until the lab period ends.

APPENDIXES

A. SOLDERING

The following figures might be helpful to show some good (and bad) soldering examples.

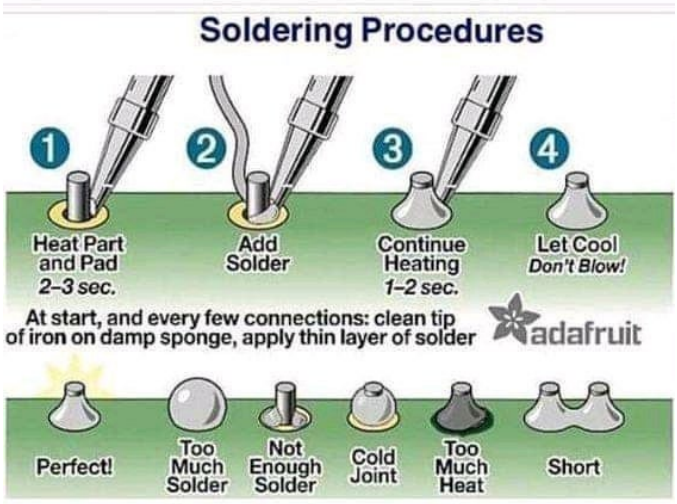

Figure A.1: Soldering examples.

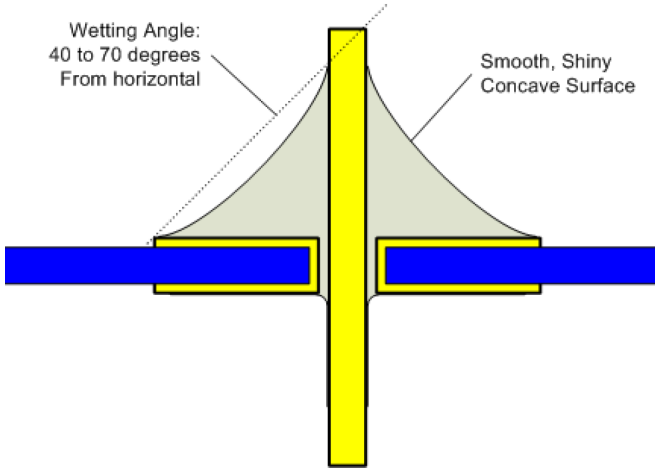

Figure A.2: Ideal solder joint.

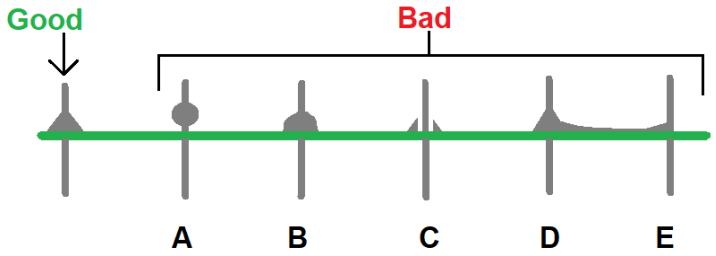

Figure A.3: Good and bad soldering examples.

A good solder should have the shape of a *Hershey's Kiss* (without the wrinkles). By the way, the first Hershey's Kiss was manufatured in 1907!

Figure A.4: Ideal solder joint.