Course Information

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 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 16 online modules, 6 labs, and 2 computer projects 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 126)

**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:** 16 online tests, administered by OWL

**Electronics Lab:** 6 bi-weekly labs (M, Th, or F; 2:30–5:30, in Marston 221)

**Computer Lab:** 2 computer projects, done on your own.

Instructors

**Marinos Vouvakis**
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**Responsibilities:** Overall class organization, lectures, laboratory

**Bill Leonard**
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**Responsibilities:** Overall administration, recitations, modules, web site

TAs

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**Responsibilities:** grading labs and projects

**Shanka Wijesundara**
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**Responsibilities:** lab TA supervisor, tutor

Prerequisites

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

Textbooks

**Required**

- *Circuits, First Edition*, by Ulaby and Mararbiz, NTS, 2009
- *PSpice for Linear Circuits* (with CD-ROM), by J.A. Svoboda, Wiley, 2002

**Recommended Supplement** (available online at a variety of sites)

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 and computer labs are also required, as described below. Thus, there are only two required components in this course: Labs and Mastery modules. We will be using a mastery approach for both.

**Electronics Labs.** During this semester, you will do 6 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 25 points. Make-up labs are on selected Friday afternoons.

**Computer Labs.** There are two computer projects, designed to extend your abilities with MATLAB. The two projects contain 5 problems, worth a total of 50 points (10 points each).

**Mastery modules.** There are a total of 16 online modules, administered by OWL. 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.

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

When material is being covered in lecture, 8 attempts will be made available in OWL for the associated module. Except for B1 and I1, the first two attempts will be due a week or so after the corresponding material is covered in lecture, and the remaining 6 attempts will be due at the end of the semester. (After an attempt is past due, you will lose it.) Two additional attempts at each module will be available only during Finals week.

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 at least a C in this course, you must master 10 Basic modules, 4 of which must be from the first five modules (B1 through B5), 1 must be either B6 or B7, 3 must be from the next four (B8 through B11), and 2 must be from the last three (B12 through B14); you must master B1 (Complex Numbers) and I1 (Solving Basic AC Networks); and you must earn at least 175 points in labs and projects.

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 
onoptional, 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 6 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 26.

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

Electronics labs are worth a maximum of 150 points. (Computer labs are worth another 50 
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. Academic dishonesty (either taking or giving answers 
at the secure site, theft of another’s work, etc.) will be dealt with harshly; you will receive an 
F for the course, and the Ombuds Office will be notified immediately.

Rough Course Outline

1. AC Analysis (Chapter 7)
2. AC Power (Chapter 8)
3. Polyphase Circuits (Chapter 8, Section 6)
4. Magnetically Coupled Circuits
5. Laplace Transforms and s-domain Circuit Analysis (Chapter 10)
6. Frequency Response and Bode Plots (Chapter 9)
7. Fourier Circuit Analysis (Chapter 11)
The core of the instructional design is a set of 16 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 required modules must be attempted in a secure setting.

Changes in the approach

Here is a summary of the changes to the Mastery approach since last semester:

- There are two "Prerequisite" modules covering topics and ideas that you should know already. The first is a review of circuits I; the other covers exponentials, logs, and trigonometry. You can earn up to 6 Bonus points for mastering both.

- There are 14 Basic modules.

  Different modules are required. The first Basic module (B1: Complex Numbers) is now required. As before, module I1 is required.

- There are no "Bonus dates". You are expected to be able to manage your time appropriately.

  In general, all but two attempts at each module will be made available during the semester. The last two will be made available only during Finals week. In other words, when you have used up all your attempts during the semester without mastering a module, it is time to move on. You will have another opportunity to master the module during Finals week.

  The 14 Basic modules are organized differently: The first 5 cover solving second-order systems with complex forcing functions; the next two are applications of this technique to more sophisticated systems; the next 4 cover Laplace and the s-domain; and the last 3 cover Fourier and basic signal processing.

  More modules are required to earn at least a C. You must master 10 Basic modules (and I1). Within each group of modules, you must master all but one.

  There is only one Intermediate module, I1. There is no module I2 or I3.

If you have any questions or concerns, please send an email to Prof. Leonard.

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 8 "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 required modules (B1 and I1), there are 10 Mastery attempts available.
Mastery attempts that are past due can be viewed only in the designated secure site.

Mastery attempts will not be discussed in lecture, in recitation, 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 also 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 modules 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 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 availability

When a topic is first introduced in lecture, its accompanying Practice assignments will be made available in OWL. It is recommended that you read the questions as soon as possible, even though you might not be ready to answer any of them. If you want any assignments made available sooner, just email Prof. Leonard.

About the time a topic is scheduled to be completed in lecture, its accompanying Mastery attempts will be made available in OWL. Required modules will have 10 attempts each; all the others will have 8 attempts each.

Starting with module B2, two attempts will be due before the end of the semester, usually about one week after the corresponding material has been covered in lecture. (This is to encourage you to make one or two Mastery attempts sooner rather than later.) Any unused attempts will be lost. The other 6 attempts will be available until the end of the semester.

During Finals week, there will be an additional two attempts made available for each module except C1.

Module C1 will be available only during Finals week. Each attempt will be available only for 2 hours. (So, for example, if you start testing on the second day during Finals week, 3 or 4 attempts will already have come and gone.) Therefore, if there are two attempts available, check the due dates before starting; one of them will be due in an hour, and the other will be due in two hours.
Designated secure site

Mastery modules are administered much like tests, so they must be attempted only at a secure location. There will be one or two monitors on site at all designated times. You will be required to sign in, show your ID and calculator, and sign out again. You are allowed one bound lab notebook to write in. Loose sheets will be collected, so tape into your notebook anything that you might find useful. No cell phones, PDAs, etc. are permitted. No books or other resources are allowed. You may not talk to anyone. You may not access any other assignments while you are making a Mastery attempt.

There are three secure sites: DuBois 720 and 767 (7th floor, Tower Library), and Marcus 8 (in the basement). For availability, go to "Secure schedule (DuBois 720/767 and Marcus 8)". Note that hours in the Library are "drop in" and subject to first-come/first-served. You need to sign up for the time slots in Marcus 8.

During Finals week, the schedule of the secure site will change. Most likely, it will be open three days of Finals week, 12–4pm or 11am–3pm. You will be allowed to sign up for 6 hours of time at secure site. If your schedule makes it difficult to schedule these hours at the secure site, you can sign up for time in Marcus 8. However, the total time you will be allowed at a secure site will be restricted to 6 hours.

For more detailed information, go to "Mastery Guidelines".

If you have any questions or concerns, please contact Prof. Leonard (5.3513 or leonard@ecs.umass.edu).

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 required modules, 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 8 Mastery attempts available for most modules. Therefore, if you fail to master 3 or 4 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 us know.

Calculators

You will not be allowed to use your own graphing or programmable calculator in the secure setting. Instead you should purchase a SHARP, model EL-531W 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>These modules do not count toward the total number of modules mastered. For best scores of 8 or above, you earn Bonus points.</td>
</tr>
<tr>
<td>P1</td>
<td>Circuits I Review. Passive sign convention; nodal and mesh analysis; Thevenin equivalence; power balance; properties of capacitors and inductors; the complete response to RC and RL networks.</td>
</tr>
<tr>
<td>P2</td>
<td>Logs, Exponentials, and Trig. Identities; combining, evaluating, and inverting functions.</td>
</tr>
<tr>
<td><strong>AC Analysis</strong></td>
<td>B1 is required. You must master 4 of these 5 modules.</td>
</tr>
<tr>
<td>B1</td>
<td>Complex Numbers. Rectangular and exponential forms; translating between forms; basic operations; combining complex numbers with logs and exponentials.</td>
</tr>
<tr>
<td>B3</td>
<td>Sinusoidal Steady-State Analysis. KCL/KVL, nodal, mesh, superposition, and source transformation; equivalent impedance; current and voltage division; Thevenin and Norton equivalence.</td>
</tr>
</tbody>
</table>
B5  \textit{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.

\begin{itemize}
\item \textbf{AC Applications} \quad \text{You must master 1 of these 2 modules.}
\item B6  \textit{Polyphase Circuits}. Double-subscript notation for I and V; phasor diagrams; phase sequence; phase vs. line voltage; phase vs. line current; Y-connection; Δ-connection.
\item B7  \textit{Magnetically Coupled Circuits}. Mutual inductance; dot convention; \(k\); \(Z_M\); linear transformer; voltage across \(L\); input impedance; reflected impedance; ideal transformer; turn ratio.
\end{itemize}

\begin{itemize}
\item \textbf{s-Domain} \quad \text{You must master 3 of these 4 modules.}
\item B8  \textit{Laplace Transforms}. Complex frequency; addition; scalar multiplication; time differentiation; initial and final value theorems; transforms of common functions; inverse transforms of common functions.
\item B9  \textit{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.
\item B10  \textit{Resonance and Transfer Functions}. Resonance; break frequency; high and low frequency limits; filters; transfer functions.
\item B11  \textit{Bode Diagrams}. dB scale; gain; phase shift; Bode diagrams (phase and magnitude); break frequency; asymptotic behavior.
\end{itemize}

\begin{itemize}
\item \textbf{Fourier} \quad \text{You must master 2 of these 3 modules.}
\item B12  \textit{Fourier Analysis}. Odd/even/half-wave symmetry; Fourier coefficients.
\item B13  \textit{Fourier Series}. Harmonics; phase and amplitude spectra; fundamental frequency; transforming back to the time domain.
\item B14  \textit{Multi-tone Signal Processing}. Power transfer; system function.
\end{itemize}

\begin{itemize}
\item \textbf{Intermediate} \quad \text{This module is required. It integrates topics within the first 5 Basic modules (AC Analysis).}
\item I1  \textit{Solving Basic Networks using AC Analysis}. Nodal and mesh analysis using phasors; power balance.
\end{itemize}
**File: Grading**

**Grading**

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

**Requirements**

Since there are no exams, quizzes, or weekly homework, your grade is almost entirely determined by how many and which modules you master. To earn a C in ECE 212, you must:

1. master 10 Basic modules, including B1 (Complex Numbers), of which 4 are among the first 5 (B1–B5), 1 is among the next 2 (B6 and B7), 3 are from the next 4 (B8–B11), and 2 are among the last 3 (B12–B14);

2. master module I1 (Solving Basic Networks using AC Analysis); and

3. earn at least 175 points in labs and projects.

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

**Grade Increments**

Once you have earned a C, you earn one grade increment (e.g., C to C+) for each of the following:

1. Master one additional module.

2. Earn 15 "Bonus" points.

**Bonus points**

There are many different ways to earn Bonus points:

1. **Attempt a module without mastering it.** As you are working toward Mastery of a module, your best score counts. It is recommended that you keep trying until you master a module, but if you cannot, then your best score earns the same number of Bonus points (e.g., a best score of 7 earns 7 Bonus points).

2. **Earn at least 8/10 on Prerequisite modules.** For modules P1 and P2, you earn Bonus points for each best score above 7, one Bonus point per point above 7. (max = 6 Bonus points)

3. **Complete a group of modules.** You are required to master all but one module within each group. However, if you master all of them, you earn 4 Bonus points for each completed group. (max = 16 Bonus points)
4. **Earn at least 8 points on a quiz.** In lecture, there will be 3 or 4 quizzes, worth a maximum of 10 points each. Each score of 8/10 or above earns 1 Bonus point. (max = 3 or 4 Bonus points)

5. **Earn 180 or more points in labs and projects.** You need at least 175 points in labs and projects to earn a C in this course, but if you earn 180 or more points, you earn 1 Bonus point for every 5 lab/project points you earn above 175. Since there is no penalty for resubmission, perfect scores are attainable for all students. (max = 5 Bonus points)

6. **Fill out a survey.** At least 2 times during the semester, you will be asked to fill out an optional survey. Your answers are very important to us, so we offer 1 Bonus point for filling out each one. (max = 2 Bonus points)

**Note:** If you do not meet all three requirements above needed for a C, the highest grade you can earn is C–, no matter how many modules you master and how many Bonus points you have earned.

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