ECE 3710 Circuits and Electronics (2-0-2)

Prerequisites: Phys 2212/2232
Corequisites: None

Catalog Description: An introduction to electric circuit elements and electronic devices and a study of circuits containing such devices.

Section Instructor: Yiying Zhu, Ph.D., yiyi@ieee@gatech.edu

Lectures & Labs: Tuesdays and Thursdays 4:45 – 6:08 p.m.

Office Hours (tentative): Thursdays 2:00 – 4:00 p.m.

Final Exam: Friday, July 19 2019, 3:10 – 6:00 p.m.

Required Materials:

- National Instruments myDAQ available online at Barnes and Noble bookstore. The myDAQ can be new or used, and can be shared by a pair of students.
  The following link has the unit for $179.00 with 30 day software trial for NI labview, NI Multisim, & NI Ultiboard.
  The other link has the unit for $199.00 and it comes with the NI Labview, Multisim, & Ultiboard.

- NEW lab parts kit, which is available here:
  https://www.sparkfun.com/products/13946?custom_code=GTECE3710

- Install the NI ELVISmx software. It is easiest to use the CD that comes with the myDAQ, but you may also download it from the National Instruments website at:

  Please make your purchases immediately once you decide to enroll the class!

Textbook: Circuits by Fawwaz Ulaby & Michel Maharbiz. Available at Barnes and Noble

Online Resources: Online lectures and homework available at www.canvas.gatech.edu
Course Structure:

This course is divided into three mini-courses:

- Linear Circuits 1: DC Analysis
- Linear Circuits 2: AC Analysis
- Introduction to Electronics

All of the lectures for the term are online. The homework will be completed online. There will also be daily quizzes and worksheets in class based on the online lecture material. The assigned lectures for each class period are listed in Canvas.

There will be 7 in-class labs where students will perform hands-on activities using data acquisition boards. Some of these activities include exploration of RC and RLC circuits, op amp circuits, filters, and physically motivated applications of electronic circuits. These hands-on activities are designed for students to complete during class and turn in a worksheet.

Grading

1. Homework completed on the www.canvas.gatech.edu platform (15%). No late submission will be allowed unless there is 24-hour in advance permission.
   - Linear Circuits 1: DC Analysis (5%)
   - Linear Circuits 2: AC Analysis (5%)
   - Intro to Electronics (5%)
2. Participation/attendance (10%)
   - In-Class Quizzes (5%, lowest 2 will be dropped)
   - In-Class Worksheets (5%, lowest 2 will be dropped)
3. Labs (15%)
4. Exams (60% total):
   - Exams are completed in class. No conflict exams will be arranged.
   - Exam1 (20%)
   - Exam2 (20%)
   - Final exam, Friday, July 19, 3:10 – 6:00 p.m. (20%). The final exam is cumulative.
5. Extra Credit:
   - Applications: Build and demo an interesting circuit (2% on your final grade)
Topical Outline

Resistive Circuits
- Components
- Ohm’s Law
- Resistors in parallel, series
- Kirchhoff’s Current and Voltage Laws
- Voltage divider and current divider laws
- Thévenin Equivalent Circuits
- Superposition

Reactive Circuits
- Inductors and Capacitors
- Parallel and series connections of inductors and capacitors
- Transient Analysis of First-Order circuits

Frequency Analysis of Circuits
- Steady-state sinusoidal analysis and impedance
- Transfer function
- Bode plots
- Filtering

Power in AC Circuits
- Real, reactive, and apparent power
- Power factor

Fundamental Devices in Electronics
- Ideal diodes
- Simple piecewise linear model of diode
- MOS Field-Effect Transistors
- Operational Amplifiers

Electronic Applications
- Rectifiers
- Amplifiers
- Active Filters
- Logic Gates (and introduction to Boolean algebra logic)

Lab Software:

We will use the ELVISmx Instrument Launcher software for the myDAQ device. This software is Windows-based, so please install it on a Windows machine or the Windows partition of a MAC. Use Bootstrap or Parallels with this software. The software comes with the myDAQ and is also available at the National Instruments site for free. WARNING: it takes more than 1 hour to download and install.

Support on the device can be found from the following link:

**Academic Integrity:**

Academic honesty is essential to achieve high-quality education and to maintain the value of a Georgia Tech diploma. While I encourage you to work together and to form study groups, it is important that you take responsibility for the content of all assignments. Collaboration is allowed on online homework. Cheating on quizzes, tests, and final exams will not be tolerated. When uncovered, violations will be reported to the Dean of Students immediately.

**Course Objectives:**

The objectives of this course are to teach students

- to analyze circuits that contain resistors, capacitors, and inductors with direct current and alternating current sources.
- to analyze circuits in the time domain showing transient response and in the frequency domain showing filtering and resonance properties.
- to be familiar with nonlinear circuit components and practical circuits can be built from these components.

**Learning Outcomes:**  At the completion of the course, the students should be able to

- determine voltages and currents in a resistive network.
- sketch the transient response of RC and RL circuits and be familiar with the standard transient responses of RLC circuits.
- use complex phasors to determine the steady-state responses of sinusoidal sources voltages or currents.
- understand and analyze the frequency response characteristics of filters
- analyze power characteristics in reactive circuits.
- build and test real circuits containing RLC components, op amps, diodes, and transistors.
- design and build simple filters, rectifiers, and amplifiers
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<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Course content</th>
<th>Lab</th>
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<tr>
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<td><strong>Linear Circuits 1: DC Analysis</strong></td>
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<tr>
<td>Week 1</td>
<td>5/21/2019</td>
<td>Course Introduction; Module 1 (1.0-1.5), Lessons 2.1 – 2.2</td>
<td>Lab 0</td>
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<td>5/23/2019</td>
<td>Lessons 2.3 – 2.6, 2.9 – 2.10, Lessons 2.7 – 2.8</td>
<td>Lab 1: Resistors and Basic Resistive Circuits</td>
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<td>Week 2</td>
<td>5/28/2019</td>
<td>Lessons 2.11 – 2.13, Lessons 2.14 – 2.15</td>
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<td>5/30/2019</td>
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<td>6/6/2019</td>
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<td><strong>Linear Circuit 2: AC Analysis</strong></td>
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<td>Week 4</td>
<td>6/11/2019</td>
<td>Lessons 1.1 – 1.5</td>
<td>Lab 4: Second-Order Responses of RLC Networks</td>
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<td>6/13/2019</td>
<td>Lessons 1.6 – 1.8, 2.1 – 2.4</td>
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<td>Week 5</td>
<td>6/18/2019</td>
<td>Lessons 2.5 – 2.9, 2.11</td>
<td>Lab 5: AC Circuit Analysis and Frequency Response of Second-Order Circuits</td>
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<td>6/20/2019</td>
<td>Lessons 2.10, 3.1 – 3.4</td>
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<td>Week 6</td>
<td>6/25/2019</td>
<td>Lessons 3.5 – 3.10; Start Intro to Electronics - Lessons 1.1, 2.1 – 2.5</td>
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<td>6/27/2019</td>
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<td><strong>Intro to Electronics</strong></td>
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<td>Week 7</td>
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<td>Lessons 3.1 – 3.5</td>
<td>Lab 6: Active Filters using Operational Amplifiers</td>
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<td>7/4/2019</td>
<td>Lessons 3.6 – 3.9, 4.1 – 4.3</td>
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<td>Week 8</td>
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<td>7/11/2019</td>
<td>Lessons 5.4 – 5.7</td>
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<td>Week 9</td>
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<td>Lessons 6.1 – 6.6</td>
<td>Lab 7: AC to DC Converter</td>
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<td>7/18/2019</td>
<td>Final exam review</td>
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**Final Exam:** Friday, July 19 2019, 3:10 – 6:00 p.m.