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

Spring 2016

Electrical Networks Lab

Course Number:	ECE 214
Credits:	2
Lecture:	8:00 - 9:15 am, Tuesday; Barrows 119
Lab Sessions:	2:00 - 4:50 pm, Monday, Tuesday, Wednesday, Thursday Texas Instruments (TI) Lab, Barrows 221
Prerequisite:	ECE 210 – Electrical Networks
Corequisite:	ECP 214 – Engineering Communication Program I (Note: If ECE 214 is dropped, ECP 214 must also be dropped)
Course Web Site:	http://ece214.eece.maine.edu

Instructor

Dr. David E. Kotecki
Office: 277 Barrows / ESRB
Tel: 207 581-2248
e-mail: `kotecki@maine.edu`

Office Hours

12:30 - 2:00 pm Monday — Thursday
You are strongly 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 laboratory notebooks to the TA for sign-off.

Textbook

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

Engineering Notebook

All students must have and maintain a proper "Engineering Notebook." 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 starting on page 5.

Course Goals

ECE 214 will prepare you for more advanced courses in circuit analysis, signals and systems, and electronics. There are six goals for this course:

1. Become familiar with basic properties of "real" circuit elements. These include the resistor, capacitor, inductor, operational amplifier, diode, and transistor.
2. Become proficient in the use of electrical test equipment. These include the voltage meter, current meter, resistance meter, capacitance meter, inductance meter, DC power supply, signal generator, and digital oscilloscope.
3. Become familiar with computer simulations of circuit behavior using SPICE (Simulation Program with Integrated Circuit Emphasis).
4. Develop techniques for debugging electrical circuits.
5. Introduce basic data analysis using MATLAB®.
6. Learn how to use and maintain a proper "Engineering Notebook."

Laboratory Periods

Attendance during the laboratory period is mandatory. There are a total of ten graded labs (Lab #1 – Lab #10). Most labs are divided into three parts:

- "Pre–Lab" – Circuit design calculations and simulations which can and should be completed **before** the laboratory period.
- "Laboratory Procedure" – Actual construction of circuits and measurements of circuit performance which should be completed **during** the laboratory period.
- "Post–Lab" – Analysis of measured results and comparison of simulations with measurement results which are to be completed **after** the laboratory period.

You should bring a laptop computer, breadboard, DVM, and engineering notebook to each lab. The "Pre-Lab" portion of the lab should already be completed and recorded in your engineering notebook.

For maximum laboratory credit, the functional circuit along with completed "Pre–Lab" and "Laboratory Procedure" must be signed-off by one of the TAs on the day of the lab. Points will be deducted for late completions. The post-labs are graded when laboratory Notebooks are collected during mid-semester break and at the end of the semester.

Some of the labs can be completed using the Digilent Analog Discovery. If you use the Digilent to perform the lab, you will need to bring your wired breadboard along with the Digilent to the lab to have it signed-off by one of the TAs.

Lab Partners

You will be expected to work in teams of two during the lab periods. If there is an odd number of students in a laboratory section, a team of three students will be allowed. Each student must keep a separate engineering notebook for calculations and to record the lab results. If you and your laboratory partner have irreconcilable differences, you will have the opportunity to change laboratory partners at the mid-semester break.

Laboratory Etiquette and Safety

- 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.
- Food and beverages are not allowed in the lab at any time.
- 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.

Circuit Simulation Software

Micro–Cap 11 by Spectrum Software (`http://www.spectrum-soft.com`) will be used to perform circuit simulations. An evaluation version of Micro–Cap is available for free and allows simulations of circuits with up to 50 components. Everyone should install Micro–Cap on their laptop before Lab #2.

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/` .

Data Analysis Software

MATLAB® or **GNU Octave 4.0** will be used for data analysis and graphing. These provide a numerical computing environment and programming language used for technical computing. MATLAB® by MathWorks (`http://www.mathworks.com/`) is available for Windows, Mac, and Linux. The cost for the student version is $99.

GNU Octave 4.0 is an open source alternative to MATLAB® that uses the same commands and syntax as MATLAB® and provides all of the capabilities you need for this course. GNU Octave is available from `http://www.gnu.org/software/octave/` for Windows, Mac, and Linux. GNU Octave is free.

Everyone should install either MATLAB® or GNU Octave on their laptop before Lab #3.

Tentative Schedule

Class	Date	Topic
Lab #0	19 Jan. 2016	Organize Groups & Electrical Safety
Lab #1	26 Jan. 2016	Test Equipment Loading
Lab #2	2 Feb. 2016	First Order RC Circuits
Lab #3	9 Feb. 2016	RC Filter
Lab #4	16 Feb. 2016	Basic Operational Amplifier Circuits
Lab #5	23 Feb. 2016	Schmitt Trigger and Oscillator
Exam #1	1 Mar. 2016	Examination #1
Lab #6	22 Mar. 2016	DC Voltage Multiplier
Lab #7	29 Mar. 2016	RLC Circuit
Lab #8	5 Apr. 2016	Boost Converter
Lab #9	12 Apr. 2016	Astable Multivibrator
Lab #10	19 Apr. 2016	DC–DC Converter
Exam #2	26 Apr. 2016	Examination #2
Final Report	3 May 2016	Final report is due
Final Exam	10 May. 2016	Final Exam and Lab Notebooks due

Exams

There are two Preliminary Exams and a Final Exam. The preliminary exams will take place during the Tuesday morning lecture sessions. Your Engineering Notebook and a hand held calculator (no laptops) may be used during the exam.

Grading

Laboratory Sign-offs (Pre–Lab and Laboratory Procedure)	20%
Engineering Notebook (Post Lab)	20%
Exam #1	15%
Exam #2	15%
Final Exam	20%
Final technical reports	10%
Total	100%

Letter Grade Assignment

$\geq 92\%$	A
90% – 91%	A –
88% – 89%	B +
82% – 87%	B
80% – 81%	B –
78% – 79%	C +
72% – 77%	C
70% – 71%	C –
68% – 69%	D +
62% – 67%	D
$< 62\%$	F

Engineering Notebook Guidelines

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.

You will also collect and generate a number of pages of printed material that are related to the lab work. These will include lab handouts, data sheets, and Computer Simulation and MATLAB® printouts to name a few. These handouts can be kept in a separate 3-ring binder that you bring to lab or taped into your engineering notebook. Copies of all important results and conclusions should be included in your engineering notebook.

Since we will not have weekly lab reports, your engineering notebook provides a mechanism for evaluating your performance. Furthermore, you will need your engineering notebook during exams. Some exam questions will require information gathered during lab sessions. Engineering notebooks will be collected and graded at the mid-semester break and at the final exam.

The Book Itself:
Every student will keep a single engineering notebook. The notebook must be a bound book with consecutively numbered pages. Do not tear pages out of your notebook. Do not tare any page of the 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 without pre–numbered pages, loose leaf binders and electronic notebooks are not acceptable.

Format:

- Reserve the first few pages for a table of contents. Each time you use your notebook (pre-lab calculations, during lab, or post-lab summary) draw a line, write the date, title of the new section, lab number and name of your team member (if working as part of a team), and make an entry in the table of contents along with the date.
- Date each page. Each page should have at least one date. All pages should be dated consecutively.
- Do not skip any pages or leave blank spaces in a page.
- Always use ink (not pencil). If you make a mistake, draw a single line through it, leaving it legible. Some of the greatest advances in modern technology began life as mistakes. Use all pages consecutively; leave no blank pages and do not remove pages.
- All entries should be made by hand except for computer printouts of schematic diagrams or computer printouts of plots. No text printouts should be attached to your notebook. All printouts should be trimmed to fit one page of the notebook, and should be glued or taped into the book. Do not use staples.
- A summary of each laboratory experiment should be included in the notebook.

Contents:
Your notebook will contain a record of each of the phases of your weekly lab. The notebook should be

limited to work related to the ECE 214 labs. Do not include notes from the classroom unless they directly apply to the assigned lab. Here are a few guidelines:

- **Before the Lab:** Before you come to lab, you should have a plan for what you are going to do. As you formulate this plan, put any calculations, designs, ideas, questions, etc. in your notebook. The lab handout will often include a Pre–Lab work section. This work should be done before you come to lab. It may require calculations or graphs that must be added to your lab notebook or the assembly of a circuit.
- **During the Lab:**
  1. The notebook should contain a written description of each laboratory procedure. The description should be sufficient so that a reader given the lab handout could follow the work done and identify the results requested in the handout. The Lab procedures are numbered in the handouts. Make sure you indicate in your notebook how the notebook entries correspond to the procedure steps.
  2. Describe the experimental setup completely but succinctly. Include the equipment and model numbers but do not include equipment serial numbers.
  3. Include a complete diagram for each circuit you design or construct. Label the values of each component, including units if there might be a question.
  4. Indicate clearly the points in the circuit where voltage or current measurements were taken.
  5. All data should be recorded directly in to the notebook at the time it is taken. Never write data on scrap paper.
  6. Multiple or sequential measurements should be recorded in a table. Table headings should include the name of the variable and the units. The table should also have a title and description of what it is; make sure to include the procedure step and number from the class handout.
  7. You may be asked to draw a waveform as seen on the oscilloscope or to plot measured data points from a table. These drawings should be done by hand during the lab session.
  8. Label each axis of a graph, including units, and give each graph a title and description of what it is; make sure to include the procedure step and number from the class handout.
  9. If something does not work or behaves unexpectedly, make a note of it. When you fix something, describe what was wrong and how you fixed it.
  10. The lab handouts will contain a procedure section describing what you should do in lab. You may, for example, be asked to take certain measurements or to describe the behavior of a circuit. Make sure that you do all the procedures and answer all the questions. It should be easy to find the results in your notebook and associate them with the procedure step and number.
- **After the lab:** After most labs you will answer a series of questions and perform tasks described in the post-lab section. You will use the data generated during the lab and recorded in your notebook to complete the post-lab. This is another reason to develop good habits with your notebook. All of the information needed to complete the work sheet should be added to your engineering notebook.

Basic Presentation Guidelines

These guidelines will set down dome basic tips that will help you present your work in the best possible way. The way you present your work is important in your academic life as well as your future career as an engineer. Good presentation will:

- Help you clearly demonstrate your understanding of the material to those who will review it
- Train you to use the correct format and concise wording when you create your work
- Emphasize the importance of the process used to obtain an answer
- Make it easier to revise and correct what you have done

Use the following list of tips whenever you create work to be handed in for this class. Another way to think about what is expected of you is to consider the question: Would the class understand your work if it was photocopied and distributed but not given any accompanying verbal explanation? If the class would find your work difficult to follow, then your work is unacceptable.

1. Identify the answer to each problem by drawing a box or circle around it.
2. If the steps required to solve a problem are not clear from the layout of the problem, identify in writing what steps you have used.
3. Draw schematics for all circuits under consideration, and redraw them when the circuit is collapsed, expanded, or modified. Do not draw circuits on top of other circuits.
4. If you define a new variable (e.g. V0, R1) be sure to identify it on your drawing.
5. Define all variables in a circuit and use consistent notation. For example, Va is not equal to va nor is it equal to VA.
6. Equations should have an expression on both sides of the equal sign.
7. Voltages are usually defined by a value and two measurement points (nodes) labeled with a "+" and "−" respectively. If a voltage at a single point (node) in a circuit is defined, it will be assumed that the second node is the ground node (zero volts) of the circuit.
8. Currents are defined by a value and a direction in a circuit branch.
9. Use the notation "||" to denote components added in parallel. For example: $40\Omega.||10\Omega. = 8\Omega$.
10. ~~Cross out~~ things you do not want considered toward your grade.
11. Your work should proceed left-to-right and top-to-bottom. If you must alter this scheme, use arrows to indicate the flow.
12. Use at least four significant digits for preliminary results on a problem. Doing so will guarantee that the final result is accurate to three significant digits.
13. Express your final answer in three significant digits using scientific notation. For example: $20/3$ is written as 6.67; $10/3 \times 10^{-3}$ is written: 3.33×10^{-3}. The number 0.003 has only one significant digit. Do not express variables with more than three initial or trailing zeros. For example, do not express 4.20μF as $0.0000042F$ or express 25×10^4 as $250,000$ when it should be expressed as: $2.50x10^5$.

14. When your work leads to a set of simultaneous linear equations, place the fundamental equations in a column and draw a box around them. Then proceed to solve them by hand, using Matlab, or with a calculator. You do not need to show the steps used to solve the simultaneous equations unless they are being solved by hand.

15. Complex numbers are written in the form of: $3 + j4$ or $6\angle 30^o$, where $j = \sqrt{-1}$. Complex numbers are not written as (4,3), a popular calculator format, or as $4 + i3$ (i denotes current).

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, please contact Disabilities Services, 121 East Annex, 581-2319, as early as possible in the term.

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/