Course Information

ECE 212 Spring 2014
Circuit Analysis II

Catalog Description

With lab. Continuation of ECE 211. Analyzing and solving ac networks using complex forcing functions. AC power analysis, including average, reactive, and complex power. Applications of techniques to polyphase power systems and transformers. Circuit analysis in the s-domain (Laplace), including transfer functions and resonance. Frequency response, including filters and Bode diagrams. Fourier analysis, including harmonics; even, odd, and half-wave symmetry; and Fourier coefficients. Bi-weekly lab meetings include simulating circuits by hand and/or using PSpice, then building the circuits and taking measurements for comparison. Prerequisite: grade of C or better in E&C-ENG 211 or its equivalent. (4 credits).

Goals and Objectives

The objective of this course is to continue to show you the methodology of electrical and computer engineering and lay a foundation for future work in the field through the study of electrical circuits. After taking this course, you should be able to:

- develop models of circuits in terms of differential equations;

- analyze circuits comprised of resistors, capacitors, inductors and op-amps driven by sinusoidal inputs (employ the concepts of phasors, impedances, admittances and compute power);

- use Laplace transforms for the analysis of circuits in the s-domain (including filters, frequency response and Bode plots);

- perform Fourier circuit analysis; and

- construct simple electric circuits and make measurements in the laboratory (using basic laboratory equipment and working in teams).

Instructional Approach

As in ECE 211, we are using the "Mastery" approach. Course credit is earned entirely and exclusively through mastery of 18 online modules, 5 labs, and 5 computer exercises covering all the topics of the course. There are still lectures and recitations, but there are no midterm exams and no required homework. Since the modules are administered online, you may retake them. This means that if you do not master a module, it does not count against you, but if you do master a module, it counts toward your semester grade. The questions and contexts will change with every attempt, but the central concepts and techniques do not change. Thus, if you have truly mastered the material, you can be given any circuit, be asked any question, and you will be able to answer it correctly.

It is strongly recommended that you attend all lectures and recitations. These will help you learn the concepts and techniques needed to demonstrate mastery in the online modules and computer assignments.
Course Format

Lecture: Three 50-minute lectures per week (MWF, 9:05–9:55, in HASA 134)

Recitation: One 75-minute recitation per week (Tu, 9:30–10:45, 11:15–12:30, or 1:00–2:15, all in Marston 220)

Mastery Modules: 18 online tests, administered by OWL

Electronics Lab: 5 bi-weekly labs (M, Th, or F; 2:30–5:30, in Marston 221)

Computer Exercises: 5 problems to solve on the computer, done on your own, using MATLAB or Excel

Instructors

Bill Leonard
Marcus 8B
545-3513
leonard@ecs.umass.edu
Office Hours: Any time I am in my office
Responsibilities: Overall class organization and administration, lectures, OWL, Moodle, Recitation 1 (Tu, 9:30)

Jason Fraser
fraser@ecs.umass.edu
Office Hours: Friday, 1–3pm, Marcus 5 (M5)
Responsibilities: Recitations 2 and 3 (Tu, 11:15 and 1:00), grading labs and exercises

Undergraduate Assistants

Head Lab TA

Brian Hickey
bmhickey@umass.edu
Responsibilities: Preparing TAs to run the lab sections, lab logistics, making sure there is enough equipment, kits, and supplies in the lab

Prelab / MATLAB Help

Peter Blum
pblum@umass.edu
Help Session: by appointment
Responsibilities: Answering questions about prelabs and MATLAB exercises

Andrew Kelley
atkelly@umass.edu
Help Session: Sunday, 6–9pm, Marston 134
Responsibilities: Answering questions about prelabs and MATLAB exercises
Prerequisites

A grade of C or better in ECE 211 (or its equivalent) is required to take this course.

Textbooks

Required

PSpice for Linear Circuits (with CD-ROM), by J.A. Svoboda; Wiley, 2002

Recommended


Course Components

There is no required homework in this course. There are no semester exams, and there will not be a final exam. Instead, your grade will be determined by the number and type of online modules you successfully master. Electronics labs and computer exercises are also required, as described below.

Electronics Labs. During this semester, you will do 5 labs, constructing actual circuits and taking measurements. Each lab will have a prelab assignment, usually a PSpice simulation. Each lab is worth a maximum of 30 points. Make-up labs are on selected Friday afternoons.

Computer Exercises. There are five computer problems, designed to extend your abilities with MATLAB. The problems are worth a total of 50 points (10 points each), with up to an additional 10 Mastery points available for perfect scores, as well as another 10 Bonus points for perfect scores before a certain date.

Mastery modules. There are a total of 18 online modules, administered by OWL. Two cover "Prerequisite" knowledge. Fourteen are "Basic" modules, covering definitions and basic techniques. One is an "Intermediate" module, which integrates topics within the first five Basic modules and encourages efficient decision-making. There is one "Cumulative" module, covering the entire course. You can earn up to 6 "Mastery" points for a perfect score on each module.

Each module is worth 10 points. To earn mastery, you must answer all questions correctly in a designated secure setting.

At least 12 attempts will be made available in OWL for each module. Attempts will be due
periodically until the end of the course, 5/8/14. (After an attempt is past due, you will lose it.)

You only need to master one of the attempts. If you fail to master any particular attempt, it does not count against you. You simply make another attempt at that module.

For more information, go to Modules.

**Grading**

To earn a guaranteed C in this course, you must earn...

- at least 180 points on Mastery modules, including Mastery points, but not including Bonus points;
- at least 180 points on labs and exercises, also including Mastery points, but not including Bonus points.
- at least 9/10 on B1 and I1;
- at least 10/10 on B1 or I1;
- at least 6/10 (each) on P1, P2, and B2 through B14; and
- at least 30 points (total) on B12 through B14.

In other words, B1 and I1 are critical for future success, so you must master one and earn at least 9/10 on the other. Also, you are expected to at least attempt every module (except C1) and earn at least 6 points on it. Finally, the whole course is designed to help you understand and do Fourier, so you need at least 30 points in this last group of modules.

Once you have fulfilled all of these criteria, every 20 points is a grade increment, e.g., C to C+. Thus, you need 480 points for a guaranteed A.

If you do not reach one or more of these minimum scores, talk to Prof. Leonard about your options. (If you are close, there will usually be a way to pass with at least a C.)

For more information, go to Grading.

**Exams**

There are no evening exams, and there is no final exam. Your grade is determined entirely by your score on labs and the number and type of online modules you master.

**Homework**

There is no required homework in this course. However, associated with each Mastery module will be a set of Practice modules, also administered by OWL. Although these are completely optional, they will serve the role of homework, as they help you to prepare to master the required modules. We recommend that you do all of the Practice modules associated with each Mastery module.

**Electronics Laboratory**
There are 5 bi-weekly laboratories, held in the Electronics Lab (MRST 221). You will work in teams to construct circuits and answer questions about them.

Each laboratory meeting has a preparatory assignment associated with it (prelab). Usually this is a PSpice simulation. You must complete this assignment before you will be allowed to work on the lab. The TA will collect the prelab assignments at the beginning of lab.

You will be assigned to a group (A or B) at a brief information meeting at the beginning of the semester. This group assignment will determine which week of the cycle you should attend lab. (This will help keep the maximum number of students in each lab meeting relatively small.) The first meeting will be held on Monday, January 27.

The lab schedule can be found at "Lab Schedule".

Electronics labs are worth a maximum of 150 points. (Computer labs are worth another 60 points.)

**Collaboration vs. Cheating**

You are encouraged to work together, especially on Practice attempts and in the Lab; however, ultimately you must master modules on your own at the secure site, so do not rely too heavily on other students for help. You also may not work too closely with someone on the computer exercises. In particular, you can brainstorm before you start programming, and you can compare results after you are finished, but you should not be sharing lines of code with each other. Occasionally, you might need or know a useful command or function, and you may collaborate. But the intent is that your code is your own. It should reflect your own understanding and your own way of organizing the solution. If you need additional help, you should be asking me or the TA for help, not your classmates.

I will deal informally with most cases of academic dishonesty, however, I am required to report all cases, formal or informal, to the Ombuds Office. Note that the Ombuds Office is required, in turn, to inform the University administration if there are three or more reports of academic dishonesty regarding the same individual, who then decides if more serious disciplinary action is warranted.

**Rough Course Outline**

1. Sinusoidal Steady-State Analysis (Chapter 10)
2. AC Circuit Power Analysis (Chapter 11)
3. Polyphase Circuits (Chapter 12)
4. Magnetically Coupled Circuits (Chapter 13)
5. Complex Frequency and the Laplace Transform (Chapter 14)
6. Circuit Analysis in the s-Domain (Chapter 15)
7. Frequency Response (Chapter 16)
8. Fourier Circuit Analysis (Chapter 18)
Modules

ECE 212 Spring 2014
Circuit Analysis II

Overview

The core of the instructional design is a set of 18 online modules. The more modules you master the higher your semester grade. There are no exams, and there is no required homework.

Modules are administered by OWL, so you may attempt each one multiple times. Each module is worth 10 points, and you must earn a perfect 10 to earn "mastery".

We want to ensure that credit for mastering modules is awarded fairly and appropriately, so all modules must be attempted in a secure setting.

Mastery modules

Two of the modules are "Prerequisite", covering topics you are expected to have mastered already. Fourteen are "Basic", covering definitions and fundamental techniques, including how to find your own mistakes. One module is "Intermediate", integrating topics in the first 5 Basic modules and encouraging efficient decision-making. One module is "Cumulative", covering all topics in the course. See Topics below for a list of modules and their content.

For most modules, there are exactly 12 "Mastery" attempts available on OWL, each listed as a separate assignment. They are all labeled "Required", but you need only master one attempt in a secure setting to earn mastery for that module. For certain modules (B1 and I1), there are 18 Mastery attempts available.

Old Mastery attempts can be viewed only in a designated secure site.

Mastery attempts will not be discussed in discussion or in office hours when there are other students present. You may not discuss Mastery attempts with classmates or TAs. If you have a question about a Mastery attempt, please email or make a private appointment to talk to Prof. Leonard. When in a public setting, you can usually frame your question in terms of Practice exercises.

Practice exercises

Associated with each set of Mastery attempts is a set of Practice exercises. These may be done individually or with classmates. They should be attempted outside the secure setting. Practice attempts do not count toward your semester grade. This means that if you master a Practice attempt, you must still master a required attempt in a secure setting.

Even though Practice exercises are labeled as optional, they will likely become the focus of most of your homework and studies. You can think of them as diagnostic, telling you what you need to work on and understand, and what you do not need to work on. If you have questions about the modules, they must be asked in terms of Practice attempts, for instance, during lecture, recitation, and office hours.
There will only be two or three Practice attempts for each module. Typically, the first two will be in "Question" mode, which means you can work on each problem individually and receive feedback after each submission of an answer. In this mode, you can also change the question by clicking on "Redo Question" in OWL's nav-bar on the left. The first of these attempts will be relatively easy, making it possible to learn the rudiments. The second will be relatively hard, corresponding to the level of difficulty of the Mastery attempts, making it possible to refine your understanding and smooth out more subtle issues. There will also sometimes be one Practice attempt in "Exam" mode, which makes it just like a secure attempt, except that after you submit your exam to be graded, you will be given the correct answers as feedback.

Module values

Different attempts at the same module are worth different amounts. The first four (or more) are worth 16 points, and therefore, they have a "+6" in the title. That is, when you master one of these, you have earned 16 points. The next four are worth 14 points, and the last four are worth 12 points. These values are used to partially determine your total score, which in turn determines the grade you have earned.

Module availability

When a topic is first introduced in lecture, all attempts at the corresponding module are made available, but different attempts are due at different times. Attempts worth 16 points are due before those worth 14 points, which are due before those worth 12 points. If you do not make an attempt before its due date, you cannot ever attempt it.

Module B1 (Complex Numbers) is available in two formats: (1) as a single, 10-pt attempt, or (2) as two 5-pt halves, labeled B1a and B1b. In other words, you can master B1 in one sitting, like other modules, or separately in two sittings. If you make a mistake in the 10-pt attempt, you will need to attempt the whole module again. But if you make a mistake in one of the 5-pt parts, you only need to attempt that piece again. Once you have mastered one part, you don't need to attempt it again. (Note that these attempts have their own folders, always at the end of the list.)

Secure testing

For now, you have one option for secure testing:

1. You can visit Marcus 8. Before 4pm are "drop in" hours, which do not require a reservation. After 4pm, a reservation is recommended. The sign-up sheet is located at Marcus 8 Secure Testing Reservations. The sign-up sheet is open starting Tuesday, January 21, at 6:00pm. The secure testing site is available starting Wednesday, January 22, at 10am.

Time limits

All of the modules have a time limit. If you have mastered the material, you should not need the entire time given. For Prerequisite and most Basic modules, the time limit is 60 minutes. For B1 and I1, the time limit is 75 minutes. For the Cumulative module, it is 90 minutes.

Feedback

When the time limit has expired or you decide to submit your attempt to be graded earlier, you will receive
feedback. For a few questions, suggestions or other comments will appear at the bottom of the question. For every question, you will be shown your last submitted answer and whether or not your answer is correct. For Practice questions, you will also be shown the correct answer. (You will not see the correct answers after doing a Mastery attempt.)

**Recommendations**

We strongly recommend that you complete all Practice attempts at each module before trying a Mastery attempt (in a secure setting). We also recommend that you redo questions in the "Question mode" Practice attempts. In other words, do not stop simply because you have answered every question correctly one time. Different questions have different contexts, and you can develop your mastery best by attempting as many as possible.

Note that there are only 12 Mastery attempts available for most modules. Therefore, if you fail to master 1 or 2 of these, you should stop making attempts and seek some advice and assistance, either from a classmate, a TA, or a professor.

You should keep a bound lab notebook with you during all Mastery attempts, and you should work out all problems in this notebook, sketching the circuits and writing down all equations and values for parameters. This is especially useful when you are visiting a professor with questions about a particular attempt.

For a more complete list of recommendations, go to [Suggestions](#).

**Special needs**

If you have a special need, you should tell Prof. Leonard as soon as possible (5.3513 or leonard@ecs.umass.edu). For instance, if you need extended time on tests or if you cannot go to the secure site at any of the designated times, please let me know.

**Calculators**

You will not be allowed to use your own graphing or programmable calculator in either secure setting. Instead you should purchase a SHARP, model EL-531X (or -W) scientific calculator. It is recommended that you also use it while practicing, so that you become entirely familiar with its operation and layout. In particular, this model has 6 memory registers, and it can convert complex numbers to/from rectangular from/to exponential (polar/phasor) form. If you would like to substitute another scientific calculator, see Prof. Leonard, so that he can tell the monitors that another model is approved for use at the secure site.

**Topics**

The following table shows the content of each of the 18 modules:

<table>
<thead>
<tr>
<th>Group/Module</th>
<th>Comments/Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prerequisite</strong></td>
<td>Some basic circuits and mathematical ideas that are needed to do well in this course.</td>
</tr>
<tr>
<td>P1</td>
<td><em>Circuits I Review.</em> Passive sign convention; nodal and mesh analysis; Thevenin</td>
</tr>
</tbody>
</table>
equivalence; power balance; op-amps; properties of capacitors and inductors.

**P2**  
*Logs, Exponentials, and Trig.* Identities; combining, evaluating, and inverting functions.

**AC Analysis**  
An alternative to time-domain solutions to first- and second-order linear differential equations when the forcing functions are sinusoidal operating at the same frequency. Extremely useful for power systems and Fourier series.

**B1**  
*Complex Numbers.* Rectangular and exponential forms; translating between forms; basic operations; combining complex numbers with logs and exponentials.

**B2**  
*Sinusoidal Forcing Functions.* Phasors; I-V relationships for $R$, $C$, and $L$; impedance and admittance; complex forcing functions.

**B3**  
*Sinusoidal Steady-State Analysis.* KCL/KVL, nodal, mesh, superposition, and source transformation; equivalent impedance; current and voltage division; Thevenin and Norton equivalence.

**B4**  

**B5**  
*AC Power Analysis.* Maximum power transfer; effective values of current and voltage; apparent power; power factor; active and reactive power; complex power; units of power.

**Intermediate**  
Pulling together the first five Basic modules, and applying the techniques to circuits. Honing your decision-making skills for solving problems.

**I1**  
*Solving Basic Networks using AC Analysis.* Nodal and mesh analysis using phasors; power balance.

**AC Applications**  
Going beyond basic AC analysis and learning about two fundamental parts of the power grid.

**B6**  
*Polyphase Circuits.* Double-subscript notation for I and V; phasor diagrams; phase sequence; phase vs. line voltage; phase vs. line current; Y-connection; $\Delta$-connection.

**B7**  
*Magnetically Coupled Circuits.* Mutual inductance; dot convention; $k$; $Z_M$; linear transformer; voltage across $L$; ideal transformer; turn ratio.

**s-Domain**  
Another alternative technique for solving differential equations, useful when the forcing functions are not necessarily sinusoidal. The basis for filters.
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<tbody>
<tr>
<td>B8</td>
<td>Laplace Transforms. Complex frequency; addition; scalar multiplication; time differentiation; initial and final value theorems; transforms of common functions; inverse transforms of common functions.</td>
</tr>
<tr>
<td>B9</td>
<td>Circuit Analysis in the s-domain. Z(s); Y(s); behaviors of R, C, and L in the s domain; poles; zeros; transfer functions; nodal and mesh; partial fraction expansion.</td>
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<td>B10</td>
<td>Resonance and Transfer Functions. Resonance; break frequency; high and low frequency limits; filters; transfer functions.</td>
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<tr>
<td>B11</td>
<td>Bode Diagrams. dB scale; gain; phase shift; Bode diagrams (phase and magnitude); break frequency; asymptotic behavior.</td>
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<tr>
<td>Fourier</td>
<td>A third technique for solving differential equations, useful when the forcing functions are periodic but not sinusoidal. The foundation of modern communication and other fields.</td>
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<tr>
<td>B12</td>
<td>Fourier Analysis. Odd/even/half-wave symmetry; Fourier coefficients.</td>
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<tr>
<td>B13</td>
<td>Fourier Series. Harmonics; phase and amplitude spectra; fundamental frequency; transforming back to the time domain.</td>
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<tr>
<td>Cumulative</td>
<td>Applying everything you have learned to interesting situations, integrating different parts of the course.</td>
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<tr>
<td>C1</td>
<td>Solving AC networks.</td>
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</tbody>
</table>
Mastery Calendar
ECE 212 Spring 2014
Circuit Analysis II

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<thead>
<tr>
<th>212s14</th>
<th>P1, P2</th>
<th>B1</th>
<th>B2, B3</th>
<th>B4, B5</th>
<th>I1</th>
<th>B6, B7</th>
<th>B8, B9</th>
<th>B10, B11</th>
<th>B12, B13</th>
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* Marcus 8 closes early on these dates, 8pm on 4/18 (before a Monday holiday) and 4pm on 3/14 (before Spring Break).
Grading

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Circuit Analysis II

Overview

This page will tell you how you will be graded in ECE 212.

There are no exams, quizzes, or weekly homework. Instead, your grade is determined by your best scores on Mastery modules, electronics labs, and MATLAB exercises, all of which can be redone until you are satisfied with your score.

The maximum points possible (not including Bonus points) is 498. If you earn at least 360 points (distributed as outlined below), you are guaranteed a C. Every additional 20 points earns one grade increment (e.g., C to C+). So, for example, you need a total of 480 points to earn a guaranteed grade of A.

Mastery points

In order to fully understand the grading system, you must first understand what each OWL assignment is worth. Each assignment is labeled with the number of "Mastery" points you will earn with a perfect score, either "+2", "+4", or "+6". Thus, an assignment is worth up to 16 points.

Once a module is visible on OWL, all its associated assignments will be available at the same time. The +6 attempts are due first, so if you want to be "ahead", you need to master one of these. The +4 attempts are due next, so if you want to be "on track", you need to master one of these. The +2 assignments are due last.

Labs and Exercises

Another component of ECE 212 are electronics labs and MATLAB exercises. You will perform 5 labs, building circuits, predicting responses, and making measurements, and solve 5 problems using MATLAB, each problem exploring those parts of the course not well covered by the Mastery modules or electronics labs.

Each lab is worth 30 points. Labs can be redone and/or resubmitted without penalty.

Each exercise is worth 10 points. There is a "Mastery" date associated with each exercise. A perfect score on or before the Mastery date is worth 2 additional points. There is no penalty for doing exercises late.

The maximum possible score on labs and exercises is 210, including Mastery points.

Bonus points

For each group of modules, you earn 2 Bonus points for mastering all of the modules in it, for a maximum of 14 points. The groups are:

- P1, P2, and B2
• B1 and I1  
• B3, B4, and B5  
• B6 and B7  
• B8 and B9  
• B10 and B11  
• B12, B13, and B14

There will also be two surveys and an optional writing assignment that you can complete, for a total of 9 points. Finally, there will be 2 attempts each at four "Bonus" modules, worth up to an additional 20 Bonus points.

**Total Score**

Your total score is the sum of your best scores on Mastery attempts (including Mastery points), your best scores on labs and exercises, and any Bonus points you have earned.

**Requirements**

To earn a guaranteed grade of C in ECE 212, your total score must be at least 360 points, distributed as follows:

• 180 points (or more) on labs and exercises; and
• 180 points (or more) on Mastery modules, including Mastery points but not Bonus points;

Further, you must also...

• earn at least 6/10 on both Prerequisite modules (P1 and P2) and every Basic module (B2 through B14);
• earn at least 9/10 on both B1 (complex numbers) and I1 (solving basic AC networks), not including Mastery points;
• mastery either B1 or I1; and
• earn at least 30 points on modules B12 through B14.

This will ensure that you are prepared to take ECE 313 (Signals & Systems) and ECE 323 (Electronics I) next Fall.

**Note:** If you do not meet all of the requirements above needed for a C, the highest grade that is guaranteed is C–, no matter how many modules you master and how many points you have earned. However, if you are close, talk to Prof. Leonard to find out your options.

If you are not sure exactly how you will be graded, please talk to Prof. Leonard.

**Grade Increments / Guaranteed Grades**

Once you have earned a C, you earn one grade increment (C to C+) for every additional 20 points above 360. The resulting grade is guaranteed. Thus, there is no grading curve, and you are not in competition for
grades with your classmates.