Electrical and Computer Engineering Laboratory Requirements and Safety Manual

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Table of Contents:

Laboratory Requirements Manual Applicability:

These requirements are applicable to the following courses:

ECE.2070	Circuits I
ECE.2080	Circuits II
ECE.3110	Electronics I
ECE.3120	Electronics II
Other	As identified by instructor and / or course syllabus.

Individual instructors may alter a portion of these requirements based on the course needs and instructor preferences.

Chapter 1
Laboratory Safety

General Laboratory Safety:

- No "eating or drinking" at the laboratory benches.
    - The term "eating and drinking" includes eating, drinking, applying cosmetics, adjusting contact lenses, taking/storing medicine, and other related activities. It also includes items and equipment used for storing, preparing, and consuming food and beverages.

    - **Reasons for Prohibition**
        - The main reasons why "eating and drinking" is not permitted on or near the lab benches is for your personal safety as well as the protection of laboratory equipment.

          Personal safety risks can result from cross-contamination and ingestion of contaminants that may reside on or near the laboratory benches. Although the laboratory staff attempts to maintain laboratory cleanliness, certain activities may occur that may result in less than desirable laboratory conditions between cleanings.

          Equipment damage may result if food or liquids are spilled on or near the equipment. Depending on the severity of the spill, other hazards may result due to equipment damage.

Electrical Safety:

- Contact the ECE Lab Manager ***prior to*** working on or in the vicinity of high voltage power sources that supplies high voltage/current. High voltage is defined as greater than 30 volts alternating current (a.c.) or direct current (d.c.)

The *Electrical Safety - High Voltage Standard Operating Procedure* (SOP) MUST BE adhered to. The following is a link to the SOP:

https://www.dropbox.com/s/hzhhw9a7rxbla9u/Electrical_Safety_High_Voltage_SOP.pdf?dl=1

- Never work alone on exposed energized circuits
- Never install or remove components from an energized circuit or equipment.
- Do not construct circuits while energized.
- Do not lift a piece of electrical equipment by the cord or pull the cord to disconnect from the outlet to prevent damage.
- Power cords must have grounding plugs (3 prong) and be properly insulated.
- Only qualified electrical workers may install, service or repair electrical equipment.
- Follow ALL electrical safety precautions noted in the laboratory experiments.

- **Electrical Emergency Response:**

  - **In case of emergency call University Police:**
    - From Lab Phone … x44911
    - From Cell Phone … 978-934-4911

  - **Electric Shock:**
    - When someone suffers serious electrical shock:
      - They may be knocked unconscious.
    - If the victim is still in contact with the electrical current
      - Immediately turn off the electrical power source

    - **IMPORTANT**:
      - Do not touch a victim that is still in contact with a live power source; you could be electrocuted.
      - Have someone call for emergency medical assistance immediately. Administer first-aid, as appropriate

  - **Electrical Fire:**

    - If an electrical fire occurs:
      - Evacuate the lab, pull the nearest fire alarm pull station and then go to a safe area and call extension 44911 or 978-934-4911 from a cell phone. Follow the fire safety evacuation plan.
      - For small, isolated fires, attempt to disconnect the electrical power

source, if possible
    - If the fire is small and you are not in immediate danger; and you have been properly trained in fighting fires, use the correct type of fire extinguisher to extinguish the fire

- ***DANGER:***
    - NEVER use water to extinguish an electrical fire

- **Class C Fires:** Also known as electrical equipment fires:
    - The following types of materials which would burn in a Class C fire are:
        - Computers
        - Energized or energy active electrical equipment.
        - Electrical sources
        - Fuse boxes
        - Wiring
    - Class C fires are contained using **Carbon Dioxide (CO_2)** fire extinguishers and **Dry Chemical** fire extinguishers

Soldering Safety:

- The *General Soldering Standard Operating Procedure* (SOP) MUST BE adhered to. The following is a link to the SOP:

  https://www.dropbox.com/s/g3glhp3z94vh0gm/Soldering_SOP.pdf?dl=1

- The following, as required by the SOP, are in effect when soldering:
    - **DO NOT** wear gloves while soldering.
    - **WEAR** Safety Glasses When Soldering.
    - **DO NOT** work alone (danger of burns or fire).
    - **NO EATING or Drinking.**
    - **Use only Lead-Free Solder.**
    - Ensure proper ventilation (open a window or use a fume extractor if needed).
    - Ensure work area is not cluttered.
    - Unplug the soldering iron when soldering is complete.
    - Wash hands when complete

- **In case of emergency call University Police:**
    - From Lab Phone … **x44911**
    - From Cell Phone … 978-934-4911

Chapter 2
Laboratory Policies

The following policies shall be abided by when performing work within any of the University ECE Laboratories:

- All laboratory occupants shall be familiar with the locations and operation of safety and emergency equipment, including but not limited to, fire extinguishers, first aid kits, fire alarm pull stations, emergency telephones, and emergency exits and egress.
- Laboratory occupants MUST Sign-in and out of the lab during Open Lab Hours using the Lab Sign-In/Sign-Out Log located in the Laboratory.
- Only students authorized by their instructor or the ECE Laboratory Manager can use the laboratory.
    - If you require card access to a laboratory door, your instructor or advisor MUST contact the ECE Laboratory Manager and provide the following information:
        - Laboratory requiring access (room number)
        - Timeframe access is required (Start Date and Complete Date)
        - Reason for access
        - Student's name, Student ID number, and student's email address
- Laboratory occupants shall not grant entry to unauthorized students.
- No overriding the door locks unless authorized by the ECE Laboratory Manager
- Laboratories shall be secured when unoccupied.
- Never open (remove cover) of any equipment in the laboratories. Never "jump," disable, bypass, or otherwise disengage any safety device or feature of any equipment in the laboratories.
- All safety instructions, warnings, posted signs, verbal orders shall be complied with

by all Laboratory occupants.

- Report problems and potential hazards to the Laboratory Instructor, or TA
- In case of emergency dial 4-4911 from a lab phone or 978-934-4911 from cell phones
- Carry-out and properly dispose of ALL trash.
- Do not disconnect any computer from the network.
- Be respectful to others in the lab.

Failure to comply with the above will result in immediate removal from the laboratory as well as card access to ALL ECE Laboratories.

Repeating the Course and/or Repurposing (Reusing) Prior Materials:

If for any reason you are repeating the course or if you have materials from a prior assignment, prior semester, or prior laboratory experiment that can be utilized in submission of course materials, the following MUST BE followed when submitting course work for grading:

- All data MUST BE from the current semester and current laboratory experiment. Data from prior semesters will NOT be accepted. In other words, labs and assignments must be repeated.
- Your submissions are expected to reflect new approaches and insights into the topic to demonstrate your intellectual growth since the last time you worked on the materials.
- In general, you may use only small portions of documents as background or foundational material. You may NOT merely copy and paste substantial sections from one laboratory report to another.
- When using your own scholarly work (a laboratory report for example), you MUST cite yourself as a primary author and your previous coursework as unpublished papers, using citing guidelines of "The Publication Manual of the American Psychological Association" (APA). In other words, reuse previous work sparingly, use it only with good reason and the instructor's permission, and cite it using APA format. The *Laboratory Requirements and Safety Manual* provides details on how to cite yourself.
- IF you purely reuse your previously submitted materials without the modifications as outlined above, your materials will be graded as a zero.

Required Laboratory Materials (Must bring to each lab):

NOTES: The following applies to EVERY SCHEDULED laboratory session as well as those sessions where bench exams are conducted. Failure to come prepared for lab and/or

exams may result in a grade reduction in proficiency (for lab work) and exam grade(s)

a) Ability to log into Blackboard.
b) Bring a memory stick (USB Flash drive)
c) Bring you breadboards.
d) Bring your wire strippers/cutter, when supplied.
e) Bring your parts/component kit.
f) Bring your Analog Discovery Kit
g) Bring your hand-held meter (which was provided in Circuits I)
h) Bring your lab notebook.
i) Have your pre-lab accomplished NOTE: Pre-labs SHALL BE accomplished as scheduled in Blackboard, regardless of if you will be performing the lab on the day the lab is scheduled to start or not.

Lab Report Due Dates:

Refer to the course syllabus.

Late Policy:

Refer to the course syllabus.

Laboratory Participation Process and Requirements:

Definitions:

Online:

- Laboratory course conducted "online" is defined as a laboratory course and its laboratory experiment (Lab) which are conducted outside of the laboratory and no formal laboratory sessions are scheduled, they are asynchronous. However, due dates apply.

Virtual, as defined by the university, is as follows:

- **In the Virtual Classroom, your participation in the class at all scheduled class meeting times is expected.** Face-to-Face/Virtual Classroom provide the real-time connection between the instructor and the students. Please check your schedule in SIS to see when your Virtual Classroom course is scheduled to meet.

Online/Virtual Laboratory Process:

The process for conducting the laboratory procedures when a course is being conducted Online or Virtually are as follows:

1. **Virtual Only.** Students, TAs, Graders, and the Course Instructor(s) shall log into the appropriate ***Zoom Laboratory*** at the beginning of their laboratory periods and will remain logged in throughout their entire laboratory period. Students, TAs, Graders, and Course Instructor(s) will be logging in from remote areas where lab performance is practical. If you are unable to work, you MUST contact your TA immediately to discuss your options. ***It is highly recommended that you log into your online Laboratory session 10 minutes prior to the start of your Laboratory session*** to ensure that your hardware is working properly.

   Log-on links are provided in the course Blackboard. To log into the ***Zoom Laboratory***, perform the following using your computer (mobile devices may be different):

2. **Virtual Only.** Use of webcam, microphones, and speakers or headphones are strongly encouraged. During your scheduled Virtual laboratory section and Virtual Laboratory Lecture timeframes, you will be logged into your virtual ***Zoom Laboratory*** and are strongly encouraged to have your webcam turned on and microphone available as well as a speaker or headphones. The microphone shall remain muted unless you are communicating with others in the laboratory section, TA, Grader, or Instructor(s). When using Zoom, you can use an appropriate background. The background will block the area located behind you.

3. **Virtual Only.** The TA will be using a microphone to provide directions to the class as well as individual help in the performance of the laboratory experiment, therefore, you must have a speaker or headphone available to hear the TA.

   When you need assistance during the laboratory period, it is recommended to use the "***Raise hand***" feature in the virtual ***Zoom Laboratory***. This will notify the TA, grader, and instructor that you have a question and requires help.

   NOTE: To ensure active participation in the lecture, the instructor will periodically ask all students in attendance to "raise their hand." Failure to do so will result in an absence.

4. **Online and Virtual.** You will utilize your Analog Discovery Kit (ADK) and handheld meter in the performance of your experiments. There are very few labs or portions of labs that you will NOT be able to be performed using your ADK and handheld. When situations arise where you cannot perform a lab, notify your TA immediately. If you have access to bench top laboratory equipment, that can be utilized with the permission of your TA.

   NOTE: Contact your TA immediately if you do not have an ADK. Purchasing of an ADK has been a requirement of ALL the laboratory courses. Ordering information is contained in the syllabus.

5. **Online and Virtual.** During each section of the laboratory experiment, take a short video. ***Links*** to your videos ***shall be provided in the Appendix to your laboratory reports.*** Record at least one video for each section that demonstrates your ability to perform the measurements within that section of the procedure. You do NOT need to video the entire lab performance. The video MUST be as follows:

   a. Less than 2 minutes in duration. Minimum time is determined by meeting the requirements. For example, the time it takes to show you taking a sample measurement.

   b. Provide a ***LINK*** to your video. Contact your TA if you cannot provide a link.

   c. Each video will capture the following:

      i. Start with a voice introduction showing your face, then turn and show your computer with Waveforms running and the circuit connected to the computer. The video must be uncut or unedited. Failure to identify yourself, your circuit, or editing your video will result in a zero (0) for the entire laboratory report. Why? This is an online/virtual course that requires proper identification that you performed your own work.

      ii. If the handheld meter or other personally owned equipment is being used in the performance of the experiment, then substitute Waveforms in 5.c.i above with this equipment.

6. **Online and Virtual.** You are required to photograph each of your assembled circuits located on your breadboard. Photographs MUST be of quality that

allows your TA and grader to see your components and wiring. It is critical that the wiring and circuits are neatly constructed on your boards and component values are clearly seen. This may require more than one photograph per circuit. Your Student ID or other government picture ID ***MUST*** be in each of your photographs. Photographs shall be included in an Appendix to your laboratory reports and will be properly labeled.

It is only necessary to photograph circuits when they are initially built or changed.

Online and Virtual Lectures:

Virtual lectures will be at their time scheduled in SiS. Zoom will typically be utilized. To get credit for attending, you must be logged in and participating during the entire lecture period. The use of webcam, microphones, and speakers or headphones is identical to Online/Virtual Laboratory Process described above.

NOTE: To ensure active participation in the lecture, the instructor may periodically ask all students in attendance to "raise their hand" or method to determine attendance. Failure to do so will result in an absence from the lecture.

Online lectures will be conducted asynchronously. Weekly laboratory information will be in the form of a weekly agenda and/or online recordings, which will be available in Blackboard. Completing the weekly journal or other method will provide credit towards lecture attendance.

Chapter 3

Pre-Lab Preparation

IMPORTANT – If you are planning on reusing materials from a prior course or prior laboratory assignment, you MUST abide by the ***Repeating the Course and/or Repurposing (Reusing) Prior Materials*** requirements contained in Chapter 2 of this manual.

Prior to the lab period that the lab is scheduled to start (refer to due date in Blackboard), you shall:

- Read the ***entire*** lab procedure.
- Ensure that you ***understand*** all the steps and information contained in the lab procedure.
- Preform all calculations in the lab notebook.
- Establish tables in your notebook.
- Create a draft lab report (requirements are contained below)

IMPORTANT: Pre-labs SHALL BE accomplished as required by the course syllabus, NOT the date that you will perform the lab, unless you are ahead of the course laboratory schedule, in that case the pre-lab shall be accomplished prior to starting the laboratory experiment. Typically, the pre-lab is due the day prior to the first scheduled section to start regardless of performing the lab on that day or not.

Pre-labs shall ensure that you have a full understanding of what is to be accomplished, the results that are expected, and provides a draft lab report.

The pre-lab shall be uploaded to Blackboard prior to the lab period that the lab is scheduled to start. Scan or take pictures of those pre-lab portions of your lab notebook. Pre-labs will be graded concurrently with your finalized lab reports using the materials that you upload. ***Pre-labs not submitted on time will be graded as a zero.***

NOTE: A technique that will aid in identifying areas or materials in your draft lab report that need to be updated with lab performance data or other information can be highlighted using Word's highlighting tool.

Elements of a pre-lab:

1. Read the ***entire*** lab report.
2. Ensure that you understand what the lab is accomplishing as well as how it will be accomplished.
3. ***Laboratory Notebook Preparation:***
    a. Perform all calculations in your lab notebook and / or, ***when required*** by the lab or instructor, simulate the circuit using MultiSim. Multisim software is available free to all students (see the UML IT webpage).
    b. Establish data tables in your lab notebook. DO NOT leave large empty areas in your lab notebook. Observations will be recorded on future pages of your lab notebook.
    c. Scan a copy of the laboratory notebook pages containing the elements above and upload a separate PDF document with the draft laboratory report (outlined below) to Blackboard.
4. ***Create a draft laboratory report***, which will be uploaded as indicated above. The draft report, as a minimum, shall contain the following (see Laboratory Report requirements later in this document for detailed requirements of a laboratory report):
    a. Prepare the entire lab report coversheet except for the submission date.
        i. The date the report will be submitted is not yet known, therefore, use the draft report date and highlight it to indicate that the date needs to be updated in the final version of the report.
    b. Summary/Abstract
        i. State the overview of the lab. Other portions will be completed after performance of the lab.
    c. Equipment
        i. Construct the equipment table identifying all the equipment that the lab states to be used as well as standard test equipment that you may use to obtain the needed data.

           The final report should eliminate equipment not used as well as add equipment that was not initially identified.

           The final laboratory report MUST INCLUDE equipment serial numbers. If your bench assignment does not typically change, then the draft will include the standard list of bench equipment and their associated serial numbers.
    d. Introduction
        i. This entire section shall be completed during the pre-lab
    e. Circuit Description

   i. This entire section, with the exception of the pictures and videos, shall be completed during the pre-lab.
   ii. Include schematic diagrams from your Multisim simulations, when invoked, otherwise screenshots of circuits from lab procedure (properly cite).

f. Measurement Results
   i. Only the section header can be included during the pre-lab.
   ii. Blank tables shall be prepared and included.

g. Discussion
   i. Only the section header can be included during the pre-lab.

h. Conclusion
   i. Only the section header can be included during the pre-lab.

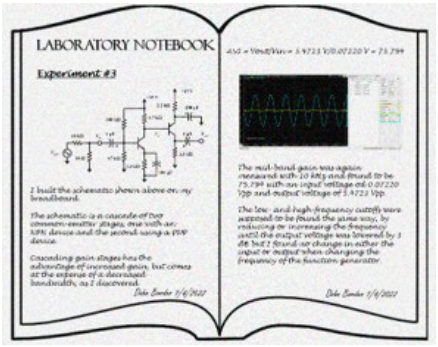
i. Questions
   i. Identify all questions asked throughout the lab. Those questions that are related to pre-lab items shall be answered. Other questions shall be stated and answered after completion of the lab.

j. References
   i. This section can be started, and most likely completed during the pre-lab draft lab report establishment.

k. Appendices
   i. So as not to "clutter" the actual laboratory report, place all hand calculations, raw data, extra graphs and plots, MATLAB results, etc. at the end of the report. Separate appendices will be used to separate the various information. This does NOT mean that all of the above information is placed in the appendices, rather extra and other items not specifically referenced during your report write-up.

      NOTE: Notebook pages will be uploaded as a separate file.

Chapter 4
Laboratory Notebook



IMPORTANT – If you are planning on reusing materials from a prior course or prior laboratory assignment, you MUST abide by the ***Repeating the Course and/or Repurposing (Reusing) Prior Materials*** requirements contained in Chapter 2 of this manual.

4.1 Purchasing a Laboratory Notebook:

Refer to the course syllabus.

4.2 Laboratory Notebook Grading (face-to-face/in person course):

Refer to the course syllabus for notebook grade percentage and other related materials.

Notebooks are graded twice per semester. The first grade is upon completion of ***experiment #2***. The second grading occurs upon completion of the ***second to last*** experiment.

> ***For example***, the second time the notebook will be graded occurs after experiment #5 is completed IF the laboratory course has 6 experiments. If the course has 5 experiments, then the second grading occurs after experiment #4.

The process for identifying when you are ready to have your laboratory notebook evaluated is described in paragraph 3 of this chapter.

4.3 Laboratory Notebook Grading Process:

1. The course Blackboard has Laboratory Notebook Grading modules. ALL modules MUST BE accomplished during the semester. Grading criteria is in paragraph 4.5 of

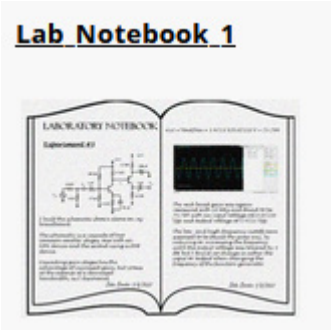
this chapter. The instructor may add or subtract grading elements.

2. Both Laboratory Notebook Grading, as identified in Blackboard, MUST be completed by the due date identified in Blackboard.

3. When a student has completed experiment #2 and again after completing the second to last experiment, the student SHALL:

    a. Open the "***Laboratory Notebook Evaluation***" folder in Blackboard, which is typically located under the "Labs & Laboratory Procedures" folder

    b. Open the corresponding Blackboard Laboratory Notebook Grading module located in Blackboard. An example is shown below.

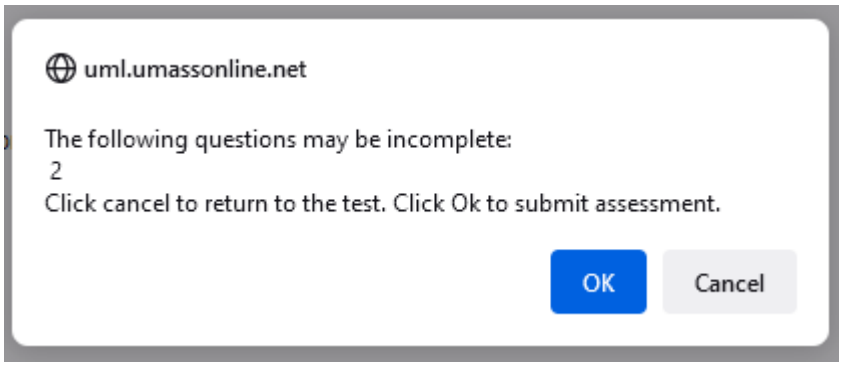


    c. Answer the first question in the module indicating that you are ready to be evaluated

        DO NOT answer any additional questions unless directed by the TA or instructor

    d. Submit when ready for the notebook to be graded

        When you submit in Blackboard, a message like the one shown below may appear. This is due to the additional question that was not answered. The evaluator will respond during your notebook evaluation.



e. Notify BOTH the TA and instructor that your notebook is ready to be evaluated

f. Be present for the notebook evaluation during the same class or, if the submission was submitted outside of the scheduled course timeframe, then the next scheduled day

    i. NOTE: Your notebook evaluation will be performed in the order received by the TA and instructor. Based on the quantity of submissions, the evaluation may be a follow-on class day

4. The TA and/or instructor shall perform the notebook evaluation based on the Blackboard rubric and the criteria within this LRSM, Evaluation shall include:

    a. The TA, grader, or the instructor shall grade the notebook by first reviewing the inside cover ensuring proper identification has been annotated.

    b. For the first grading of the semester, all pages from the beginning of the semester to present shall be evaluated using the Blackboard rubric and the ***Laboratory Requirements and Safety Manual***.

    c. As a minimum, the TA, grader, or the instructor shall clearly indicate on the last page graded the following:

        i. Date graded.
        ii. Name of the grader (graded by).
        iii. Numeral grade.

    Additional grading comments can be included with the above information, however, typically the rubric contains all the grade details and comments.

    d. For the second notebook grading of the semester, the process outlined above shall be followed.

The TA, grader, or instructor shall again verify the inside cover and grade pages from the point where the first grading stopped.

The evaluation shall be based on the grading rubric and the ***Laboratory Requirements and Safety Manual***.

The notebook shall again be annotated as indicated above with the date graded, graded by, and numeral grade

4.4 Laboratory Notebook Grading (virtual or online course):

Refer to the course syllabus for notebook grade percentage and other related materials.

Notebooks are graded twice per semester. The first grade is upon completion of ***experiment #2***. The second grading occurs upon completion of the ***second to last*** experiment.

> ***For example***, the second time the notebook will be graded occurs after experiment #5 is completed IF the laboratory course has 6 experiments. If the course has 5 experiments, then the second grading occurs after experiment #4.

The process for identifying when you are ready to have your laboratory notebook evaluated is described in paragraph 4.3 of this chapter, with the follow additional requirements.

1. When ready for your notebook evaluation (as described above) follow the process outlined in paragraph 4.3 except use the second question to upload a scanned copy of your notebook. Pages are scanned, converted to a PDF document, and uploaded.

First notebook scan shall include a scan of the inside cover of the notebook and all laboratory notebook pages from the beginning of the semester to the date of submission.

Second notebook scan shall include a scan of the inside cover of the notebook and all laboratory notebook pages from the point where the first scan left off to the date of submission.

4.5 Utilizing a Laboratory Notebook:

NOTE: Late points, as indicated in the syllabus, shall be deducted for each day the submission is late. Failure to submit within the grace period will result in a laboratory notebook grade of zero for

that grading timeframe. Notebooks collect valuable information. Failure to provide your laboratory notebook will impact your final laboratory grade.

You SHALL adhere to the following reference (available at the link below as well as on Blackboard) when collecting and recording data into your laboratory notebook.

> Kanare, H. M. (1985). *Writing the Laboratory Notebook*. American Chemical Society. Washington, D.C.
>
> https://www.dropbox.com/s/khpu25rud41jzlz/Writing_the_Laboratory_Notebook.pdf?dl=1

You must have your own lab notebook during every laboratory session. Your lab proficiency grade may be affected by not bringing your lab notebook to your lab session.

Lab notebook entries shall always be recorded legibly, neatly, and in black or blue ***permanent ink*** (such as a ballpoint pen). Pencil is NOT allowed.

Pre-lab results and data shall be recorded in your lab notebook. Completing the prelab is very important time management technique for using your time in the lab efficiently. Knowing what to expect from your lab measurements will allow you to understand the instructions as well as to catch mistakes before you have wasted a lot of time potentially troubleshooting a non-problem.

Recording data. Immediately record and date in your notebook all original concepts, data, and observations, using separate headings to differentiate each. Record all equipment used and corresponding information (make, model, and serial number) in your lab notebook.

Record all concepts, results, references, and other information in a systematic and orderly manner. Maintain consistent language, charts, and numbering systems throughout your notebook.

It is acceptable to make your entries brief. However, always include enough details for someone else to duplicate the work you have recorded.

Label all figures and calculations. Use proper formatting.

Never, under any circumstances, remove pages from your notebook.

Start entries at the top of the first page, and always make successive, dated entries, working your way to the bottom of the last page.

After completing a page, sign and date the page in the "SIGNATURE" and DATE" blocks before continuing to the next page.

For face-to-face laboratory sessions, either the TA, grader/Laboratory Assistant, or the instructor shall sign and date each page in the "DISCLOSED TO AND UNDERSTOOD BY" and "DATE" blocks of the notebook used during that laboratory period. For notes taken outside of the laboratory period, the student shall N/A this signature.

Make sure that you record the date of each entry clearly and unambiguously.

Never let anyone other than yourself write in your Notebook (excluding witness signatures, discussed later).

Never leave blank spaces.

- Simply draw an "X" through any blank spaces at the same time you are making your entries

Never erase or remove material you have added. If you make a mistake or need to change any materials already entered in your notebook

- Simply draw one line through the materials at the same time you are making your new entries.
- Then add your initials next to the changed or removed materials.
- Then enter the correct entry nearby, if applicable

Supplements and secondary sources. You can supplement your entries with supporting material (e.g., test-result printouts and other documentation), but you must permanently affix the material onto a page in its proper chronological location.

Never rely solely on any supplemental attachment. Always include your own entry describing the attachment and add any conclusions that you might draw from its substance.

Occasionally, secondary sources might be too large or inappropriate to attach directly to your notebook. In this case, you can add all secondary sources to an ancillary record maintained precisely for this purpose. However, always remember to write a description of these secondary sources, clearly and unambiguously, in your notebook.

It is a good idea to use prominent headings to label the beginning of each new lab experiment, as well as the sections within each lab.

How much detail do you record in the lab notebook? There should be enough so that someone else can duplicate your experiment and verify your results. Show all essential calculations which are used to interpret measured data. Comment, as necessary. Alternatively, you may need to return to the notebook later when doing the write-up, or perhaps for a later lab.

Circuit diagrams shall have component values (e.g., 1kΩ), reference designations for each component (e.g., Q1), part numbers for diodes and active devices (e.g., LM741). Voltage and current signals should be clearly labeled with polarity indicated (-/+ for voltages) and units.

Be sure to distinguish among directly measured values, indirectly measured values based on calculations made from measurements, and expected values from theoretical calculations (e.g., from the prelab). Indicate important results with a box or underline.

Describe any specifications of equipment or components that affect the accuracy of an experiment. Record the bench number at which you perform the lab.

Use lots of graphs and tables to organize and present information about experimental measurements and results. Even if you cannot do a precise plot of results, it is very important to do a rough plot as you go along, as a sanity check of your results to make sure you are not making any huge mistakes in the lab. Label the axes with the signal or variable measured, a numerical scale, and units. Detailed graphs shall be produced using MATLAB.

The following link provides additional information for maintaining a laboratory notebook as well as reasons why to properly maintain the notebook:

www.bookfactory.com/special_info/engr_notebook_guidelines.html

Chapter 5
Laboratory Reports (Standard Report Format)

IMPORTANT – If you are planning on reusing materials from a prior course or prior laboratory assignment, you MUST abide by the ***Repeating the Course and/or Repurposing (Reusing) Prior Materials*** requirements contained in Chapter 2 of this manual.

The standard report format is the typical format required for submission. Occasionally, the instructor may allow the use of the condensed format, which is a reduced laboratory format. The condensed format is described further in this document.

INFORMATION: There is a sample laboratory report available on Blackboard

Standard Report Format (see details of each section listed in follow-on areas of this document):

Cover Page

Summary/Abstract

Equipment

Introduction

Circuit Description

Measurement Results

Discussion

Conclusion

Questions

References

Details of the Standard Laboratory Report Format:

IMPORTANT:

> ***ALL Analog Discovery screenshot submissions in lab reports SHALL contain the COMPLETE serial number of the device as well as the date and time. This information is available in all modules with WaveForms. Failure to include the above information will result in marking the screenshot as not included in the report.***
>
> ***ALL Oscilloscope screen capture submissions in lab reports shall contain the oscilloscope serial number, as well as the date and time the screenshot was taken. Refer to the oscilloscope manual for setting up the display. If the oscilloscope on your bench cannot display this information, it needs to be noted in the equipment section.***

The lab report is a concise report of the important results in the lab. It should be a complete record of your work in the lab: theoretical background, calculations and anticipated performance, empirical verification, and discussion of the results. While the report does not need to be as detailed as the lab handout, it should "stand alone" - that is, it should be sufficiently self-contained so that one can be read and understand without reference to the lab handout itself.

The length of the lab report is dependent on the topics covered within the laboratory experiment. There is neither minimum nor maximum length. The write-up needs to cover all the required information.

General Report Formatting

Microsoft Word software **shall be utilized**. Unless otherwise noted within the individual sections, font, point size, and line spacing shall be:

Point size: $\geq$ 10 point and $\leq$ 12 point (be consistent throughout the document).

Font: Of your choice, but be consistent (Use one type of font for the section headings, another for the body, etc.) FYI - Labs are written in Times New Roman, which is the preferred font.

Line spacing: Single or double spacing. Your choice.

Each page, except the cover page, shall have a page number (page x of y).

If, for some reason, a section of the report is not needed, which is rare, you shall keep the section header and indicate the following under the section header:

Not Applicable

Each section should be clearly labeled, and the title should be bolded: For example –

Pictures, Figures, and Tables

Pictures, figures, and tables shall be numbered and have short descriptions. Use a recognized format such as the Institute of Electrical and Electronics Engineers (IEEE) and the American Psychological Association (APA) formats.

Pictures, figures, and tables shall be placed in the page so that it does not disrupt the rest of the text.

Use your word processor for Greek symbols for common engineering quantities as β, π, φ, ω, and Ω.

Cover Page:

Lab title:
Your name:
Your lab partner's:
(When assigned in groups of 2 or more)
Bench #
(Indicate if you used more than one bench. Other benches used will have equipment information recorded.) If a bench is not utilized, for example in a virtual or online laboratory course, state "Virtual" for the bench #.
Course Name:
Course Number:
Course Section Number:
Date:

Cover Page Format
Font --- ***maximum*** of **14 point, and shall be bolded**

The cover page shall be on a separate page.

Summary/Abstract:

The summary/abstract section is a mini-lab report. It allows the reader to quickly get an overview of the lab and the main conclusion(s) drawn by the lab. This section should include brief statements on:

1. What was done?
2. Why was it done?
3. How was it done?
4. What were the overall results?
5. The main conclusion(s)

The summary is a concise description of the material covered in the lab, as well as a summary of the important results.

Do not copy and paste the introduction from the lab handout.

Include some specific result(s) from your work. Spell out acronyms (LED for example) the first time they are used.

Equipment:

When constructing the equipment section, you shall list all the ***equipment*** that you used during the conduct of the lab. Ensure that you include the following for of all the equipment utilized during the experiment:

1. Make
2. Model
3. Serial number. The serial number ***MUST BE*** listed when you utilized the:
    a. Bench top Oscilloscope
    b. DMM
    c. Bench top power supply
    d. Analog Discovery

Always keep the reader in mind and assume they are going to recreate your lab.

Record all equipment used and corresponding information (make, model, and serial number) in your lab notebook. If you are using the same bench on a weekly basis, equipment data can be captured during the first lab. This data can be used throughout the semester. It is highly recommended that throughout the semester

you verify that the equipment has not been changed out.

Create a table in your lab report. The following is an example of what the table could look like (the table is a partial listing of the equipment that may have been used during the conduct of the lab):

Type	Make	Model	Serial #
Oscilloscope	Tektronix	MDO3014	1234
Signal Generator	Keithley	AFG1022	ABC123
Benchtop Multimeter	Keithley	2110-120	ZX341
Power Supply	Keithley	2231A-30-3	123AB
Analog Discovery	Digilent	ADK2	GHF34567

If you change test equipment during the lab, you will record ***both*** the old and the new test equipment information and the date(s) the change was made.

Introduction:

The introduction shall provide the theoretical background for the work you will be presenting. Include equations, on their own lines, when appropriate. Number all equation so you can refer to it later in the text if necessary. If there are any new symbols introduced, explain them in the text immediately following the equation. Your introduction should concisely state the purpose of the lab.

In the introduction you let the reader know what the lab is going to include. This typically includes goal/purpose of the lab, the procedure, and any background information the reader may need. You should assume that the reader is not a professional with 30 years of industry experiences or someone pursuing an advanced degree. This would also be a good time to reference the lab manual and the recitation textbook.

An effective introduction to a lab report typically performs the following tasks, generally in the order presented:

1. It establishes the learning context for the lab by:

    a. Stating what the lab is about, that is what scientific concept (theory, principle, procedure, etc.) you are supposed to be learning about by doing the lab.

b. Providing the necessary background for the learning context by providing pertinent information about the scientific concept (this information can come from the lab manual, the textbook, lecture notes, and other sources recommended by the lab manual or teacher; in more advanced labs you may also be expected to cite the findings of previous scientific studies related to the lab).

2. It provides the primary goals of the lab by:

    a. Presenting the objective(s) for the experimental procedure (what is being done in the experiment, such as to measure something, to test something, to determine something, etc.)
    b. Defining the purpose of the lab (the way the experimental procedure is linked to the learning context).

Do not re-write or copy the lab procedure. This is completely unacceptable. Instead, you should have three parts:

1) Cite the procedure in the manual. Your first sentence should then be something like, “The procedure for this lab has been described in detail in the lab manual. [Insert citation number or reference means here]." Make sure you remember to include the full citation at the end of the report.

2) Brief description of what you did. Simply write a few sentences describing what you did in the lab. There is no need for a detailed description; this can be found in the lab procedure, which you previously cited.

3) Note any changes. If you deviated in any significant way from the procedures described in the lab procedure, you need to describe those significant deviations. These should be described briefly (preferably, no longer than a paragraph).

The reader does not need a step-by-step procedure or full-page derivations of equations but does need general procedure and theory. For example, citing Ohm’s Law or describing setting up a few basic series or parallel circuits would be good. Additional relevant sources are always welcome too.

The introduction section provides a context for the lab performed. Providing a context entail:

1) Describing the specific goal of the lab

What are you trying to figure out?

2) Stating what scientific information already exists on the subject of this lab.

What theories and equations are employed in your lab?

3) Describing how your specific lab goal from point #1 relates to the scientific theories described in point #2.

How does your experiment illustrate or use the theory?

Tips:

Do:

1) Keep it brief, 1 – 2 paragraphs
2) Read from as many sources as possible to understand the context of your experiment
3) Cite, in the reference section and body of the report, the source(s) that you used
4) Use your own words or examples to illustrate theories

Do not:

1) Do not copy the introduction from your lab textbook or anywhere else
2) Do not use "I" or "we" if possible
3) Do not include results and/or conclusions. These go in the Results and Conclusions sections

Circuit Description:

For each circuit you build please describe the elements used (resistors, capacitors, inductors, diodes, metering equipment, power supply, etc.), how they are connected to each other, and how the circuit functions. When you have multiple circuits that are functionally the same to each other you do not have to redo all that work describing it. However, you should be discussing what is different about it in comparison to the original circuit.

This is also a good time to talk about how you expect the circuit to behave. You may want to list theoretical currents or voltages based of nominal supply voltages

and resistor values. The saying 'a picture is worth a thousand words" holds true for pictures of your lab reports and circuits. Make sure any picture included is meaningful and easy to follow. Overall, the descriptions should be written so someone with a basic understanding of the circuit could build it.

Computer generated circuit schematics using Multisim are required when invoked, otherwise use screenshots of circuits from the laboratory procedure (properly cite).. Include component values (e.g. 20 kW), and reference designations for each component (e.g. Q1), part numbers for diodes and active devices (e.g. LM741). Clearly, label voltage and current devices with polarity indicated. Units are a must!

Explain how the physical measurements you make in the lab are related to the theoretical concepts you are investigating. Be sure to discuss (somewhere in your report) any shortcomings of the techniques you are using. It may be more appropriate in the discussion section, for example, to explain deviations in measured results from expected performance.

When performing the pre-lab, predicted/expected readings shall be calculated and / or included on the Multisim drawing that is included in the report.

Your description shall show that you understand the operation of the circuit.

INCLUDE:

1. ***Pictures of your completed breadboard and setup. There needs to be a corresponding picture for each portion of the lab.***

2. ***Video link which contains a video of the operation of your circuit (see Online/Virtual Laboratory Process described earlier in this document for video details).***

Measurement Results:

The overall results of the lab should be discussed in a few sentences. That's not to say a deep conclusion needs to be developed here. It's just the overall trend of the results. You may need a few sentences for each section because they're too dissimilar.

The Results section would include a mix of written descriptions, figures, tables, and graphs.

Use as many figures as possible: circuit diagrams, waveform sketches, graphs and tables of measured results, visual comparisons of measured vs. predicted data.

Include ***both*** oscilloscope and Analog Discovery screenshots. Include the horizontal and vertical scales of the scope plot. Oscilloscope and Analog Discovery screenshots shall include oscilloscope serial number, time, and date unless the oscilloscope does not have this capability. Labs that require the use of an oscilloscope shall use a mixture of both the Analog Discovery and the Oscilloscope, each approximately 50% of the time (through the entire lab).

Include what you did see in lab, also note what you did not see, and explain. Refer to your laboratory notebook for recorded observations noted during the conduct of the experiment.

Whenever possible, use tables to present numerical data. Include the units of the measurements. Include measured and calculated values along with deviations from measurements to calculations. Include all your raw data, as well as the equations you used in your calculations. Use a math software package (MATLAB), which is required, or a spreadsheet if first discussed with the TA or instructor. These tools will automate your calculations - but check a few of the points by hand or with a calculator, to make sure the equations in your spreadsheet are accurate.

> Why should you create a table? A table summarizes a long list of experimental data and/or calculated results so that the reader can glance at the table and easily see the information in an easy-to-understand fashion.
>
> The design of the table (see equipment section for a recommended table):
>
> 1) Recommend embedding an Excel Table in your document. Excel tables are considerably easier to create and format.
>
> 2) Each column should have a heading in the top cell.
>
> 3) Headings should be in bold.
>
> 4) Very Important! Units of measurements or calculations should be listed in the heading.
>
> 5) Above the table, there should be a caption. The caption should identify the table by its number and include a brief descriptive title.

Another table within this section should be, depending on the data collected, a comparison between the predicted/calculated values and the actual values collected (measured) during the experiment. On effective method of displaying these results is by utilizing a table. The table consists of a column with the "predicted or calculated" results. Another column contains the "actual or measured" results from the experiment, and another column contains the calculation displaying the % difference between "measured" and "calculated." The equation for % difference is:

$$\frac{measured - calculated}{calculated} \times 100\%$$

If the % difference is positive, then the "measured" value is higher than "calculated", by that % value, and if negative, the "measured" is lower than "calculated" by that % value. Using these results, your report shall discuss how closely the experimental results matched the calculated.

Why do you include a graph? A graph shows visually how one variable depends on another. This visual representation is useful to deduce a trend.

The basic design of a graph:

1) Use MATLAB

2) The independent variable should be on the x-axis (horizontal). The dependent variable should be on the y-axis (vertical).

3) The axes of the graph should be labeled with their units of measurement. [e.g., Time number and Voltage (V)]

4) If there is more than one trend line on the graph, the figure caption must clearly indicate which data corresponds to which trend line.

5) Like tables, all graphs should have a caption which clearly indicates what is shown in the graph.

Discussion:

The discussion section of the lab report is where the results are interpreted, especially as they relate to the goals stated in the Introduction. It is also a place where experimental anomalies, errors, or other surprising results can be discussed.

The discussion is essential to conveying the meaning of the information you have gathered in the lab. Use figures and tables to illustrate the significance of your data. Never "fudge" your data to make it agree with expectations, rather attempt to explain the deviations and as well as the results received. A comparison of measurement to theoretical prediction should be as clear as possible.

Here you have the opportunity to come full circle and connect what you outlined in the introduction to what was measured. This is also the time to talk about any questions (outside the ones the lab asks) that may have arisen or what may have possibly gone wrong. The discussion is where you start to connect to theory and support your claims with results. Essentially, the assigned laboratory experiments are proving the theory that is provided during your theory course lecture and your textbook.

Your discussion section needs to cover, when applicable, answers to the following:

- Did the experimental results obtained verify the claims set forth in the Introduction section? Explain both yes and no answers.
  - For the no's, results did not match: What possibly went wrong?
  - When answering "yes," tie the results to the introduction.
- Did you include tables?
- Did you include graphs?
- Did you provide a comparison between the measured results and the theoretical prediction?
- Did you discuss any experimental anomalies, errors, or other surprising results?

Conclusion:

Finally, you make a claim that you learned something and support it with your results. This section should be related to, but distinct from the discussion section above.

Summarize the main results, perhaps adding a few words regarding the results that

may be of interest to significant applications. This section should not be lengthy!

The Conclusion section states the most important thing learned during the lab and justifies how it was learned. In cases where you could not meet your experimental goal, you may also comment on difficulties in experimental design/procedure or on future experiments you might do to achieve your experimental goal. If you are inspired, you may comment on the real-world implications of your data. The Conclusion does not need to be very long. It could be as short as one sentence or as long as a paragraph. In some situations, it could be even longer, but in these labs a short conclusion will generally suffice.

NOTE: The conclusion is usually a little bit redundant. Don't worry about this.

One way to write the conclusion is to ask yourself a few questions:

1) What was the single most important result of this lab?

2) How did I get my result?

3) If my lab did not work, what procedure should be changed or what additional labs should be done?

4) What is the real-world implication?

Answers to items 1 and 2 above are required for all labs. Item #3 is for labs that did not work well and item #4 is for when you feel inspired to take it a little further.

Questions:

Consolidate ***all the answers*** to the experimental questions indicated throughout the experimental procedure in this section.

You can also answer questions within other sections; however, you must duplicate the answers in this section.

List the experimental section and subsection that the question originated from.

Lab questions listed at the end of the experiment shall include the question number.

References:

Reference section shall start on a new page. References shall be formatted in accordance with an acceptable format as noted below. Every reference listed SHALL BE cited within the body of your report, otherwise remove it from the list. In other words, do not include a reference that is not cited within your report.

Throughout your lab report, you may base some of your writing on ideas found in other sources. When you use an idea from another source or when you quote directly from a source, you must cite the source in the reference section.

Acceptable reference formats are the Institute of Electrical and Electronics Engineers (IEEE) and the American Psychological Association (APA) format. Additional information on both of these formats is located at:

IEEE

IEEE Standards Style Manual (PDF). Establishes preferred style for the preparation of IEEE standards drafts.

https://development.standards.ieee.org/myproject/Public/mytools/draft/styleman.pdf

The IEEE website is located at:

http://standards.ieee.org/develop/policies/opman/

APA

The American Psychological Association (APA) website is at the following link:

https://www.apastyle.org/

The primary resource for the APA style of writing is the ***Publication Manual of the American Psychological Association***. This resource is by far the best source to refer to. It contains all the requirements.
https://www.apastyle.org/manual

The Purdue website is a very well-organized APA resource:
https://owl.english.purdue.edu/owl/resource/560/01/

If you wish to use another reference format, consult the grader, Teaching

Assistant (TA), or the instructor ***PRIOR TO*** using a different format.

How to Cite Yourself:

If you cite or quote your previous work, treat yourself as the author and your own previous course work as an unpublished paper, as shown in the APA publication manual or IEEE resources.

For example, if Dohn Bowden wanted to cite a laboratory report that he wrote at the University of Massachusetts Lowell in 2018, his citation might look like this:

> Bowden (2018) asserted that the introduction lab for circuits I was to "familiarize oneself with the laboratory equipment that was used during the remainder of the laboratory assignments for the semester" (p. 2).

And in the reference list:

> Bowden, D. A. (2018). EECE.2070 (Circuits I) *Equipment and Lab Familiarization*. Unpublished laboratory report, University of Massachusetts Lowell.

If your original work contained citations from other sources, you would need to include those same citations in the new laboratory report as well, per APA or IEEE guidelines.

Proper Method to Cite a Course Laboratory Procedure:

If you cite the laboratory procedure provided in the lab, treat the document as an "Unpublished papers, as shown in the APA publication manual.

For example, to cite a laboratory procedure from the course, the citation might look like this:

> Bowden (2018) provides the procedure for conducting the familiarization of the oscilloscope, which states (summarize in your own words what the procedure is requesting) (p. 7).

And in the reference list:

> Bowden, D. A. (2018). EECE.2070 *Lab #1 - Equipment and Lab Familiarization*. University of Massachusetts, Lowell, Lowell, MA. Retrieved from https://lowell.umassonline.net/bbcswebdav/pid-456847-dt-

content-rid-7342665_1/xid-7342665_1

Citing a Video:

Per APA 6th edition (p.209):

Format:

Producer, A. A. (Producer), & Director, B. B. (Director). (Year). Title of motion picture [Motion picture]. Country of Origin: Studio

Example:

American Psychological Association (Producer). (2000). *Responding therapeutically to patient expressions of attractions* [DVD]. Available from http://www.apa.org/videos/

Chapter 6
Condensed Laboratory Report Format

IMPORTANT – If you are planning on reusing materials from a prior course or prior laboratory assignment, you MUST abide by the ***Repeating the Course and/or Repurposing (Reusing) Prior Materials*** requirements contained in Chapter 2 of this manual.

IMPORTANT: This section, the "Condensed Laboratory Report Format" SHALL ONLY BE USED when specifically authorized by the instructor. This is NOT the typical laboratory format for the semester.

A condensed lab report is strictly used to document results of the laboratory performed. You are NOT required to produce a full report of what you performed; however, **you still need to perform the entire lab experiment.** For example, with regards to laboratory questions, they still need to be answered as you perform the lab, but they do not need to be document in the report.

The condensed laboratory report shall include all section headers that are required by the Standard Lab Report Format. Each section of the Standard Laboratory Report Format shall appear in your report. **Those sections deemed "Not Required" shall have the section header and in the body of the section indicate "N/A" for "Not Applicable."** For example, if the Summary/Abstract section is not applicable, the laboratory report shall contain:

Summary/Abstract:

Not applicable

Condensed Laboratory Report Structure.

When authorized by the instructor to use this section, which is the "Condensed Laboratory Report Format." Pre-labs for laboratory reports allowing condensed final format shall conform to the structure identified within the condensed format section.

General Report Formatting

General report formatting must meet the same criteria as specified in the

"General Report Formatting" section above for the Standard Laboratory Report Format, Chapter 5.

Cover Page:

The cover page must meet the same criteria as specified in the "Details of the Laboratory Format" section above for the Standard Laboratory Report Format.

Summary/Abstract:

NOTE: The information contained here is for the condensed laboratory format ONLY. Use the full laboratory report criteria unless specifically authorized by the instructor.

Not required for the condensed format. Place "N/A" in this section.

Equipment:

This section must meet the same criteria as specified in the "Details of the Laboratory Format" section for the Standard Laboratory Report Format, Chapter 5.

Introduction:

NOTE: The information contained here is for the condensed laboratory format ONLY. Use the full laboratory report criteria unless specifically authorized by the instructor.

Not required for the condensed format. Place "N/A" in this section.

Circuit Description:

NOTE: The information contained here is for the condensed laboratory format ONLY. Use the full laboratory report criteria unless specifically authorized by the instructor.

Required:

1. Computer generated circuit schematics using Multisim (once Multisim is introduced in the course or required by the lab). If software is

unavailable or has not been introduced in the course, hand drawn circuit schematics would be acceptable.

Include component values (e.g. 20 kW), and reference designations for each component (e.g. Q1), part numbers for diodes and active devices (e.g. LM741).

Clearly, label voltage and current devices with polarity indicated. Units are a must!

2. Indicate expected measurement values either using hand calculations or Multisim values.

3. Include pictures of your completed breadboard and setup. There needs to be a corresponding picture for each portion of the lab.

4. Include video link which contains a video of the operation of your circuit (see Online/Virtual Laboratory Process described earlier in this document for video details).

Measurement Results:

NOTE: The information contained here is for the condensed laboratory format ONLY. Use the full laboratory report criteria unless specifically authorized by the instructor.

Required:

- Data (in tabular format), graphs, and ***both*** oscilloscope and Analog Discovery screenshots
- Data analysis (in other words, in the data tables show the percent difference between the expected and experimental data collected)

Not Required

- The written portion of this section is not required.

Discussion:

NEW TO REVISION B - This section must meet the same criteria as specified in the "Details of the Laboratory Format" section above for the

Standard Laboratory Report Format.

Conclusion:

This section must meet the same criteria as specified in the "Details of the Laboratory Format" section above for the Standard Laboratory Report Format.

Questions:

NOTE: The information contained here is for the condensed laboratory format ONLY. Use the full laboratory report criteria unless specifically authorized by the instructor.

Not required for the condensed format. Place "N/A" in this section.

References:

This section must meet the same criteria as specified in the "Details of the Laboratory Format" section above for the Standard Laboratory Report Format.

Chapter 7
Lab Report Grading Methodology

7.1 Lab Report Grading Methodology:

Each lab is graded utilizing a rubric, found in Blackboard. To obtain the highest possible grade, the grader will look at, as a minimum, the following, therefore you need to ask yourself the following questions (but not limited to the following):

1. Concepts: Do you know them? Can you recognize if you did something wrong in the lab and figure out why it is wrong and how to correct the error? Are you applying the correct equations? Can you explain, in words, how a circuit works?

2. Verification: Can you think like an engineer? Can you prove your work is correct? Are you sure your work is correct, if so, how is it correct? Can you compare the data you obtained to the theory you have learned? Do you understand why you did the following procedure and how to check if you did the procedure correctly?

3. Ability to Apply Knowledge: Are you able to take what you learned and apply it to a design of your own, or any application for that matter? Can you think beyond the lab, and understand why certain circuits are useful, or the reason behind why we use certain components?

4. Ethically Collected Data: Did you cite your sources? Did you honestly collect data in an academically ethical manner? Did you record all serial numbers, mention all bench changes? Did you put an honest good faith effort into your work? If you didn't know something, did you research it and cite this source? Did you use the required reference format?

5. Completeness of Lab: Did you do everything that was required? Did you take all required amounts of work? Where you able to collect additional information, not

necessarily asked/required, but needed in order to do proper verification of data? Did you answer all questions, or at least attempt to answer all questions? Did you do the MATLAB, prelab, and circuit designs required? Did you use the Analog Discovery? Did you use an oscilloscope? Is anything missing?

6. Discussion: Can you describe what you saw, in sufficient detail? Can you be able to communicate a brief synopsis of the procedure? Are you taking good notes during the lab in your notebook of your findings? Errors? Did you provide extra work to prove your answers and then discussed them with appropriate detail? Are you writing at least a page? Did you use technical rhetoric? Are you able to write like an engineer and are able to provide technical documentation? Can you, in your own words, describe your data without copying the lab handout or rewriting the lab handout? How well can you describe to the reader what is happening and why?

This list above is not in any order but are the main six components that are expected within every report. Since these are an ABET requirement, it is required that you can communicate effectively and efficiency to be successful in your engineering career. Students who receive a grade of "A" usually can prove that they know the material, they followed the directions, they made honest efforts and where able to recognize when the data was wrong or incorrect, and realize it is there responsibility to proof-read the material, ensure that all oscilloscope pictures are clear and contains the serial number and date. They identified when another lab bench was utilized and why.

Chapter 8 (Beta Version)
Proficiency Evaluation and Competencies

Electrical and Computer Engineering (ECE) competencies includes core abilities that are required for fulfilling one's role as an electrical and computer engineer. Lab proficiency is the means used to evaluate each of the core abilities. The evaluation is continuously performed by the TA or instructor throughout the semester as defined within these requirements.

IMPORTANT: Laboratory proficiency is an evaluation of **YOUR** laboratory knowledge and skills, your competency, therefore, you shall NOT receive any assistance while being evaluated on any competencies, including any materials required to be done prior to the actual evaluation. It is expected that you agree to the honor pledge when preparing and performing the evaluation, which is:

> **Honor Pledge:** I promise that I will not give or receive any unauthorized help in performing any portion of the Laboratory Proficiency Evaluations and that all work will be my own.

Throughout this chapter, the term TA is interpreted as either TA (Teaching Assistant) or SLCA (Senior Laboratory Course Assistant).

8.1 What are the core competencies for each laboratory course?

> Laboratory core competencies build upon themselves starting in Circuits I up through Electronic II. Competencies developed in Circuits I, EECE.2070, are the foundation for competencies identified for Circuits II, EECE.2080, which are foundations for Electronics I followed by Electronics II. Not all prior competencies are evaluated each semester, rather new and critical competencies are evaluated in follow-on courses.

8.2 What is a Proficiency Evaluation?

A proficiency evaluation is a hands-on laboratory evaluation observed by a TA and/or instructor. An analogy would be the road test that an individual takes when obtaining their driver's license. During a road test, the student is evaluated on the rules and regulations of the road and their ability to drive a vehicle on the roadway. The laboratory proficiency evaluation is a road test for the ECE laboratory and associated equipment. It is expected that a student gains a certain amount of knowledge and abilities throughout the semester while performing the assigned experiments and other coursework. The evaluation is verifying that a student can operate the equipment essential to entering the workforce.

Laboratory proficiency evaluations are evaluation of the core laboratory competencies. The basic core laboratory competencies for the four instructional laboratory courses (EECE.2070, EECE.2080, EECE.3110, and EECE.3120) are identified in the Chapter 8 - Appendix 1, Table 8-1.

Students are evaluated on each competency. They must identify when they are ready to be evaluated. Each competency module has a due date which MUST BE adhered to. Proficiency evaluations ARE spread out through the entire semester. It is unacceptable to be evaluated on the last day of the semester for all competencies. To avoid bunch up of competencies, a due date has been identified in Blackboard for each competency module. If you exceed the due date, the course late penalty deductions will be assessed. Why a late penalty? A proficient engineer is one who manages their schedule due dates.

Throughout the semester, the TA and the instructor are closely watching your preparedness, performance while conducting laboratory experiments, and your ability to stay on or ahead of the laboratory schedule. In other words, are you completing the laboratory experiments accurately and timely? Falling behind schedule may be a sign of low proficiency, whether it is a lack of knowledge or simply the inability to maintain a schedule for a variety of reasons. In addition to monitoring throughout the semester, several hands-on competency evaluations will be conducted throughout the semester. The process for identifying when you are ready to demonstrate your ability for one or more competencies is described in paragraph 3 of this chapter. The combination of all required course competency evaluations will determine your overall proficiency grade. Lab Proficiency competency modules for each course are listed in Blackboard along with an associated rubric. Your evaluator will provide meaningful comments within the rubric along with verbal comments during and / or after the evaluation.

If you do not attend lab sessions on a regular basis, your TA and instructor will not be able to fully evaluate your knowledge, which may cause your proficiency grade to be low. To avoid low proficiency grades, if you are frequently absent during the semester, you need

to be in communication with both the TA and the instructor.

Why do we look at your laboratory hands-on skills? In the past, a laboratory grade was based primarily on the written laboratory report. Many students indicated that if their writing skills were not good, but their ability to use the test equipment and take measurements was excellent; however, no credit was given to this essential ability. It is true, an engineer needs to be able to, design, work with test equipment, and write reports, therefore, the final course grade takes all these elements into account.

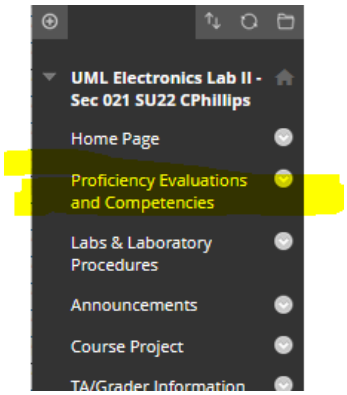
Laboratory proficiency is an extremely important aspect of the laboratory course.

8.3 Proficiency Evaluation Process:

1. Blackboard has Competencies modules identified. ALL modules MUST BE accomplished during the semester. Basic Course Competencies are identified in Chapter 8 - Appendix 1, Table 8-1. The instructor may add or subtract competencies.

2. Each Competency identified in Blackboard MUST be completed by the due date identified in Blackboard.

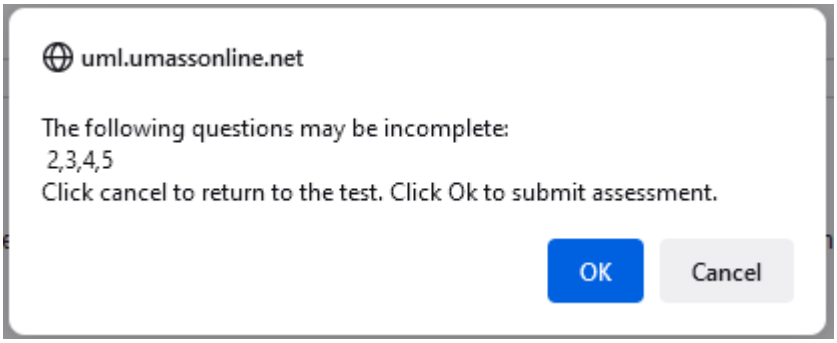
3. When a student is ready to be evaluated, the student SHALL:
    a. Go to the "Proficiency Evaluations and Competencies folder either by selecting the shortcut, shown below, or go to the folder, which is typically located under the "Start" folder



    b. Open the corresponding Blackboard Competency module located in Blackboard. An example is shown below.

c. Answer the first question in the module indicating that you are ready to be evaluated
d. Submit the Competency in Blackboard

When you submit in Blackboard, a message like the one shown below may appear. This is due to the questions that contain the competencies were not responded to. You will be responding during your evaluation noted in #4 below.



e. Notify BOTH the TA and instructor that they are ready to be evaluated
f. Be present for the evaluation during the same class or, if the submission was submitted outside of the scheduled course timeframe, then the next scheduled day
    i. NOTE: Your evaluation will be performed in the order received by the TA and instructor. Based on the quantity of submissions, the evaluation may be a follow-on class day

4. The TA and/or instructor shall perform the corresponding proficiency evaluation for the identified competency.
    a. Proficiency Evaluations shall be performed in the order received in Blackboard (student's Blackboard submission date and time)
    b. TA and/or instructor shall interface with each student individually
    c. The TA and/or instructor will be asking a series of questions which are related to

the competency being evaluated

Chapter 8 - Appendix 1

Table 8-1 – Basic Core Competencies

NOTE: The number in the Course column refers to the Competency number located in Blackboard. For example, Competencies_1 module in Blackboard for 3120 will contain all competencies identified with a "1" in the 3120 column.

Competency	Sub-competency	Course			
		2070	**2080**	**3110**	**3120**
Breadboard Assembly	Demonstrate that the breadboard is properly assembled and is in good working order. Items to demonstrate include all banana posts are intact and tight, feet are on the bottom of the breadboard, all positive terminals are connected, and all negative terminals are connected.	1	1	1	1
	The PowerBRICK circuit has been built on the breadboard	1		1	1
	Ensure that the PowerBRICK is NOT on the breadboard for Circuits II. Circuits II does not utilize d.c.power. A.c. power can destroy the PowerBRICK		1		
Component Identification	Demonstrate the ability to identify resistors, including the use of color codes	3			
	Demonstrate the ability to identify variable resistors, including how to read the package values	3			

Competency	Sub-competency	Course			
		2070	**2080**	**3110**	**3120**
	Demonstrate the ability to identify capacitors, including how to read the package values		1		
	Demonstrate the ability to identify inductors, including how to read the package values		1		
	Demonstrate the ability to identify diodes, including how to read the package values			2	
	Demonstrate the ability to identify transistors, including how to read the package values			3	1
	Demonstrate the ability to identify integrated circuits (ICs), including how identify the actual device. Students need to be familiar with 555, 741, 358, 386, LF398, ADC0804, etc. This list is not all inclusive.			2	1
	Demonstrate the ability to identify the primary and secondary wires on a CT transformer.		3		
Datasheets	Demonstrate the ability to locate and understand the contents of a variety of datasheets.			3	1
Soldering	Demonstrate knowledge of soldering safety. What safety practices and tools are required?	4			
	Demonstrate a knowledge of how to solder.	4			

Competency	Sub-competency	Course			
		2070	**2080**	**3110**	**3120**
Decade Boxes	Demonstrate the ability to use a resistance decade box, when available	3			3
	Demonstrate the ability to use a capacitance decade box, when available		2		
	Demonstrate the ability to use an inductance decade box, when available		2		
Multisim	Create and simulate circuits. Utilize either a laboratory circuit or one provided by the evaluator.	2	2	2	2
MATLAB	Demonstrate the ability to use MATLAB	2	3	3	3
Circuit Construction	Demonstrate the ability to construct a serial-parallel resistor circuit.	2			
	Demonstrate the ability to construct a serial-parallel network consisting of at least an inductor, a capacitor, and a resistor.		3		
	Demonstrate the ability to construct an Operational Amplifier circuit consisting of a 741 Op Amp. In addition, explain the various types of Op Amp circuits that are typically used.			1	
	Demonstrate the ability to construct a circuit containing diodes. In addition, explain what effect the diode and other components has on the performance of the circuit constructed.			2	

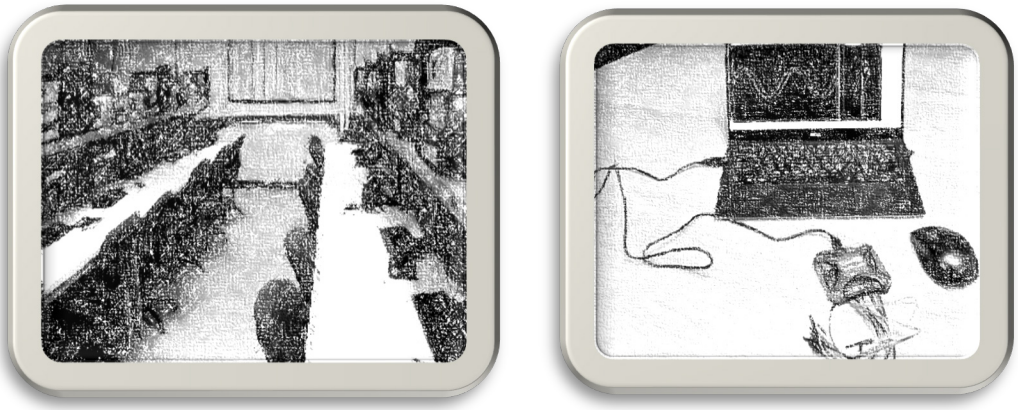
Competency	Sub-competency	Course			
		2070	**2080**	**3110**	**3120**
	Demonstrate the ability to construct a circuit containing one or more BJT transistors. In addition, explain what effect the transistor and other components has on the performance of the circuit constructed.			3	
	Demonstrate the ability to construct a circuit containing one or more MOSFET transistors. In addition, explain what effect the MOSFET and other components has on the performance of the circuit constructed.				2
	Demonstrate the ability to construct a Frequency Response of Transistor Amplifiers circuit.				3
	Demonstrate the ability to construct an ADC circuit. In addition, explain the ADC circuit.				1
	Demonstrate the ability to attach a bench top power supply to the breadboard.	1		1	
	Demonstrate the ability to attach the USB power supply (ADK) to the breadboard.	2		2	
	Demonstrate the ability to set up a positive and negative d.c. voltage from the bench top power supply	1		1	

Competency	Sub-competency	Course			
		2070	**2080**	**3110**	**3120**
	Demonstrate the ability to attach a bench top function generator to the breadboard.		1	2	
	Demonstrate the ability to attach the USB function generator (ADK) to the breadboard.		2	3	
PowerBRICK	Demonstrate the ability to use the Digilent PowerBRICK	2		1	
Resistance Measurements	Demonstrate the ability to use the benchtop multimeter to take resistance readings	1			
	Demonstrate the ability to use the handheld multimeter to take resistance readings	2			
d.c. Voltage Measurement	Demonstrate the ability to use the benchtop multimeter to take d.c. voltage readings	1			
	Demonstrate the ability to use the handheld multimeter to take d.c. voltage readings	2			
	Demonstrate the ability to use the Analog Discovery to take d.c. voltage readings	3			
d.c. Current Measurement	Demonstrate the ability to use the benchtop multimeter to take d.c. current readings	1			
	Demonstrate the ability to use the handheld multimeter to take d.c. current readings	2			
a.c. Voltage Measurement	Demonstrate the ability to use the benchtop multimeter to take a.c. voltage readings		1		
	Demonstrate the ability to use the handheld multimeter to take a.c. voltage readings		2		

Competency	Sub-competency	Course			
		2070	2080	3110	3120
	Demonstrate the ability to use the Analog Discovery to take a.c. voltage readings		2		
a.c. Current Measurement	Demonstrate the ability to use the benchtop multimeter to take a.c. current readings		1		
	Demonstrate the ability to use the handheld multimeter to take a.c. current readings		2		
Phase Measurements	Demonstrate the ability to use the benchtop oscilloscope to measure the phase between two waveforms.		3		
	Demonstrate the ability to use the USB connected device (ADK or similar) oscilloscope to measure the phase between two waveforms.		3		
Oscilloscope	Demonstrate the ability to use the benchtop oscilloscope to take manual waveform measurements. Measurements include peak-to-peak, peak, and RMS		2	2	2
	Demonstrate the ability to use the USB connected device (ADK or similar) oscilloscope to take manual waveform measurements. Measurements include peak-to-peak, peak, and RMS		3	3	3

Competency	Sub-competency	Course			
		2070	**2080**	**3110**	**3120**
Waveform Generator	Demonstrate the ability to use the benchtop waveform generator to output waveforms such as sine waves and square waves		1	1	
	Demonstrate the ability to use the USB connected device (ADK or similar) waveform generator to output waveforms such as sine waves and square waves		2	2	
Impedance Analyzer	Demonstrate the ability to use the Digilent Impedance Analyzer.		TBD		3
Network Analyzer	TBD				
Spectrum Analyzer	TBD				

Chapter 9
Alternating Laboratory Venue



When invoked by the course syllabus, your laboratory work will be evenly divided between the on campus Electrical and Computer Engineering (ECE) teaching Laboratories and out of laboratory work using your required USB device which is typically the Analog Discovery. This chapter provides the details and your requirements.

IMPORTANT: Venue change is NOT defined as laboratory work and time off, rather it is defined as work in a laboratory setting and, when not assigned to a laboratory, work is performed in a non-traditional venue such as a space that is not equipped with traditional laboratory equipment hence you will use a USB connected device.

9.1 Overview.

> ***IMPORTANT NOTE FOR SUMMER LABORATORY COURSES:*** For summer laboratory courses, EACH laboratory day is equivalent to one week during the fall and spring semesters. For example, the summer typically runs for 6 weeks. Laboratory courses are scheduled to meet BOTH Tuesdays and Thursdays along with two (2) Fridays. This equates to the typical 14-week fall or spring semester. In addition, Laboratory lectures are not scheduled during the summer sessions.

This approach is a blended flipped laboratory, based on the integration of a USB device, typically the Analog Discovery, which fosters an environment which teaches you how to learn, how to integrate laboratory skills with experience, and encourages you to experiment further than the typical lab structure. Two class sections will alternate on a weekly basis such that one week one section will be working in the laboratory while the other section works independently using the USB device.

In addition to the blended flipped-laboratory, based on the integration of Analog Discovery, the weekly fifty-minute laboratory lecture will be a recorded lecture consisting of one or more videos and reading materials. Weekly lecture materials will be available each Friday.

9.2 In-laboratory Schedule as Identified in SiS.

Currently SiS does not identify the alternating schedule, therefore the instructor will:

1. Divide each section into two sub-sections. See "***Non-SiS Sub-Section Breakdowns***"
2. Set the schedule as indicated within this chapter.
    a. See "***Non-SiS Fall/Spring Alternating Laboratory Venue Laboratory Course Scheduling***"
    b. See "***Non-SiS Summer Alternating Laboratory Venue Laboratory Course Scheduling***"

9.3 Non-SiS Sub-Section Breakdowns.

Laboratory instructor shall randomly split each section roster as evenly as possible into two sub-sections. For the fall/spring semesters, one sub-section will be section A, the other will be section B. For the summer semesters, one sub-section will be T (Tuesdays) and the other will be R (Thursdays). Section identities will be displayed in a column in Blackboard called "Venue." For example:

Fall/Spring section 801 will be split into the following:

801A

801B

Summer sections will be split into the following:

Tuesdays (Tuesday group)

Thursdays (Thursday group)

9.4 Non-SiS Fall/Spring Alternating Laboratory Venue Laboratory Course Scheduling.

To be determined.

9.5 Non-SiS Summer Alternating Laboratory Venue Laboratory Course Scheduling.

Students shall be in the laboratory 7 of the 14 scheduled days as identified below. The other 7 days the students shall utilized their USB connected devices in a non-laboratory setting as identified by the instructor.

Students ***MUST recognize*** the following for their Alternating Laboratory Venue laboratory course:

1. Materials required to be performed is based on a 14-week schedule. Half of the material will be performed in the laboratory during the SiS scheduled timeframes; the other half will be performed outside of the laboratory during the SiS scheduled timeframes but at times when they are not scheduled to be in the laboratory (see below). When working outside of the laboratory, students shall utilize their USB connected device.

2. Syllabus schedule MUST BE maintained, therefore on the days that you are not required to be in the laboratory you need to use your USB connected device and continue the experiments.

3. In laboratory attendance is mandatory on the days you are assigned to be in the laboratory. Attendance will be recorded.

4. During days when NOT scheduled in the laboratory (see below), access to the TA, SLCA, grader, and instructor is available by going to the laboratory. Attendance will not be recorded.

Students in the "**Tuesdays**" venue are:

- Scheduled to be in the laboratory EVERY TUESDAY during their SiS assigned time.
- Scheduled to be in the laboratory on the ***first SiS scheduled Friday*** of the summer session. This date is in Blackboard under "Friday Required."

Students in the "**Thursdays**" venue are:

- Scheduled to be in the laboratory EVERY THURSDAY during their SiS assigned time.
- Scheduled to be in the laboratory on the ***second SiS scheduled Friday*** of the summer session. This date is in Blackboard under "Friday Required."

9.6 Benefits of the Alternating Laboratory Venue.

Over a span of three semesters, (2017 through 2018) a research study was performed examining the ***Alternating Laboratory Venue***. The conclusion from that research concluded that the ***Alternating Laboratory Venue*** did not negatively impact the quality of the education for the participants, nor did it significantly increase the final grade of the course for the participants.

The ***Alternating Laboratory Venue*** encourages students to manage their time, thus improving the overall student success rate. Student laboratory learning was not negatively impacted and showed a slight increase over the traditional approach. The study also indicates a benefit of time management.

Time management included the opportunity for students to perform some of their laboratory work at their own scheduled time, at a time that may be more convenient for them. This is a skill that can be utilized in industry.

Revision History:

Revision B3 (July 04, 2022)

- Changed Ch 4 title. Was "Maintaining a Laboratory Notebook"
- Changed Ch 4 Laboratory Notebook Grading process. Submissions are now after completion of experiment #1 and after completion of the second to last experiment.
- Extensive update to Ch 8. Changed proficiency process to competencies and now throughout the semester
- NEW: Chapter 9 added (Alternating Laboratory Venue)

Revision B2 (May 07, 2021)

- Administrative corrections and formatting throughout the document
- Added to Chapter 2, from the syllabus – Repeating the Course and/or Repurposing (Reusing) Prior Materials, including note in Chapter 3, 4, 5, and 6
- Added from syllabus - Required Laboratory Materials (Must bring to each lab)
- Added - Citing a Video

Revision B1 (March 03, 2021)

- Laboratory notebook grading process added, sections 4.2 and 4.3.
- Clarified notebook scanning requirements for pre-lab.
- **NEW:** Chapter 8 added (Laboratory Proficiency evaluation process)
- Corrected the equation for % difference located in Chapter 5.

Revision B (January 31, 2021)

- Major updates.
- Incorporates the online laboratory requirements document.

Revision A1 (January 08, 2020)

- Minor administrative updates.

Revision A (January 22, 2019)

- This is the initial released revision of the Laboratory Requirements Manual.
- Changed name from ***Lab Information Booklet*** to ***Laboratory Requirements Manual***.

- Added Laboratory Safety.

References:

Chapter 8 Title Photograph https://www.istockphoto.com/illustrations/calibration
https://media.istockphoto.com/vectors/electronics-repair-vector-vector-id584570730?k=6&m=584570730&s=612x612&w=0&h=zwMrrHY4cBLBncJnUhN_pk9DTexCt-RRbFX2iKsqRVk=