

ECE 331**Electronics Principles I****Fall 2024 (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, by 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)
- For students majoring in electrical engineering, 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: Stadium 1204

Instructor: Kevin Lear

Office: Scott Bioengineering Room 346

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: See information on Canvas

Teaching Assistants: See information on Canvas

Textbook: *Fundamentals of Microelectronics*, 3rd ed. (although 2nd ed. is okay) by Behzad Razavi. Wiley, 2021. This is a required text from which readings and homework will be assigned.

Webpage: This course will use CSU’s [Canvas](#), and the ECE331 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 or linked 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 and avoid using the Canvas email feature as it does not incorporate prior email threads or specialized subject lines.

Course Topics

The course topics and time allocated for them are:

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|------------------------------------|-----------|
| • 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, or in-class response 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; *LSM 1 to 5)	20%
*Math Foundations	2% extra credit

* These are elements of the ECE department's RED program across 311, 331, and 341.

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 in late September, early November, and early December. See Canvas for the exact dates. KI grading may include several components, including prework, question/discussion contributions, video presentations, social responsibility case studies, and attendance. See the Canvas site for KIs for details of the associated assignments as well as how to participate in the Math Foundations classes. Extra credit of 1% 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. Since ECE331 is no longer a required course for computer engineering students, they may have different KI activities than electrical engineering students. See the ECE311 and KI course information for more details.

Learning Studio Modules (LSMs) are collections of related topics that integrate across ECE 311, 331, and 341. For 331, LSM1 relates to diodes, LSM2 relates to semiconductor physics, LSM3 relates to large-signal models for transistors, LSM4 relates to small-signal models for transistors including amplifier circuits, and LSM5 relates to non-ideal operational amplifier circuits.

Exams and Tests Including Dates

The midterm exams will be held during class time for 70 minutes and are tentatively scheduled for October 7 and November 20. Additionally, Preliminary Readiness Evaluation for Motivating Improved Exams (PREMIE) tests will be given in class approximately two weeks prior to these dates, i.e., September 23 and November 4. 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 Friday, December 13 at 7:30 AM.

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 teaching assistant between the time of the PREMIE test and midterm exam to 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 can guarantee a minimum score on a portion of the midterm exam if you do not elect to redo it on the midterm, 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 both via a Google form as well as a PDF file upload of your work on Canvas. The Google form submission enables computerized grading that provides feedback on your answers up to one week before the due date, giving you a chance to correct your work, and reduces grading burdens for the TAs. Ambiguous or unclear writing on PDF submissions will be counted wrong and typewritten assignments are preferred when feasible. Scan handwritten portions of assignments in black and white when possible to enhance contrast and reduce file size, and check your submitted file to make sure it is complete and readable. Partial credit grading of homework will only be done to the extent that TA time allows. Grading may be done based on cursory review or existence checking and may incorporate random problem selection where not all parts of assignments are graded. Learn to carefully check you own work before submission, a process that will benefit you later as an engineer.

Tutorial assignments, if used, 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. A classroom response system (CRS) may be used in class to help determine participation and promote student engagement. 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 on Friday of each week unless there is a Wednesday midterm exam.

Grade Scale

Grades will be assigned according to the following scale:

	> 90%	A	85-90%	A-	
80-85%	B+	75-80%	B	70-75%	B-
65-70%	C+	55-65%	C		
		40-55%	D	< 40%	F

Note for 2022 and later: This grading scale is substantially more lenient for grades below an A than the grading scale used for this course by this instructor in any prior year due to administrative directives aimed at decreasing DFW rates.

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 will be perceived as begging for a personal favor that is inappropriate and unfair to other students.

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.

Use of Chegg or other online corporate cheating websites or any not explicitly authorized source of homework solutions, including solutions from prior years, is strictly prohibited for this class. You cannot use online sources of detailed solutions other than those published or linked in Canvas for this course, either for seeking problem solutions or for posting of class materials. Doing so are clear violations of CSU academic integrity policies including those on unauthorized possession or disposition of materials.

You won't have access to Chegg on exams, so you should learn how to solve problems without it when doing homework. Part of learning how to problem solve is translating problem statements into an approach. Trying approaches that don't end up solving a problem provides helpful reinforcement of which approaches work in which situations. Using pre-existing detailed solutions to problems robs you of these experiences as well as violating class and CSU policies. Save yourself some money, improve your academic performance, and avoid disciplinary actions by canceling your Chegg or similar account now.

Classroom Behavior: You are expected to be civil and respectful to others in class and not discriminate against, 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.

CSU PRINCIPLES OF COMMUNITY

- **Inclusion:** We create and nurture inclusive environments and welcome, value and affirm all members of our community, including their various identities, skills, ideas, talents and contributions.
- **Integrity:** We are accountable for our actions and will act ethically and honestly in all our interactions.
- **Respect:** We honor the inherent dignity of all people within an environment where we are committed to freedom of expression, critical discourse, and the advancement of knowledge.
- **Service:** We are responsible, individually and collectively, to give of our time, talents, and resources to promote the well-being of each other and the development of our local, regional, and global communities.
- **Social Justice:** We have the right to be treated and the responsibility to treat others with fairness and equity, the duty to challenge prejudice, and to uphold the laws, policies and procedures that promote justice in all respects.