**ECE 331**              **Electronics Principles I**              **Spring 2020 (Lear)**

ECE 331 is the first of a two-semester sequence covering operating and design principles of semiconductor diodes and transistors and circuits incorporating them. The primary devices studied are diodes, bipolar junction transistors (BJTs), and metal-oxide-semiconductor field-effect transistors (MOSFETs). These devices have non-linear current-voltage characteristics and expand on passive linear bilateral circuit elements covered in prerequisite courses by each having multiple operating regions and for transistors having three terminals and providing signal amplification, switching, and impedance transformation capabilities.

**Description from CSU course catalog:**  Discrete component semiconductor devices, characteristics and applications. Rectifier circuits, single-stage and multi-stage amplifiers.

**Course Learning Objectives (from CIM):**
Students successfully completing the course will be able to...
1. Qualitatively describe the basic semiconductor physics of these devices.
2. Name the operating regimes for each device and determine the appropriate algebraic formula for the current-voltage terminal characteristics in that regime.
3. Plot the combined current-voltage characteristics of the regimes for each and use similar graphs to determine critical parameters for the devices.
4. Reproduce equivalent circuits for each device.
5. Apply the algebraic formulas, equivalent circuit models and graphical representations of current voltage characteristics to solve for the terminal currents and voltages of the devices in simple circuits.
6. Describe the most important deviations from the ideal models observed in actual devices.
7. Describe the difference between large signal, small signal and bias point analysis and the associated assumptions.
8. Name the three basic single-transistor amplifier configurations and choose the best one for various applications.
9. Design circuits for biasing a transistor in each of the three basic amplifier configurations.
10. Describe how to use transistors in switching applications and as current sources.
11. Design rectifier circuits including selecting capacitor values to meet ripple specifications.
12. Draw basic current mirror circuits and describe their purpose and function.
13. Build diode and single-transistor circuits and measure their operation using laboratory bench instruments.
14. Analyze simple circuits containing diodes or transistors using analytical methods.
15. Analyze circuits containing diodes and transistors using electronic design software.
16. Write laboratory reports that effectively communicate the student's design,analysis and characterization of simple diode or transistor circuits

**Prerequisites:**
- PH 142 (calculus based electricity and magnetism, circuits, ...; min. grade of C)
- ECE 202 Circuit Theory Applications (minimum grade of C)
- MATH 340 Differential Equations (minimum grade of C)
- Concurrent registration in
    - ECE 311 Linear Systems Analysis I
    - ECE 341 Electromagnetic Fields I or ECE 451 Digital System Design

**Course Credits:**  4 (3 credit hour lecture, 1 credit hour lab)
**Class Lecture Sessions:**  4:00 – 5:15 pm Monday and Wednesday
**Classroom Location:**  Offered online in Microsoft Teams for Fall 2020 due to COVID-19 capacity restrictions
**Instructor:**  Kevin Lear
**Office:**  Working remotely during Fall 2020 semester; available via Microsoft Teams
**Email:**  KLLear <at sign> engr.ColoState.edu
When emailing me regarding class, please include "ECE331" as part of the subject line.
I filter emails and may not see yours if you do not include "ECE331" in the subject line.
**Phone:**  Video and audio calls can be placed via Microsoft Teams during office hours.

**Office Hours:**  Tentatively
    Tuesdays 10:30 to 11:30 AM
    Wednesdays 2:30 to 3:30 PM
    Fridays 12:30 to 1:30 PM (at instructor's option; please confirm ahead of time)
These hours may be adjusted based on student feedback.  If students have scheduled course conflicts with these times, they may request in advance an appointment at other times.  Please plan ahead on homework to use available office hours for myself and GTAs.
**Graduate Teaching Assistants:** The GTAs for this course are:
- Ming-Hao Cheng  MingHao.Cheng <at sign> colostate.edu
- Priscilla Vazquez  pvazquez <at sign> engr.colostate.edu

**Textbook:**  *Fundamentals of Microelectronics*, 2nd ed. by Behzad Razavi. Wiley, 2014.
This is a required text from which readings and homework will be assigned.
**Webpage:**  This course will use CSU's Canvas, and the ECE 204 course webpage in Canvas is only accessible to registered students. To reach Canvas, direct your browser to http://canvas.colostate.edu and log in using your eID.  If you are unable to log into Canvas, contact the ACNS helpdesk for support.  Be aware that the publicly accessible webpage for this class linked from https://www.engr.colostate.edu/ece/current_students/courses.php may contain out-of-date information from a prior term.

Lecture notes, assignments, solutions, grades, and general announcements will be posted on the Canvas webpage.  It is your responsibility to regularly check (at least every 3 days) Canvas for new assignments and announcements.  Please never send me messages via Canvas as I rarely read messages there.  You may use the Canvas email feature if it sends the email to my engr.colostate.edu address listed above.

**Course Topics**
The course topics and time allocated for them are:
- Diodes　　　　　　　　　　　　　　　　　　　　　　3 weeks
- BJTs　　　　　　　　　　　　　　　　　　　　　　　2 weeks
- MOSFETs　　　　　　　　　　　　　　　　　　　　3 weeks
- Amplifiers　　　　　　　　　　　　　　　　　　　　3 weeks
- Bias circuits　　　　　　　　　　　　　　　　　　　1 week
- Knowledge integration activities　　　　　　　　　1.5 weeks
- Reviews, exams, and other topics　　　　　　　　3 weeks

**Grading:**  Your overall score will be based on the following weighting:

| | |
|---|---|
| Knowledge Integration | 8% |
| Quizzes & Tutorials used to assess reading and participation | 5% |
| Laboratory Reports and Assignments | 22% |
| Homework | 15% |
| Midterm Exam 1 (diodes and BJTs; LSM 1 & 2) | 15% |
| Midterm Exam 2 (MOSFETs and amplifiers + prior topics; LSM 3 & 4) | 15% |
| Final Exam  (comprehensive including KIs) | 20% |
| Math Foundations | 2% extra credit |

_RED_ (Thanks to A. Pezeshki for some of the following descriptions.)
ECE 331 is integrated with ECE 311 (and ECE 341 for EEs) as part of the ECE Department's RED program (https://www.engr.colostate.edu/ece/red/red.php). Knowledge Integration (KIs) activities will occur during class time on September 23, November 4, and December 9, the last scheduled day of class prior to the final exam. KI grading has several components, including prework, question/discussion contributions, video presentations, and social responsibility case studies. See the Canvas site for KIs for details of the associated assignments as well as how to participate in the Math Foundations classes on Wednesdays beginning September 2. 1% of extra credit will be earned by any student who attends at least seven math foundation lectures. Another 1% of extra credit will be earned by any student who receives an average grade of 85% or more on math foundation problem sets.

Learning Studio Modules (LSMs) are collections of related topics that integrate across ECE 311, 331, and 341. For 331, LSM1 relates to semiconductor physics, LSM2 relates to diodes, LSM3 relates to large-signal models for transistors, LSM4 relates to small-signal models for transistors including amplifier circuits, and LSM5 relates to operational amplifier circuits. In addition to overall course grading, students must also demonstrate competency in each individual LSM by achieving a satisfactory score on exam questions associated with each LSM. (Questions on exams will be labeled with the corresponding LSM.) Students who do not demonstrate competency on an LSM via the exams will be given the opportunity to gain competency through related remedial work. **If students do not demonstrate competency in all five LSMs either through exams or remedial work, they will receive an F grade regardless of their overall course score.**

*Exams and Tests Including Dates*
The midterm exams will be held during classtime for 70 minutes and are tentatively scheduled for October 12 and November 18. Additionally, I plan on having a Preliminary Readiness Evaluation for Motivating Improved Exams (PREMIE) test in class approximately two weeks prior to these dates, i.e., September 28 and November 2 (two days early due to KI #2 class exercise). See the next paragraph for details on the PREMIE tests. If you have official university conflicts on any of the four test and exam days, you must notify the instructor at least four weeks in advance of the date to make other arrangements. Exams and PREMIE tests are closed book, but you are allowed to bring one sheet of notes (front and back) to the first PREMIE test and midterm exam, two sheets of notes to the second PREMIE test and midterm exam, and three sheets of notes to the final exam, which is scheduled for Monday, December 12 at 4:10 PM.

The purpose of the PREMIE tests is to increase student preparation for the midterm exams, hopefully leading to higher midterm exam scores. PREMIE tests will cover the most basic fundamentals of material on the subsequent midterm exams. They will last 25 minutes and contain approximately 5 multiple-choice questions on essential topics. For example, the first PREMIE test will likely cover topics such as plots of diode and BJT I-V characteristics, load-line analysis, and diode rectifier circuits. Your score on the PREMIE tests will account for 25 to 33% of your overall score for the midterm exams. However, if you perform poorly on a PREMIE test, you will be allowed to replace your entire score on the PREMIE test with your score for a subset of questions on the subsequent midterm exam that cover the same fundamental material. To take advantage of this PREMIE test score replacement, you will be required to fill out a replacement form, meet with the instructor or a graduate teaching assistant between the time of the PREMIE test and midterm exam and actively discuss the mistakes you made on the PREMIE test, and obtain their signature on the replacement form. If you perform well on the PREMIE test, you can skip the fundamental material questions on the corresponding midterm exam and substitute your PREMIE test score for those questions. Thus, the PREMIE test guarantees a minimum score on a portion of the midterm exam, and the midterm exam can function as a safety net if you score poorly on the PREMIE test.

*Homework and Tutorial Assignments*
Tutorial and homework assignments must be submitted online and we hope to use computerized grading for some of them which may require you entering your answers on a Google form as well as submitting a PDF file showing your work. Ambiguous or unclear writing will be counted wrong and type written assignments are preferred when feasible. Scan assignments in black and white when possible and check your submitted file to make sure it is complete and readable.

Tutorial assignments are intended to be done after reading the textbook, but before necessarily covering the material in class to better prepare you for class discussions. Pop quizzes during class may also be used to assess whether or not students have completed the assigned reading from the textbook. Homework assignments should be done after the Tutorials and after covering the material in class including addressing questions about the homework you ask in class. See Canvas for due dates of tutorial and homework

assignments, but I hope to make homework assignments due either Wednesday or Thursday of each week unless there is a Wednesday midterm exam. Late homework assignments will be penalized 2% for each hour or fraction of an hour they are late and will receive no credit 50 hours after they are due.

*Grade Scale*
Grades will be assigned according to the following scale:

|  |  |  |
|---|---|---|
| | > 90%  A | 87-90%  A- |
| 84-87%  B+ | 80-84%  B | 77-80%  B- |
| 74-77%  C+ | 70-74%  C | |
| | 60-70%  D | < 60%  F |

The grading scale may be adjusted to award higher grades at the instructor's option. Overall scores are rounded to two decimal digits. For example, a 76.99% results in a C+, not a B-. Final grades are not negotiable, and are not based on what you hoped to receive or what you need for specific academic or scholarship requirements; they are based strictly on your overall score. Any request for a score change on a prior assignment, quiz, or exam due to a grading error or any other reason must be emailed to the instructor no later than 14 days after the score and solution for that item are available to you. In the absence of a scoring or grade calculation mistake, asking for a higher grade than you earned only serves to irritate the instructor.

**Academic Integrity Policy:**  This course will adhere to the [Academic Integrity Policy of the Colorado State University General Catalog](#) and the [Student Conduct Code](#). Failure to abide by this policy and code may result in an academic penalty up to and including failing this course. You may discuss homework with others but are expected to do your own calculations and are not allowed to duplicate another student's work. You may not assist another student, receive assistance, access any unauthorized materials, or otherwise cheat during quizzes, tests, or exams. You are expected to know and review definitions of the following terms in the Student Conduct Code: cheating, plagiarism, unauthorized possession or disposition of academic materials, falsification, and facilitation of any act of academic misconduct. If you are not certain that you understand the meaning of all of these terms, look them up at the links given in this paragraph.

You are expected to be civil and respectful and not discriminate, abuse, or harass any other person involved in ECE 331 class. You are expected to not disrupt class or lab sections and not damage CSU property or remove it from labs without authorization.