Meeting times:

Lecture: Tuesday 10:35-11:25, Sloan 150
Labs (beginning week of August 27, 2018):
  Section 1: Tu, Wed  3:10-6PM, EME34
  Section 2: Wed, Th  3:10-6PM, EME34
  Section 3: Tu, Th   3:10-6PM, EME34

Instructor: Ben Belzer; Office: EME 401; Phone: 335-4970; Email: belzer@eecs.wsu.edu
Instructor office hours: MWF 11:05AM-12:00PM, or by appointment.
Teaching assistant: Ahmed Aboutaleb; Email: ahmed.aboutaleb@wsu.edu

Course web page: http://www.eecs.wsu.edu/~ee352. Course syllabus, lab assignments, weekly lecture notes, course project assignment, and related informational documents are available here.

Co-requisites: EE311, EE321. Exposure to MATLAB is helpful but not necessary; enough background on MATLAB will be given to complete any assignments requiring it.

Catalog data: Conduct experiments in electrical circuits, measurements, and electronics to relate theoretical concepts with real and non-ideal components.

ABET learning outcomes (ABET criterion 3 outcomes in parentheses):
At the end of this course, students must be able to:
  • Use electronics lab equipment (digital multi-meters, oscilloscopes, signal generators, power supplies, capacitance/inductance meters, and curve tracers) to take circuit and device measurements (1, 6)
  • Work in teams of two or three to accomplish course objectives (5)
  • Experimentally characterize key parameters of operational amplifiers, diodes, MOSFETs, and bipolar junction transistors and compare with relevant theory. (1, 6)
  • Design op-amp, MOSFET, and BJT amplifier and current mirror circuits and verify experimentally that they meet specifications. (1, 2, 6)
  • Experimentally measure and analyze mutual inductance circuits. (1, 6)
  • Experimentally measure and analyze circuits modeled with state-space models. (1, 6)
  • Experimentally measure circuit transfer functions and compare with theory. (1,6)
  • Starting from a course project specification, design, simulate, construct, measure and analyze a system involving multiple sub-circuits, and conduct an in-person demonstration to show that the system meets specifications. (1, 2, 3, 5, 6)
  • Communicate relevant theory, design process, experimental results and analysis through written lab notebook entries and calculations, written lab reports and the interim and final course project reports, as well as through the final project demonstration. (3)

Course texts:
  Required: National 43-648 lab notebook (or equivalent). Available at the Bookie.
  Additional references (not required):

Course Grade:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab notebook:</td>
<td>15%</td>
</tr>
<tr>
<td>Weekly lab reports:</td>
<td>55%</td>
</tr>
<tr>
<td>Interim project report:</td>
<td>10%</td>
</tr>
<tr>
<td>Final project report:</td>
<td>20%</td>
</tr>
</tbody>
</table>

Note: EE352 has no midterm exams or final exam.
Lab policies:

1. Labs will be conducted in EME34. You will have access by swiping your student ID card through the card reader on the door.
2. EME34 is an open lab; you are free to use the lab any time, unless it is in use by another class.
3. No equipment may ever be removed from EME34, except with instructor’s permission.
4. No food or drink is allowed in EME34.
5. Students will work in teams of two. Instructor permission is required for teams larger than two. Team members should be chosen from students in the same section. Although the lab work is done in teams of two, each student must maintain his/her own lab notebook, and each student must turn in a lab report that is an individual effort.
6. Each student will be expected to contribute to each lab assignment. Most assignments include a demonstration of one or more circuits to the instructor or TA. Each student will be expected to answer questions about his/her team’s circuit operation during the demonstrations; lack of familiarity with the circuit will result in point deductions from a student’s lab report.
7. Each student needs an Analog Parts Kit from Digilent, Inc. These are the same parts kits used in EE262. These may be purchased at Dana 15 (the FIZ service center), which is open 10AM-7PM weekdays, and 12-4PM Sat/Sun. They may also be purchased online from Digilent at https://store.digilentinc.com/analog-parts-kit-by-analog-devices-companion-parts-kit-for-the-analog-discovery/.
8. Each student also needs a solderless breadboard (of approximate size 6” x 8”) for constructing and wiring circuits. The EIC-106, MB-106, and other comparable large solderless breadboards are available online from a variety of sources including Amazon, Digilent, and also Digikey (http://www.digikey.com/product-search/en/prototyping-products/solderless-breadboards). You do not need a solderless breadboard if you already have a Digilent Explorer board.
9. MATLAB will be used for mathematical modeling of circuits. WSU has recently acquired a university-wide MATLAB site license. Please go to https://its.wsu.edu/matlab for information on how to access MATLAB for free. Two useful MATLAB tutorial websites are at http://www.math.ucsd.edu/~bdriver/21d-s99/matlab-primer.html http://www.mathworks.com/help/matlab/getting-started-with-matlab.html
10. LTSPICE will be used to simulate circuits. A free download of LTSPICE is available at http://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html. Documentation, including an “LTSPICE Getting Started Guide,” is also available at this URL.

Safety in the Lab:

- Safety is the highest priority whenever you use electrical equipment - whether in the classroom, in the lab, or at home.
- Avoid damage to equipment - you must know how to operate the assigned equipment and work carefully to assure a safe environment.
- Always use the correct instrument for the intended measurement.
- Make certain each instrument is preset to a range above the value of the measurement. If the value is unknown, begin with the largest setting.
- Warning: The amount of electrical current that can damage your body is highly variable from one person to another and from one part of your body to another. Household voltages have killed many people. Even low voltages can be dangerous. Your metallic bracelet or watchstrap inadvertently placed across a laboratory power source could cause arching and welding, which in turn could cause serious bodily injury.
- Use safe methods while working in this EE lab:
  - Never work alone in the lab!
  - Wire circuit toward power source.
  - Use standard connectors provided in lab.
  - Check for proper grounding.
  - Completely check the circuit before energizing the electrical system.
  - Report all defective equipment to the TA or instructor.
- Know the location of key safety equipment in the lab:
  - Electrical circuit breakers
  - Telephone
  - First aid kit
  - Fire equipment
Lab Notebooks and Lab Reports: Guidelines and Grading

1. Pre-labs:
   - Pre-labs are problem sets described in each week’s lab assignment.
   - The lab assignment and the pre-lab questions will be covered during the weekly Tuesday lecture hour.
   - The pre-lab problems must be completed prior to coming to the lab to perform the experiments.
   - The pre-labs enable you to formulate expectations of what your experimental outcomes should be before acquiring the data.
   - Pre-lab problem solutions must be recorded in your lab notebook.
   - The TAs or the instructor will initial the pre-lab work in your notebook.
   - Only properly initialed pre-labs will count toward your lab notebook grade. Pre-labs without initials will not be counted.
   - No experimental demonstrations for a lab will be signed off until your pre-lab has been initialed. These demonstrations are a key component of your weekly lab report grade. This is why it is important to complete your pre-lab before coming to the lab.

2. Lab notebooks:
   - Lab notebooks will be turned in and graded at the end of the semester.
   - The lab notebook should describe all lab procedures and record all data taken.
   - Reading your lab notebook should allow a knowledgeable person to duplicate the results.
   - All writing in the lab notebook should be in ballpoint pen with black or blue ink only.
   - Cross out errors.
   - The TAs or your instructor will initial all pre-labs in the lab notebooks.
   - The pre-labs will count toward the lab notebook grade.

Required Lab Notebook Format:
Exterior Title - EE352 Lab I
Student’s name (immediately below the Exterior Title)
Table of Contents (leave enough room for all 10 labs in the ToC))
Preface - Author, lab partners, two sentence summary of what is contained in the notebook, including the date range (Aug.-Dec. 2018).
Individual Laboratory Experiments – Lab Title, Number & Date
   Introduction: Brief statement of the problem
   Pre-lab problem solutions
   Experimental Plan: include circuit diagrams
   Observations and Data: tabulate data, generate plots when practical, note suspect data

Lab Notebook Guidelines:
   - Provide each section with a clear descriptive heading.
   - Record the entry immediately after performing the work.
   - Writing must be legible.
   - It is strongly recommended (but not required) that you use the pages after the last lab assignment to record data and results associated with your course project. However, the course project need not appear in the ToC.

Lab Notebook Grading:
   - Each lab in the notebook is worth 10 points. The maximum lab notebook grade is 100 points. Each lab in the lab notebook will be graded as follows.
     o 1 point   Lab title, number and date
     o 2 points Prelab signed
     o 1 point   Neatness and legibility
     o 1 point   Statement of problem
     o 2 points Experimental plan (including circuit diagrams)
     o 1 point   Clear heading of each section
     o 2 points Observations and data
     o Minus 1 point if lab is not written in black or blue pen.

   - The following deductions will be applied to the total lab notebook score if the indicated sections are not included in the lab notebook.
3. Lab reports:
   - Lab assignments are one week (two three-hour lab sessions) in duration.
   - One lab report must be submitted by each student for each lab assignment.
   - Even though the data in the lab report will probably be identical for both team members, each lab report must be an individual effort by each student.
   - Lab reports should be submitted to the slotted lock box at the back of EME34 by 5PM Friday of the week after the lab is performed.

Lab Report Grading:
   - Each lab report has a maximum score of 100 points.
   - Lab reports should be prepared with an electronic word processor (e.g., Microsoft Word). Points will be deducted if sections of your report are hand-written. Graphs should be created with either Excel or MATLAB (or similar software) and electronically copied/pasted into your lab report. An important exception is that neatly done hand-drawn figures (e.g., block diagrams, circuit diagrams) are acceptable in your reports.
   - All lab assignments contain a checklist of lab sections and lab demonstrations for each section, with a space for the TA/instructor to sign off on each demonstration.
   - The checklist provides a detailed breakdown of the lab report points available for each section of a lab assignment.
   - For each lab, the lab checklist, with TA/instructor initials, must be appended to your lab report.
   - Each demonstration on the checklist is associated with a section of the lab. No points will be awarded for the associated section of the lab assignment unless ALL demos within the section are initialed.
   - Include calculations and derivations performed in pre-labs as appendices to the report. You may photocopy the pre-labs in your lab notebook for this purpose, but only if they are well organized and clearly written. Otherwise, provide a neat writeup (either handwritten or word processed) of your pre-lab for the report appendix.
   - If the checklist asks for a MATLAB plot or simulation result, you must attach to your lab report the MATLAB code or list of commands that you used to create the plot or run the simulation; without code, you will receive 0 points for the associated lab section. Similarly, if the checklist asks for a PSPICE/LTSPICE plot or simulation result, you must attach to your lab report the PSPICE netlist or the LTSPICE circuit schematic that you used to run your simulation.
   - Late lab reports will be penalized 10% per day for every day late. The lock box will be checked at 5PM Saturday and Sunday. No labs will be accepted later than 6PM on the next Monday after they were due.

Lab Report Guidelines:
   - Your report should contain the results of each experiment in the lab assignment.
   - Ordering of the experimental results should follow the ordering in the lab assignment.
   - Provide each section with a clear descriptive heading.
   - For each experiment, your lab report should provide your principle results and a brief discussion of your results and conclusions.
   - Tabular or numerical results are acceptable, but results should be presented in graphical form when practical.
   - Graphs: Title the graph and label the axes with appropriate parameters and units. Connect raw data points with a smooth curve. Multiple curves on the same graph should be either separately labeled or explained with a legend, and the different curves should use different symbols/colors or line-styles for the points/curves.
   - Reports should be legible, concise, and well-written.
   - Answer all the specific questions from the lab assignment and lab checklist.
   - Include the circuit diagrams of circuits tested in lab.
   - Present results in a quantitative manner. Include specific values with your explanations.
   - The report should stand-alone for each lab assignment.
   - The report should be written for a reader knowledgeable in the field of electrical engineering, but not necessarily familiar with the particular lab experiment performed.
Course Project:

- The course project involves design of a large circuit consisting of several sub-circuits.
- The project circuit will accomplish a non-trivial task, such as, e.g., controlling a motor, controlling temperature, transmitting and/or receiving a radio frequency signal, etc.
- The course project specification document will be provided during the 8th week, along with grading guidelines and project technical details.
- All students will work on the same type of circuit with the same specifications, but there is freedom in exactly how the circuit is designed to meet the specifications.
- An interim project report, prepared with a word processor, will be due at the end of the 11th week of classes; the interim project report will be graded by the instructor and returned to students at the end of the 12th week of classes, so that feedback can be provided on the suitability of the design and of the report. The exact requirements for the interim project report will be described in the project specifications document provided in the 8th week.
- Each team will be required to demonstrate their course project to the instructor or TA during the 15th week of classes (dead week).
- The final project report, prepared with a word processor, will be due during finals week.

EE352 Lab Schedule for Fall 2018

<table>
<thead>
<tr>
<th>Week</th>
<th>Lab Number</th>
<th>Description</th>
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<tbody>
<tr>
<td>Aug 20</td>
<td>No lab</td>
<td></td>
</tr>
<tr>
<td>Aug 27</td>
<td>1</td>
<td>Equipment familiarization and first order systems</td>
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<tr>
<td>Sept 3</td>
<td>2</td>
<td>State variable circuit modeling and mutual inductance</td>
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<tr>
<td>Sept 10</td>
<td>3</td>
<td>Operational amplifier applications</td>
</tr>
<tr>
<td>Sept 17</td>
<td>4</td>
<td>Operational amplifiers: non-ideal behavior</td>
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<tr>
<td>Sept 24</td>
<td>5</td>
<td>Diodes</td>
</tr>
<tr>
<td>Oct 1</td>
<td>6</td>
<td>Transfer functions</td>
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<tr>
<td>Oct 8</td>
<td>7</td>
<td>MOSFET characterization</td>
</tr>
<tr>
<td>Oct 15</td>
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<td>Design Project</td>
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<tr>
<td>Oct 22</td>
<td>8</td>
<td>MOSFET amplifier circuits</td>
</tr>
<tr>
<td>Oct 29</td>
<td>9</td>
<td>BJT characterization; <strong>Interim project report due 5PM Friday Nov 2</strong></td>
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<tr>
<td>Nov 5</td>
<td>10</td>
<td>BJT amplifier circuits</td>
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<tr>
<td>Nov 12</td>
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<td>Design project</td>
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<tr>
<td>Nov 19</td>
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<td>Thanksgiving break</td>
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<tr>
<td>Nov 26</td>
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<td>Design project</td>
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<tr>
<td>Dec 3</td>
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<td>Project demonstrations; <strong>Lab notebooks due 5PM Friday Dec 7</strong></td>
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<tr>
<td>Dec 10</td>
<td></td>
<td>Design project final report due 5PM Thu Dec 13</td>
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**Academic Integrity:** The EECS academic integrity policy is at [http://www.eecs.wsu.edu/~schneidj/Misc/academic-integrity.html](http://www.eecs.wsu.edu/~schneidj/Misc/academic-integrity.html). It is your responsibility to read and know the policy. Under the policy, any student caught cheating in any EECS class is subject to de-certification, meaning that he/she will not be permitted to continue in any EECS degree program. For EE352, cheating is defined as follows: (1) Lab and Project Reports: Students may discuss the labs and course project among themselves, but the analysis, write-up, and conclusions of each lab or project report must be done by each individual student. Copying text from another source (e.g., a textbook, the internet, another students report) into your lab or project report is cheating. (2) Lab notebooks: Students may discuss the labs among themselves, but each student must keep his or her own lab notebook according to the instructions listed in this syllabus. It is expected that lab partners will have the same or very similar experimental data in their lab notebooks, but copying experimental data from sources other than direct measurements in the lab taken by either you or your lab partner (e.g., a textbook, another student's notebook, the internet, or simply making data up) is cheating.

**Special Needs Students:** Reasonable accommodations are available for students who have a documented disability.
If you have a disability and need accommodations to fully participate in this class, please either visit or call the Access Center (Washington Building, Room 217; 509-335-3417; http://accesscenter.wsu.edu) to schedule an appointment with an Access Advisor. All accommodations MUST be approved through the Access Center.

**Campus Safety:** Students should review the campus safety plan at [http://safetyplan.wsu.edu](http://safetyplan.wsu.edu). Students should visit the Office of Emergency Management website at [http://oem.wsu.edu](http://oem.wsu.edu) for a comprehensive listing of university policies, procedures, statistics, and information related to campus safety, emergency management, and the health and welfare of the campus community.