The University of Maine
Department of Electrical and Computer Engineering
ECE 214 – Electrical Circuits Laboratory

Spring 2021

Electrical Circuits Lab

Course:	ECE 214
Credits:	3
Web Site:	Brightspace (https://umaine.edu/studentaccessibility/brightspace)
Lectures:	Asynchronously delivered (available on Brightspace)
Recitation:	11:00 - 12:15, Tuesday & Thursday, (Zoom link on Brightspace calendar)
Labs:	2:00 - 5:00, Monday – Thursday, (Zoom link on Brightspace calendar)
Parts availability:	2:00 - 4:45, Tuesday – Thursday in Barrows 221 & 224
Prerequisite:	ECE 210 – Electrical Circuts

Instructor

Dr. David E. Kotecki
e-mail: kotecki@maine.edu
Mobile: 207.356.0168
Virtual office: https://maine.zoom.us/my/davidkotecki (passcode: circuits21)

Virtual Office Hours

11:00 am - 12:15 pm, Monday & Wednesday
You are encouraged to drop by my virtual office to ask questions and discuss the labs. If you are unable to meet with me during these times, e-mail me to set up an appointment.

Teaching/Lab Assistants

Abigail Boucher (abigail.boucher1@maine.edu) – notebook and report grader
Elizabeth Willard (elizabeth.willard@maine.edu – notebook and report grader
Ally DiFilippo (alessandra.difilippo@maine.edu – parts manager and report grader

Teaching/Lab assistants are available to answer questions, manage the parts supply, and grade the laboratory notebooks and final reports. To obtain credit for the lab, you must scan or photograph your laboratory notebook and upload the pages to Brightspace before the applicable deadline. Late submissions will incur a 50% penalty.

Course Goals

ECE 214 will prepare you for advanced courses in circuit analysis, electronics, and signals and systems. The five goals for this course are as follows.

1. Become knowledgeable and familiar with the operation and use of electrical test equipment including the digital oscilloscope, waveform generator, DC power supply, and voltage, current, resistance, capacitance, and inductance meters (Labs 1 - 6).

2. Become familiar with the properties of "real" circuit elements including the resistor, capacitor, inductor, transformer, and operational amplifier (Labs 1 - 6, and simulations in Labs 7 - 9). The diode and transistor will be introduced, and used to implement a voltage-controlled switch.

3. Become proficient with the use of computer simulations and SPICE (Simulation Program with Integrated Circuit Emphasis) to predict and analyze circuit behavior under DC conditions, in the time domain, and in the frequency domain. Understand how to simulate circuit performance as a function of temperature, how to perform a component parameter sensitivity analysis, and how to use Monte Carlo simulations for yield analysis.

4. Develop skills and techniques for debugging electrical circuits and circuit simulations.

5. Learn how to maintain a proper "Engineering Notebook," (Labs 1-10) and how to produce a well written "technical report" (Labs 7-10). The IEEE style guide and the typesetting language LaTeX will be introduced.

Laboratory Teams

Each students should partner with another student and work, within the limitations imposed by COVID-19 restrictions, as a two-person team. Each student should collaborate with his or her partner on circuit simulations and electrical measurements, and try and debug each others simulations and circuits. This collaboration is most efficiently done using Zoom. Under all conditions, students should follow CDC and UMaine guidelines for social distancing. Each student must maintain his or her own engineering notebook. However, the technical report due at the end of the semester will be a joint report from the team. If you and your laboratory partner have irreconcilable differences, you will have the opportunity to change laboratory partners at the mid-semester break.

Equipment and Supplies

The following equipment and supplies will be needed to complete the labs in ECE 214. Make sure you have acquired items 1 - 10 below before the end of the first week of class.

1. Textbook – There is no required textbook for this course. The textbook from ECE 210 should be available as a reference.
2. Calculator – It is strongly recommended that you have a calculator capable of solving simultaneous linear equations with complex variables. Calculators are needed during the labs and when taking exams. The most popular calculators are TI-89 Titanium and the TI Nspire CX CAS. If you do not own one of these calculators, make sure you can borrow one for use during the exams.
3. Laboratory Notebook – Recommend the National Brand computation notebook, model #43-648. Available from the UMaine Bookstore or order online.
4. Digital Volt Meter (DVM) – Distributed in ECE 210.
5. Electrical Breadboard – Distributed in ECE 210.
6. BNC to Alligator Clip Cable (1X Probe) – Distributed during the first week of ECE 214.
7. 60 MHz X1-X10 Oscilloscope Probes (2) – Distributed during the first week of ECE 214.
8. 100MS/s USB Oscilloscope and Waveform Generator – Digilent, Analog Discovery 2, part number 410-321. Available from the UMaine Bookstore or Digilent.
9. BNC Adaptor for Analog Discovery – Digilent, part number 410-263. Available from the UMaine Bookstore or Digilent.
10. 12V Dual Output USB Power Supply – Digilent, part number 410-293-A. Available from the UMaine Bookstore or Digilent.
11. Circuit Components – resistors, capacitors, inductors, opamps, and transistors are provided during ECE 214 as needed.

If you are missing or have difficulty obtaining any of the items, e-mail Dr. Kotecki at kotecki@maine.edu.

Useful but Optional Supplies

Having resistor and capacitor kits will reduce the number of trips you need to make to the parts cabinet in Barrows Hall. The following kits are available on Amazon.com.

1. Resistor Kit – 1Ω - 4.7MΩ
2. Capacitor Kit – 0.1 - 10μF
3. Capacitor Kit – 10pF - 100nF

Engineering Notebook

Each student must maintain a proper "Engineering notebook." A National Brand computation notebook, model #43-648, is recommended, and is available from the UMaine Bookstore. An engineering notebook must be a bound book with consecutively numbered pages. All notebook entries must be done in pen. Do not tear pages out of your notebook. Do not erase anything in your notebook. Composition books having quadrille ruled sheets make good notebooks: they allow tables, graphs, and circuit diagrams to be laid out neatly. Notebooks with duplicate pages and carbon paper are impressive, but messy and not necessary. Spiral notebooks, loose leaf binders and electronic notebooks are not acceptable.

The engineering notebook must be used to record all calculations, preliminary and final designs, circuit simulation schematics and results, measured data, graphs, and analysis pertaining to the laboratory experiments. A photograph of your breadboard showing the working circuit must be included in the notebook. Basically, everything you do in this class must be recorded in the notebook! Guidelines for maintaining an engineering notebook are provided at: http://www.eece.maine.edu/kotecki/ece214/docs/Laboratory_Notebook.pdf. When recording information in your notebook, the question you should ask yourself is: "Did I record a sufficient amount of information for someone to reproduce my results?"

An engineering, or laboratory, notebook serves several functions. In industry it can serve as a legal document to establish priority of invention in patent disputes. While we do not expect many patentable discoveries to come out of the ECE 214 labs and the U.S. has moved to a first-to-file patent system, you should still develop good engineering notebook habits. It will serve you well when you go to work for a company that has such expectations. In scientific research, an engineering notebook provides a record that allows you to duplicate your work if you succeed at your endeavor (or if you achieve some unexpected but significant result). It's also useful in identifying what might have gone wrong if you achieve neither your desired result nor a miraculous discovery.

After the lab has been completed, scan or photograph the appropriate notebook pages, and upload them to the Assignment section of Brightspace, where they will be graded.

Digilent Electronic Test Equipment

The Digilent "Analog Discovery 2" 100 MS/sec oscilloscope, function generator, and logic analyzer, the BNC adapter board, and a dual-output 12 V (± 100 mA) PowerBrick are required.

The "Waveforms" data acquisition software is used in conjunction with the Digilent "Analog Discovery 2" test equipment. The software is available for Windows, Mac OS X, and Linux. You can download the "Waveforms" software onto your laptop from the Digilent website: https://reference.digilentinc.com/reference/software/waveforms/waveforms-3/start.

Technical Report

Each team will submit a series of technical reports culminating in a final report describing the DC-DC power supply designed in Labs 7–10. The report must describe the theory of operation, design considerations, how the circuits function, simulation results including a temperature analysis and component sensitivity analysis, experimental test results, and a cost analysis.

A suggested outline for the technical report is available at: https://ece214.davidkotecki.com/report/ECE214_Report_Outline_2021.pdf. Draft and revised reports must be submitted to the assigned TA by the deadline indicated on the Brightspace calendar. The final version of the report must be submitted electronically, in PDF format, to kotecki@maine.edu no later than midnight EDT on Sunday, 2 May 2021. Late reports are **NOT** accepted.

Circuit Simulation and Data Analysis

NGspice (http://www.cppsim.com/about_ngspice.html), an open source, multi-platform, circuit simulator is used to perform circuit simulations. It is recommended that each student install the NGspice circuit simulator, the Sue2 schematic capture program, and the NGspice Matlab® toolbox on his or her laptop. The easiest way to obtain the software is to install the bundled CppSim package from http://www.cppsim.com/download.html. NGspice is a full SPICE circuit simulator, capable of simulating a circuit of any complexity using real device models.

Matlab® by MathWorks (http://www.mathworks.com/) is used to control the NGspice circuit simulator and analyze and graph the simulation results from NGspice. Matlab® is a multi-platform numerical computing environment and a programming language used for technical computing. The University of Maine provides a free Matlab® license to all students. Each student should install version 2020b of Matlab® on his or her laptop. Download Matlab® from https://umaine.edu/it/software/matlab.

Laboratory Periods

There are a total of ten graded labs. Each lab is divided into a maximum of three parts.

- "Pre-Lab" – Design calculations and simulations. The "Pre-Lab" should be completed and recorded in your engineering notebook **before** starting the experimental section – also known as the laboratory procedure.
- "Laboratory Procedure" – Implementation and measurements of circuit performance. The "Laboratory Procedure" should be completed **during** a time convenient for you and your lab partner and can be completed over Zoom. If you run into problems or have questions, enter the Zoom laboratory session between 2:00 pm - 5:00 pm on Monday – Thursday, using the Zoom link in the Brightspace calendar.
- "Post-Lab" – Analysis and comparison of theory, simulations and measurement results. The "Post–Lab" should be completed **after** the laboratory procedure has been completed.

To receive the maximum laboratory credit, scan or photograph the pages from your Engineering Notebook showing the completed "Pre–Lab," "Laboratory Procedure," and "Post–Lab;" Upload these to the Assignment section in Brightspace no later than one week after the lab is assigned. Late submissions will incur a 50% penalty.

Class/Lab Cancellations

In the event that the University closes due to inclement weather and a laboratory session is canceled, the virtual laboratory session may remain open. All canceled laboratory sessions will need to be completed during another laboratory session. The parts supply will not be available if the University is closed.

Exams

There are two Preliminary Exams and a Final Exam. The exams are to be completed individually; do not discuss the exam with any other student during the examination period. The exams are open book and open notes. You may use your Engineering Notebook, a ruler, and a hand held calculator during the exams. The lowest grade on the three exams is dropped. The exams will cover circuit theory, circuit simulation, the use of electrical test equipment, and the laboratory experiments.

Exam #1	11 Mar. 2021	(11:00 am - 12:15 pm)
Exam #2	29 Apr. 2021	(11:00 am - 12:15 pm)
Final Exam	6 May 2021	(8:00 am - 10:00 am)

Exams #1 and #2 will be held during the Thursday morning recitation period and will be delivered over Brightspace. After completing the exam, scan or photograph your work and upload your solutions to Brightspace. Poor presentation of your work will lower your grade – be neat! I will do my best to figure out what you meant to do on a problem, but if the work is poorly laid out or just a mess, your grade will suffer.

Anyone who is unable to take the exam during the scheduled examination period must notify the instructor prior to the exam. If you are excused from the exam for cause, a make-up exam will be offered during the last week of classes.

Grading

Laboratory Notebook (Labs 1 - 10)	40%
Technical Report (Preliminary)	10%
Technical Report (Final)	10%
Exam #1	20%
Exam #2	20%
Final Exam	20%
Total*	$\overline{100\%}$

* Lowest exam grade is dropped

Letter Grade Assignment

$\geq 90\%$	A
87.5% – 90.0%	B +
80.0% – 87.5%	B
77.5% – 80.0%	C +
70.0% – 77.5%	C
67.5% – 70.0%	D +
60.0% – 67.5%	D
$< 60\%$	F

Tentative Schedule

Class	Date	Topic
Lab #0	25 Jan. 2021	Organize Teams; Electrical Safety; Parts
Lab #1	1 Feb. 2021	Test Equipment Loading
Lab #2	8 Feb. 2021	First Order RC Circuits
Lab #3	15 Feb. 2021	RC Filter
Lab #4	22 Feb. 2021	Operational Amplifier Circuits I
Lab #5	1 Mar. 2021	Operational Amplifier Circuits II
Exam #1	11 Mar. 2021	Preliminary Examination #1
Lab #6	22 Mar. 2021	Inductors and the RLC Circuit
Lab #7	29 Mar. 2021	Boost Converter
Lab #8	5 Apr. 2021	Astable Multivibrator
Lab #9	12 Apr. 2021	DC–DC Converter
Lab #10	19 Apr. 2021	Thévenin Equivalent Circuits
Exam #2	29 Apr. 2021	Preliminary Examination #2
Final Report	2 May 2021	Final report due: midnight EDT
Final Exam	6 May 2021	Final Exam (8:00–10:00 am)

COVID-19 Statement

https://drive.google.com/file/d/1jOhqbS41nmC9HLYfge5JA2mtlBLL0Ao9/view

Academic Honesty Statement

Academic honesty is very important. It is dishonest to cheat on exams, to copy term papers, to submit papers written by another person, to fake experimental results, or to copy or reword parts of books or articles into your own papers without appropriately citing the source. Students committing or aiding in any of these violations may be given failing grades for an assignment or for an entire course, at the discretion of the instructor. In addition to any academic action taken by an instructor, these violations are also subject to action under the University of Maine Student Conduct Code. The maximum possible sanction under the student conduct code is dismissal from the University. Please see the University of Maine System's Academic Integrity Policy listed in the Board Policy Manual as Policy 314: www.maine.edu/board-of-trustees/policy-manual/section-314/.

Students Accessibility Services Statement

If you have a disability for which you may be requesting an accommodation, please contact Student Accessibility Services, 121 East Annex, 581.2319, as early as possible in the term. Students who have already been approved for accommodations by SAS and have a current accommodation letter should meet with Dr. Kotecki privately as soon as possible.

Course Schedule Disclaimer (Disruption Clause)

In the event of an extended disruption of normal classroom activities (due to COVID-19 or other long-term disruptions), the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

Observance of Religious Holidays/Events

The University of Maine recognizes that when students are observing significant religious holidays, some may be unable to attend classes or labs, study, take tests, or work on other assignments. If they provide adequate notice (at least one week and longer if at all possible), these students are allowed to make up course requirements as long as this effort does not create an unreasonable burden upon the instructor, department or University. At the discretion of the instructor, such coursework could be due before or after the examination or assignment. No adverse or prejudicial effects shall result to a student's grade for the examination, study, or course requirement on the day of religious observance. The student shall not be marked absent from the class due to observing a significant religious holiday. In the case of an internship or clinical, students should refer to the applicable policy in place by the employer or site.

Sexual Violence Policy: Sexual Discrimination Reporting

The University of Maine is committed to making campus a safe place for students. Because of this commitment, if you tell a teacher about an experience of sexual assault, sexual harassment, stalking, relationship abuse (dating violence and domestic violence), sexual misconduct or any form of gender discrimination involving members of the campus, your teacher is required to report this information to the campus Office of Sexual Assault & Violence Prevention or the Office of Equal Opportunity.

If you want to talk in confidence to someone about an experience of sexual discrimination, please contact these resources:

For confidential resources on campus: Counseling Center: 207-581-1392 or Cutler Health Center: at 207-581-4000.

For confidential resources off campus: Rape Response Services: 1-800-310-0000 or Spruce Run: 1-800-863-9909.

Other resources: The resources listed below can offer support but may have to report the incident to others who can help: For support services on campus: Office of Sexual Assault & Violence Prevention: 207-581-1406, Office of Community Standards: 207-581-1409, University of Maine Police: 207-581-4040 or 911. Or see the OSAVP website for a complete list of services at http://www.umaine.edu/osavp/