

EE319K Laboratory Manual

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This lab manual is updated continuously. If you find a mistake, or if you find a section vague or confusing, please email me at valvano@mail.utexas.edu or ramesh@mail.utexas.edu. If you enjoy EE319K, you might also enjoy EE445L. Furthermore, if you really like EE319K, you might consider specializing in embedded systems.

We will use both the simulator and the real board. For testing, there are some automatic graders, but generally the graders apply to different assignments, so please do not rely on the automatic graders. The TA will assign grades for all components of the lab.

1. Download and install Keil 5 first (any version of 5 is ok).
 - a. <https://www.keil.com/demo/eval/armv4.htm>
2. Download and install the all examples and simulators,
 - a. http://users.ece.utexas.edu/~valvano/Volume1/EE319K_Install.exe

Comments and Policies

EE319K is a “hands on” class and therefore, even though the labs are only 30% of the total grade, there is NO WAY to make it through this class without taking all the labs seriously. It is during the lab experience that you will really learn. The class changes every semester, so even if you are repeating the class, or have heard about the class from friends, please read the lab manual and go to lecture.

As this is a class with a strong programming component, we expect your software to be written well. Therefore, we have some policies in place about software:

1. Clearly describe the data and program structures in the software comments.
2. Simple well-structured software with descriptive labels is much easier to understand than complex software with voluminous comments.
3. Use top-down or bottom up structure.

4. The interfaces should be simple and natural.
5. The software will be graded on the correctness of the program function, the comments, the interface to the user, the style, and the organization.
6. The effort spent to write high quality software will be rewarded both during debugging and when it is time to add features in the future.

Lab Policies

1. This lab manual describes the tasks for each lab and provides examples of questions you can be asked. The questions are meant to give you an idea of the topics, depth and scope of the questions. Your TA may ask similar but different questions. You may also be asked ANY question related to the material in previous labs.
2. Please *do not print* this whole lab manual since it will be updated multiple times throughout the semester.
3. In addition, the lab manual specifies a list of “deliverables”. There is a lab grade component for the deliverables and missing some of components will affect the grade. You will create one **pdf file** with all the deliverables. You upload this file to Canvas or check it into **git** as instructed before the beginning of your check-out time. You also open the pdf file on the computer for the TA to see during demonstration. You do not need to make hard copy prints in EE319K. It is OK to capture low resolution screenshots, select the interesting parts in Paint, and then paste them into the document. (Ctrl-Alt-PrintScreen captures the active window)
4. For all EE319K labs, students work in teams of two.
 - a. For Lab 1,2, everyone must do these labs on their own (no partner).
 - b. For Labs 3 through 10, you will choose your permanent partner.
 - c. Lab partners must have the same lecture and lab time (same unique number).
 - d. Both partners should sign up for the same demonstration slot.
 - e. If you and your partner did not get along, our first, second and third option is to help you work out your differences.
 - f. Both partners are still both responsible for the lab even if you have difficulties working together.
 - g. Only under extreme cases will we split a partnership.
 - h. It is common for the TA to assign a different grade to each partner based on individual performances during your checkout demonstration.
 - i. In cases where there are an odd number of students in a lecture, one student may have to work alone.

Materials for Lab

As mentioned in the syllabus, you will need:

1. wire strippers
2. solderless breadboard
3. multimeter for this class
 - a. In case you plan to buy a multimeter, there is no need to spend a lot of money, a \$20 multimeter will be good enough.
4. A Tiva LaunchPad TM4C123) starting with Lab 2.
 - a. We cannot let you to use any other microcontroller board, because it will not match the lectures.
 - b. If you are purchasing a Launchpad board from another student, I suggest you have a TA test the board to see if it is functional. We do have a board tester, so if you think you might have damaged your LaunchPad, you can ask a TA to test it.
5. We expect every group of two students to own the LCD display (part of the kit).

You will download and install all required software tools on a Windows-compatible laptop or PC. More specifically, the development system will work on any Windows machine with a USB port. You must perform labs on your personal laptop or PC.

You can download the software tools we use for the class (Keil uVision and PCB Artist) from the web, install it on your own machine. We know that these tools were successfully used on XP, Vista, Windows 7, Windows 8, Windows 10, Mac* and Linux* (*-using virtual machines). However, we cannot assure you will be able to run it on any OS/hardware.

Lab Schedule

The schedule of the labs is available in the course syllabus. From time to time (marked in the schedule) we will use the lab slot to provide a demonstration of tools. During weeks with demonstrations, you are required to attend the whole hour or as long as that session will take. Other times, when we will do lab checkouts you will have to attend your checkout slot only. When checking out a lab you must prepare ahead of your scheduled time to set everything up.

Lab Turn in Policy

1. Labs 1, 2, and 3 will be demonstrated and collected on a first come first served basis.
2. For Labs 4 through 9, you will be assigned a specific checkout time.
3. The lab checkout times are arranged in advance, and may or may not take place during the lab slot to which you are officially registered.
4. Both partners **MUST** be present for your assigned time. If your partner does not show up for your assigned time, then one student may demonstrate, and the other student (the one not present) will receive a zero and not be allowed to make it up.
5. You must upload or check in the deliverables before your time slot.
6. Each lab will also have a Lab grading sheet. The grading sheets are on the course web site, but you can find copies of the grading sheets in lab as well. If you begin to create the deliverables file after the checkout started, you will be considered late, and it will impact the grade.
7. Starting with Lab 3 or 4, each group of two students will be assigned a check-out time by the TA.
8. You will need to come to lab ahead of your assigned time, turn on your laptop, connect your laptop to your microcontroller, if needed, and download your code. This way you are ready to demonstrate at the beginning of your assigned checkout time. The checkout times are *very* short, and there will not be time for the TA to check you out if you need to spend half of the checkout time setting up or creating documents.
9. Student(s) not ready with everything set-up on the time assigned, won't be able to check-out during their slot, they will have to do a "late-check-out" and lose at least 5 points. For more info, see table below.
10. If you are late or miss your slot, your grade will likely be lower because you will not have time to present your lab to the TA.

Turn in Procedure

1. There are [grading sheets](#) for every lab so you know exactly how you will be evaluated.
2. For Labs 1, 2 and 3, it is first come first served. You should plan to go to your lab section or your partner's period. For Labs 4 to 9, there are specific checkout times, for which you will sign up for in advance.
3. Before you checkout you must upload the one pdf file with all the deliverables as listed for each lab.
4. You will need to come to lab ahead of your assigned time, turn on your laptop, connect your laptop to your microcontroller if needed and download your code.
5. The one pdf file should be open on the computer for the TA to see.
6. At the start of your checkout time, you will show the deliverables to your TA and run your program for the TA. The TA may wish to see certain conditions, so be ready to make small changes to your programs.
7. You will be asked questions to determine your level of understanding.
8. At the end of checkout, the TA will record all parts of your lab grade on the grading sheet, so you will know your score at that time. These sheets will not be returned. Make yourself a note of which TA checked you out; this information will assist you if you have to correct errors in lab grades.
9. To checkout early or late, go to a TA office hour. TA time during office hours is first come first served.

Late Turn in

1. In case you did not make it to check-out during the slot you were assigned, you still can check a lab out later during office hours of ANY TA.
2. There is no need to ask/register for that, just show up.
3. If you show up at the end of a TA office hour, there may not be time to check you out.
4. There is a penalty of 10 points for each late day, see the table below.

Date of your lab / Date of your Turn in	Tuesday	Wednesday	Thursday	Friday	Monday	Tuesday
Tuesday	0/-5 points	-10 points	-20 points	-30 points	-45 points	Not allowed
Wednesday		0/-5 points	-10 points	-20 points	-35 points	Not allowed
Thursday			0/-5 points	-10 points	-25 points	-40%

5. “0/-5 points” means that if you check out during your scheduled time, it is possible to get full credit, but checking out later that same day will be considered late (-5 points).
6. No check-outs will be allowed after Tuesday following the due dates.
7. Students in the Thursday lab have an advantage of having their labs due later, but students in the Tuesday and Wednesday labs have more opportunities for late checkout.
8. If you have special circumstances, please talk with your professor about it.
9. If you have something that will not allow you to check-out and you know about it ahead of time, consider asking to check-out early during office hours of ANY TA.
10. For early checkouts, please send an email to the TA you want to check-out early with, explain why, and cc your original TA.

Lab Lecture

1. We will post the times of lab lectures on Canvas.
2. There will be multiple such lectures for each lab.
3. All the lectures for a particular lab will cover the same topics, so you will have the flexibility to attend the lecture most convenient for your schedule.
4. The lecture(s) will take place couple of days (up to a week) before your check-out time.
5. During the lecture a TA will answer questions you might have, present a possible solution (how your solution is suppose to operate - not the code).
6. You may not take photographs of the constructed hardware shown by the TA.
7. The TA may give some hints and will answer your questions; therefore we strongly recommend you read the lab manual before coming to the lecture so you'll have some time to think of the lab and see if you have any questions.

Grading Policy

This is a programming class. Therefore, the quality of the software you write will significantly affect your grade. In addition to writing software, each lab has specific activities that must be documented and turned in with the lab. These deliverables will be screenshots, circuit diagrams, measurements or data analyses. The TA will record the performance and demonstration grades on the grading sheet. Exceptionally “good” programs may be given extra credit. If you do extra functions in your program, point out and demonstrate the extra functions to the TA when you demonstrate your program. Partial credit, not to exceed a maximum of 75% of full credit, may be awarded to a program that does not meet all specifications. Often it is better to checkout late incurring penalties than to turn in an incomplete program. There are four components to the lab grade (each lab has a detailed grading sheet, this is just an overview):

1. Deliverables 20% (completion grade, one **pdf** file, uploaded to Canvas/github, and shown to TA during demonstration)

2. Performance 35% (graded by the TA at the time of checkout)
 - a. How well does it work? Does it crash?
 - b. Does it handle correctly all situations as specified?
 - c. How clean is the user interface?
 - d. Possible 5% bonus, does it do more than specified?
3. Adhere to coding standard 5% (organization, style, comments etc.)
 - a. Comments explaining each subroutine (inputs, outputs, summary of behavior)
 - b. Modular programming (subroutines do only the tasks they were created for)
 - c. Code is clearly organized (not too many branches)
 - d. Good variable names (divisor is called divisor, result is called result etc.)
 - e. Consistent coding style throughout (bracket placement, proper indentation, variable naming scheme)
4. Demonstration 40% (graded by the TA at the time of checkout)
 - a. Can you explain to the TA how your software works? Be prepared to explain the data flow through your system.
 - b. Can you explain why you made certain software engineering tradeoffs?
 - c. Both partners if applicable must be present during the demonstration.

There is a lot of code in the book and on the internet. It is natural and appropriate for you to look at these examples. However, during demonstration you are expected to understand both the algorithm used and the implementation details of *all* software you are running at the time of checkout. In particular, the contents of these starter files will be examinable for the lab checkouts as well as for exams. Even if your program works, you may get very poor score on the entire lab (e.g., 0 to 50%) if you do not understand how it works. For Labs 3 through 9, if your system runs on the simulator, but does not fully run on the real hardware, you may be assessed at least a 20% penalty on the entire lab.

Other grade related policies are:

1. You will receive your lab and homework grades through the Canvas.
2. Please make a note of which TA checked out each of your labs.
3. Similarly, please note which TA collected your homework.
4. The TA that checked you out should upload your grade within a week after the check-out.
5. There is no need to send emails and ask about it during that week, but, if you don't see your grade after seven days, please send an email to the TA who checked you out and cc the email to your professor.
6. If it is not the TA you usually check-out with, please cc your regular TA as well.
7. The deadline for protesting your lab grade is 14 days after the lab was checked.
8. We pass your lab software through a plagiarism checker.
 - a. Any copy/pasting from current or previous students constitutes scholastic dishonesty.
 - b. Basically, you should not be looking at solutions to EE319K labs written by other students (other than your partner of course).
 - c. See the course syllabus for more information on plagiarism.

Office Hours

1. The professors and TAs have office hours.
2. You can find the office hours of the professors on their websites.
3. TA office hours will be posted on Canvas.
4. Lab and TA office hours will be on zoom.
5. You can attend any office hours, even if it is not your professor/TA.

Communication

1. Sometimes you need to ask a specific person a specific question. For example, you might ask your TA about a missing grade, it would be nice to email Valvano about possible typos in the book, or you might want to ask your professor about a special circumstance. In these cases, contact the specific person.
2. Conversely, if you have a general question about the TM4C123, the lab, or the lab equipment, the best approach is to post a question on the class Piazza forum.
3. If you have a lab grade question, please contact the TA who checked you how. If you have an exam grade question, please contact the professor.

Useful websites

Valvano's web page	http://users.ece.utexas.edu/~valvano	
EE319K material	http://users.ece.utexas.edu/~valvano/Volume1	(specific to EE319K)
Data sheets	http://users.ece.utexas.edu/~valvano/Datasheets/	
Book examples	http://users.ece.utexas.edu/~valvano/arm/	(example code from the book)
C programming	http://users.ece.utexas.edu/~valvano/embed/toc1.htm	
Starter files	http://users.ece.utexas.edu/~valvano/Volume1/EE319K_Install.exe	