Solar Cells, LEDs and Windows

CHEN 4480 (for undergraduates)
CHEN 5480 (for graduate students)

Fall Semester 2025 Course Syllabus

Topics to be Covered
This course explains how silicon and cutting-edge metal halide perovskite solar cells are designed, fabricated and characterized. Topics will include an introduction to electronic materials, optics, band diagrams, wafer fabrication, most thin film deposition techniques, module design and economics. Other optical devices that can help the world rapidly reduce its carbon emissions, such as light-emitting diodes and energy saving windows with dynamic tinting, will also be covered.

Instructor
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Teaching Assistant
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Office hours
TBD, but ideally on Wednesday afternoon with problem sets due on Thursdays and the two midterms being on Thursdays.

Class Time and Place
TTh 11:30 AM-12:45 PM
A104 in JSCBB

Course website
The course website is on Canvas.

Prerequisites
Prof. McGehee will have lectures, primarily for the undergraduates, on topics such as statistical mechanics, calculating how distribution of charged particles determines the electric field and electronic potential, and optics. This refresher on physics will help you succeed in the course. The course has been taught for 16 years and students from nearly 15 departments, including the business school, have done well. Don't get intimidated by some of the semiconductor device physics early in the course. Please talk to the professor if you want to learn about solar cells but aren't sure if you can do well in the course.

Reading Material
Please read chapters 3 and 4 from Ben Streetman's text over the first few weeks. They are all posted online and will be covered over 5-6 lectures. There is no textbook for the class, but notes, review articles and book chapters will be handed out in class or posted on the website. The website PVEducation.org provides a free online textbook for approximately half of the course. Please attend all classes since we will not be using a textbook.

Classroom Capture
The lectures will be recorded using CU's Classroom Capture. Please watch any lectures you are not able to attend in person.

Please let us know if there is a problem viewing the videos.

Homework
There will be approximately 5 problem sets. We prefer that hard copies of assignments be handed in during class but understand if emailing the assignment is necessary. The maximum score a student can receive will be reduced by 10% for every day the assignment is late. Thus, if an assignment is 1 day late, the highest score a student can receive is 90%, 2 days late 80%, etc.

Tests
There will be one 75-minute midterm and a final exam.

Grading
Grades will be based on homework assignments (10 %), a midterms (30 %), a final exam (40 %) and the group presentation (20 %). There will be different grading curves for the undergraduate and graduate-level version of this course.

Tentative Schedule

Date	Lecture Name
21-Aug	Introduction
26-Aug	Semiconductors
28-Aug	Quasi-Fermi Levels
2-Sep	pn Junctions and Heterojunctions
4-Sep	Measuring Efficiency, Series Resistance and Shunt Resistance
9-Sep	Recombination
11-Sep	Estimating the Current Due to Bulk and Surface Recombination
16-Sep	Light trapping and multilayer stacks
18-Sep	Putting it All Together: Design of Crystalline Silicon Solar Cells
23-Sep	Finish Si cells
25-Sep	Review
30-Sep	Review
2-Oct	**Midterm**
7-Oct	Silicon Solar Cell Manufacturing
9-Oct	Group Project Day
14-Oct	Thin Films PV: CdTe Solar Cells
16-Oct	Perovskite Solar Cells
21-Oct	Building Silicon and Thin Film Panels That Last for > 25 Years

23-Oct	Modules; Review
28-Oct	The future of the solar cell industry; the electricity grid and agriphotovoltaics
30-Oct	Light emitting diodes, organic semiconductors and displays
4-Nov	Energy Efficient Windows with Dynamic Tinting
6-Nov	Energy Efficient Windows with Dynamic Tinting
11-Nov	Field trip to Tynt Technologies
13-Nov	Student projects
18-Nov	Student projects
20-Nov	Student projects
2-Dec	Exam preparation
4-Dec	Exam preparation

Syllabus Statements

Classroom Behavior

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation, or political philosophy.

For more information, see the classroom behavior policy, the Student Code of Conduct, and the Office of Institutional Equity and Compliance.

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation

Disability Services determines accommodations based on documented disabilities in the academic environment. If you qualify for accommodations because of a disability, submit your accommodation letter from Disability Services to your faculty member in a timely manner so your needs can be addressed. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance.

If you have a temporary medical condition or required medical isolation for which you require accommodation, please let the instructor know. Also see Temporary Medical Conditions on the Disability Services website.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty.
All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: honor@colorado.edu, 303-492-5550. Students found responsible for violating the Honor Code will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit Honor Code for more information on the academic integrity policy.
Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation
CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. These behaviors harm individuals and our community. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who believe they have been subjected to misconduct can contact OIEC at 303-492-2127 or email cureport@colorado.edu. Information about university policies, reporting options, and support resources can be found on the OIEC website.
Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive an outreach from OIEC about their options for addressing a concern and the support resources available. To learn more about reporting and support resources for a variety of issues, visit Don’t Ignore It.

Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, you should feel comfortable

letting the instructor know if there are any conflict that need to be addressed. Adjustments to the course schedule can be made.
See the campus policy regarding religious observances for full details.