The University of Maine
Department of Electrical and Computer Engineering
ECE 214 – Electrical Networks Lab

Spring 2020

Electrical Networks Lab

Course Number:	ECE 214
Credits:	3
Lecture:	9:30 - 10:45 am, Tuesday & Thursday, Little Hall 219
Lab Sessions:	2:00 - 4:50 pm, Monday, Tuesday, Wednesday, and Thursday, Texas Instruments (TI) Lab, Barrows 221
Prerequisite:	ECE 210 – Electrical Networks
Course Web Site:	http://web.eece.maine.edu/kotecki/ECE214

Instructor

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Office Hours

9:30 - 10:45 am Monday and Wednesday
1:00 - 2:00 pm Monday, Tuesday, Wednesday, and Thursday
You are encouraged to drop by my office to ask questions and discuss labs related to this course. If you are unable to meet with me during these times, e-mail me to set up an appointment.

Teaching/Lab Assistants

Teaching/Lab assistants will be available during the laboratory to help answer questions and sign-off on completed labs. To obtain credit for the lab, you must show both the working circuit and your completed laboratory notebooks (excluding any post-lab analysis) to the TA for sign-off no later than 5:00 pm one week after the lab due date. Late sign-offs will incur a 50% penalty.

Textbook

There is no required textbook for this course. The textbook used in ECE 210 should be used as a reference.

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:

1. Become knowledgeable and familiar with the operation and use of electrical test equipment including the digital oscilloscope, waveform generator, DC power supply, spectrum analyzer, and voltage, current, resistance, capacitance, and inductance meters.
2. Become familiar with the properties of "real" circuit elements including the resistor, capacitor, inductor, transformer, and operational amplifier. 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) simulators to predict and analyze circuit behavior at DC, in the time domain, and in the frequency domain.
4. Develop skills and techniques for debugging electrical circuits.
5. Learn how to maintain a proper "Engineering Notebook," and how to produce a well written "technical report." The IEEE style guide and the typesetting language LaTeX will be introduced.

Laboratory Teams

Students should partner with another student, and work in a two person team. If there is an odd number of students in a laboratory session, a team of three students will be allowed. Each student must maintain a their own engineering notebook. If you and your laboratory partner have irreconcilable differences, you will have the opportunity to change laboratory partners at the mid-semester break.

Calculators

It is strongly recommended that you have a calculator capable of solving simultaneous linear equations with complex variables. Calculators may be used 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.

USB Memory Stick

A USB memory stick is needed to remove data and images from the oscilloscope.

Engineering Notebook

Every student must maintain a proper "Engineering Notebook." The notebook must be a bound book with consecutively numbered pages. Do not tear pages out of your notebook. Composition books having quadrille ruled sheets make good lab 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 really necessary. Spiral notebooks, loose leaf binders and electronic notebooks are not acceptable. A National Brand Computation Notebook, model #43-648, is recommended, and is available from the UMaine bookstore.

The engineering notebook should 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. Basically, everything you do in this class should 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.

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.

Technical Report

Each laboratory team will submit a final technical report describing the DC-DC converter developed in Labs 7–9. The report must describe the theory of operation, design considerations, a description of how the circuits function, circuit simulation results, experimental test results and a cost analysis. The report must be submitted electronically, in PDF format, to kotecki@maine.edu no later than 5:00 pm EDT on Friday, 1 May 2020. 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 can be used to perform circuit simulations. It is recommended that everyone install the NGspice circuit simulator, the Sue2 schematic capture program, and the NGspice Matlab® toolbox on their 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, and capable of simulating a circuit of any complexity using real device models.

Micro-Cap 12 by Spectrum Software (http://www.spectrum-soft.com) can be used to perform circuit simulations. An evaluation version of Micro–Cap is available for free and allows simulations of circuits with a limited number of components using idealized models. Micro–Cap is a Windows based circuit simulator. However, Micro–Cap can be run on both a Mac and on Linux using "wine". For a tutorial on installing wine on a Mac using the Homebrew package manager, see: http://www.davidbaumgold.com/tutorials/wine-mac/ .

Matlab® by MathWorks (http://www.mathworks.com/) will be used to control the NGspice circuit simulator and analyze and graph the simulation results from both NGspice and Micro-Cap. It is also used with the "Waveforms" data acquisition software to analysis and graph experimental results. 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. Everyone should install version 2018b of Matlab® on their laptop. Download Matlab® from https://umaine.edu/it/software/matlab.

Digilent Electronic Test Equipment (Optional)

The Digilent "Analog Discovery 2" 100 MS/sec oscilloscope, function generator, and logic analyzer, the BNC adapter board, a pair of BNC oscilloscope probes, and a dual-output 12 V (± 100 mA) PowerBrick are required for ECE 342 and are recommended for the laboratory portion of this course. Instructions for ordering the test equipment and obtaining the student discount are described at: http://davidkotecki.com/ECE214/docs/ECE214_2018_Digilent.pdf.

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.

Laboratory Periods

There are a total of ten graded labs.
Labs are divided into three parts:

- "Pre–Lab" – Design calculations and simulations. The "Pre-Lab" should be completed and recorded in your engineering notebook **before** the laboratory period.
- "Laboratory Procedure" – Implementation and measurements of circuit performance. The "Laboratory Procedure" should be completed **during** the laboratory period.
- "Post–Lab" – Analysis and comparison of theory, simulations and measurement results. The "Post–Lab" should be completed **after** the laboratory period.

You should bring the following to each laboratory period: (1) engineering notebook, (2) laptop computer containing Matlab® and a Spice simulator, (3) breadboard and wires, (4) BNC cable with alligator clips (provided during first laboratory session), (5) digital volt meter (DVM), and (6) calculator. Electrical components (resistors, capacitors, inductors, diodes, and transistors) and oscilloscope probes will be provided.

To receive the maximum laboratory credit, your implemented circuit along with your Engineering Notebook, with a completed "Pre–Lab" and "Laboratory Procedure," must be examined and signed-off by one of the TAs no later than one week after the day of the lab. Late sign-offs will incur a 50% penalty. The post-labs are graded when Engineering Notebooks are collected during the mid-semester break and at the end of the semester.

Class/Lab Cancellations

In the event that the University closes due to inclement weather and a laboratory session is canceled, a make-up laboratory session will be available on Friday from 2:00 - 4:50. All canceled laboratory sessions will need to be completed during another laboratory session.

Laboratory Etiquette and Safety

- Food and beverages are not allowed in the lab at any time.
- The Texas Instruments (TI) lab is heavily used this semester. Please keep the lab neat, clean, and remove any trash from the tables before you leave.
- Please do not rearrange the furniture, remove furniture, or bring in other furniture.
- The lab is open between 2:00–4:50. Always be safe when working in the lab. Students are not allowed to work alone or with the doors closed. At least one TA or faculty member must be present at all times.
- Do not use or operate any test equipment unless you are familiar with its proper use and operation. Ask if you have any questions regarding a piece of test equipment.

Exams

There are two Preliminary Exams and a Final Exam.

Exam #1	3 Mar. 2020	(9:30 - 10:45 am)
Exam #2	21 Apr. 2020	(9:30 - 10:45 am)
Final Exam	5 May 2020	(8:00–10:00 am)

You may use your Engineering Notebook, a ruler, and a hand held calculator during the exams. The lowest of the three exam grades is dropped.

The exams will cover circuit theory, circuit simulation, the use of electrical test equipment, and the laboratory experiments. Poor presentation of your work will lower your grade – be neat!

Grading

Circuit and Notebook (Pre–Lab and Laboratory Procedure) Sign-off	20%
Engineering Notebook (+ Post–Lab)	20%
Technical report	20%
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	21 Jan. 2020	Organize Laboratory Teams; Electrical Safety
Lab #1	27 Jan. 2020	Test Equipment Loading
Lab #2	3 Feb. 2020	First Order RC Circuits
Lab #3	10 Feb. 2020	RC Filter
Lab #4	18 Feb. 2020	Operational Amplifier Circuits I
Lab #5	24 Feb. 2020	Operational Amplifier Circuits II
Exam #1	3 Mar. 2020	Preliminary Examination #1
Lab #6	9 Mar. 2020	Inductors and the RLC Circuit
Lab #7	23 Mar. 2020	Boost Converter
Lab #8	30 Mar. 2020	Astable Multivibrator
Lab #9	6 Apr. 2020	DC–DC Converter
Lab #10	13 Apr. 2020	Thévenin Equivalent Circuits
Exam #2	21 Apr. 2020	Preliminary Examination #2
Final Report	1 May 2020	Final report due: 5:00 pm EDT
Final Exam	5 May 2020	Final Exam (8:00–10:00 am); Engineering Notebooks Due

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.

Students with Disabilities Statement

If you have a disability for which you may be requesting an accommodation, contact Student Accessibility Services, 121 East Annex, 581.2319, as early as possible. Students who have already been approved for accommodations by SAS and have a current accommodation letter should provide a copy of the letter to me as soon as possible.

Course Schedule Disclaimer (Disruption Clause)

In the event of an extended disruption of normal classroom activities, 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.

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/