

Semiconductor Device Physics

EE5311, Fall 2020

University of Texas at El Paso

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Office Hours: M and W: 10:30 - 12:00

Content Delivery:

The course is listed as hybrid however all content will be delivered online through synchronous lectures and other online materials. Content will be provided in modules on a chapter-by-chapter basis and will follow a weekly routine.

Depending on conditions, we will reserve the possibility to meet in low density at a later point in time. Initially and most likely for the rest of the semester, there will be no face-to-face meetings.

Prerequisites:

EE 3329 Fundamentals of Semiconductor Devices

Content Description:

This course is composed of two parts: (1) advanced semiconductor fundamentals and (2) analysis of devices. The first part is designed to give you a good background of semiconductor physics. In the second part, we will use the physics from the first part to study modern semiconductor devices.

(1) Semiconductor fundamental topics that will be covered include: Crystal structure, Basic quantum mechanics, Energy band theory, Equilibrium carrier statistics, Recombination-generation processes and, Carrier transport.

(2) The second part of the course will apply semiconductor physics to analyze devices.

Required Textbook:

Advanced Semiconductor Fundamentals 2nd Ed., Pierret, 2003, Prentice Hall

Learning Objectives:

After completion of this course, students should be able to:

1. **Understand:** Understand advanced semiconductor physics such as quantum mechanics, energy band theory, equilibrium carrier statistics, recombination-generation, and carrier transport.
2. **Analyze and Model:** Apply advanced semiconductor physics to analyze and model the electronic behavior of devices including; resistors, capacitors, diodes, field-effect transistors, and bipolar junction transistor.

Topics Covered in Modules:

- Module 1: Classical Mechanics and Quantum Mechanics
- Module 2: Energy Band Theory
- Module 3: Equilibrium Carrier Statistics
- Module 4: Generation-Recombination
- Module 5: Carrier Transport

Online Communications, Activities, Time Commitments, and Resources:

Emphasis is placed on group discussion, group work, individual work, and lectures to clarify points. Reading and homework will be assigned. Knowledge and skill development obtained by working on assignments will be assessed through exercises and exams. It is through reading, working on assignments and class discussions that most learning will occur. The instructor's role will be to provide content, show how to calculate problems, guide you by discussing relevant topics and assigning problems that will require you to go through the mental steps necessary to obtain knowledge and learn problem-solving skills. The instructor's role will also be to assess your progress and give you feedback.

- **Instructor-to-Student Interactions:**

- **Online Lectures:** Lectures will be given via Blackboard Collaborate at set weekly times. The lectures will be recorded so students can review content.
 - Lectures will discuss theory and present calculation examples
 - Lectures will also invite discussion
- **Online Office Hours:** Sessions via Blackboard Collaborate will be created for open and private discussions at set weekly times.
- **Announcements:** Course announcements will be given on a weekly basis.
- **Email:** Students can send email with questions to the instructor. The instructor will reply with 24 hours.
- **Feedback:** Instructor will provide feedback and suggestions on work via Blackboard
- **Introductory Discussion Board Post:** A post will be created to give a guideline of expectations for required student posts.

- **Student-to-Student Interactions:**
 - **Group Work:** Groups with 3 students will be created. The groups will be assigned exercises. A video explaining how to complete and submit the exercises will be made available on Blackboard.
 - **Online Café:** An open discussion board will be created on Blackboard for students to post and request help from each other. Students can start and reply to discussion threads.
 - **Netiquette:** See section below for Netiquette guidelines for postings.

- **Student-to-Resource Interactions:**
 - **Textbook:** Students are required to obtain and read assigned sections of the textbook before each online lecture.
 - **Calculators:** Students will need a calculator to complete the calculation assignments.

- **Computer and Software:** Students will need a computer and software intended for numerical and symbolic engineering calculations. Licenses for Matlab and MathCAD are available to engineering students.
- **Content Modules:**
 - **Handouts:** Electronic copies of the lecture presentations will be provided
 - **Recorded Lectures:** Lectures will be recorded and available to students in Blackboard.
- **Content Assignments and Assessments**
 - **Calculation Exercises:** Calculation exercises will be assigned to learn how to solve typical problems. The exercises will be assigned through Blackboard. The due date for each exercise will be announced. Students are required to work in groups on calculation exercises.
 - **Exams:** Two exams will be given via Blackboard. The exams will involve calculation of problems with embedded conceptual constraints. The exams will typically be due within a specified length of time. Only 2 attempts will be given for each question. Problem parameters will be randomized for each attempt. Exam 1 (midterm) will be given after the 2nd module is completed and will cover modules 1 and 2. Exam 2 (final) will be an analysis report of a device selected by the student and approved by the instructor. The report format will be similar to the exercises. However, this will be individual work not group work.
 - **Module Discussion Boards:** Class discussion boards will be created for each module.
 - **New Threads:** Each student is requested to start at least 1 new 150 word posting on a concept explained

in the module reading assignments. The idea is to get a discussion started.

- **Replies:** Each student is requested to reply to at least 1 thread with 100 word peer postings for each discussion board. The idea is to keep a discussion going.

Discussion Board Guidelines:

An introduction (icebreaker) forum will be provided to allow everyone to get to know each other. Suggested topics are your background and goals and questions about the course. One important item is netiquette for posts.

Evaluation: The discussion forums will carry to 2 points of credit each up to 10 points total for participation. In order to earn credit for each discussion forum, the minimum requirements specified in the summary below should be met.

Netiquette: Appropriate Netiquette must be maintained in all posts. Postings that violate UTEP policy will be investigated and appropriate actions will be taken. For more information on Netiquette refer to online information contained in the following link: [Netiquette guide for online courses](#)

Evaluation:

	Value
Problems	40%
Participation	10%
Exam I	25%
Exam II Final	25%
Total	100%

Grading and Policies:

A: 90%-100%

B: 80%-<90%

C: 70%-<80%

D: 60%-<70%

F: 0-<60%

Non-Compliance Policy:

Late Work: Late course work will not be accepted.

Make-up Work: No make-up work will be given.

Posting Netiquette: Postings that violate UTEP policy will be investigated and appropriate actions will be taken.

Attendance: Attendance in online activities is mandatory to receive course credit. Excessive nonattendance will result in loss of credit.

Participation: Participation in assignments and discussions is mandatory to receive credit. Lack of participation will result in loss of credit.

Syllabus Changes: Some of the content in the syllabus is subject to change for improvements or other factors. Any changes will be communicated.

Academic Dishonesty:

Incidents of academic dishonesty will be referred to the Director of Electrical Engineering and the Dean of Students. [Link to Dean of Students.](#)

The descriptions and definitions of academic dishonesty can be found at: [Link to Academic Dishonesty Descriptions and Definitions](#) Look under Student Affairs and then Chapter one, section 1.3.1.

Classroom Accommodations:

If you have a disability and need classroom accommodations, please contact The Center for Accommodations and Support Services (CASS) at 747-5148, or by email to [Link to CASS email](#), or visit their office located in UTEP Union East, Room 106. For additional information, please visit the CASS website at [Link to CASS Website](#).

Summary of Activities and Expected Time Commitments:

Activities	Percent of Grade	Time per Assignment (Hours)	Number of Assignments	Time for all Assignments (Hours)	Due Dates	Attempts Allowed and Post Length	Problem and Parameter Randomization
Textbook Reading Assignments	0	4.0	5	20.0	2 days before start of new module.		
Handout Reading Assignments	0	0.5	5	2.5	1 day before start of new module.		
Online Lectures	0	1.3	30	40.0	Synchronous		
Recorded Lectures	0	1.3	6	8.0	None		
Open Online Café	0	1.0	15	15.0	None	Unlimited. No Deleting.	
Module Discussion Forums	10	2.0	5	10.0	New Thread: 2 days before start of new module. Replies: 1 day before start of new module.	Unlimited. No Deleting. New Thread: 150 words Replies: 100 words	
Calculation Exercises	40	3.0	18	54.0	Will be announced	1	No
Exam I (Midterm)	25	2.0	1	2.0	Will be announced	2	Yes
Exam II (Final)	25	3.0	1	3.0	Will be announced	1	Yes
Total Course Commitment				154.5			
Average Weekly Commitment				10.3			

UTEP ECE DEPARTMENT

SYLLABUS ADDENDUM

Course models

Most ECE courses will follow either **fully-online** or **hybrid** models. Hybrid models will provide a virtual off-campus component and an in-person on-campus component. To follow social distancing guidelines on campus, faculty will arrange staggered attendance schedules. Laboratory classes will be offered online and/or in-person, in small groups and in spaces adequate to health and safety guidelines. For additional details, read the syllabus and consult your professor.

The ECE Department recognizes that students with health conditions or international students facing travel restrictions may encounter difficult situations. Virtual classes may be recorded to offer needed study flexibility and to allow students to review course material if it's helpful.

Required COVID-19 Training

Before the semester starts, the ECE Department requires all its students to complete a training module, which includes a video developed in large part by students and hosted by the President of the Student Government Association. Follow the link to this module:

[Link to COVID-19 Training](#)

Before you come to campus

Before coming to campus all ECE students should conduct a **daily self-screening** to ensure that they are symptom-free before coming to campus. The screening includes taking your temperature and assessing for the following symptoms:

- Fever or chills
- Cough
- Shortness of breath or difficulty breathing
- Fatigue
- Muscle or body aches
- Headache
- New loss of taste or smell
- Sore throat
- Congestion or runny nose
- Nausea or vomiting
- Diarrhea



Source: [Link to Image Source](#)

If you have any of these symptoms, you must **stay at home**, seek medical attention, and report to your professor. If you show any of the following signs, **seek emergency medical care immediately:**

- Trouble breathing
- Persistent pain or pressure in the chest
- New confusion
- Inability to wake or stay awake
- Bluish lips or face

In addition, everyone **MUST** complete a COVID-19 screening before coming to campus. The link for reporting is

[Link to Screening Website](#)

This screening includes three required questions:

- In the last 5 days have you (or someone you live with) experienced any one of the COVID-19 symptoms above?
- If you have been tested for COVID-19 in the past 2 weeks, was the result positive?
- In the last 2 weeks, have you spent 15 minutes or more within 6 feet of anybody that you know has tested positive for COVID-19?

Before coming to campus, wash your hands, and pack a hand sanitizer bottle and a clean face mask.



Prevent Getting Sick from COVID-19

The best way to prevent illness is to avoid being exposed to this virus.



Masks

Wear a mask to help protect others in case you're infected but don't have symptoms.



Social Distancing

Limiting face-to-face contact with others is the best way to reduce the spread of COVID-19.

Source: [Link to Image Source](#)

While on campus

UTEP is now requiring that *everyone* on the campus wear a CDC-approved face covering over the mouth and nose in all public spaces. This requirement includes classrooms, building entrances and exits, lobbies and lounges, as well as in hallways, stairwells, restrooms and elevators. UTEP will maintain and adjust its face-covering requirement as the pandemic evolves.

While on campus, ECE faculty will wear a face mask when giving in-person instruction. Likewise, students on campus will wear face masks in classrooms and laboratories and maintain social distancing (6 feet). Anyone refusing to face covering or to social distance themselves will be asked to leave the premises. Any escalation situations will be considered a public disruption and may require actions such as calling the UTEP campus police department and reporting the case to the Chair of the ECE Department and the Office of Student Conduct and Conflict Resolution (OSCCR).

One of the most effective ways of avoiding catching the corona virus, flu, or common cold is to wash your hands thoroughly after touching surfaces in common areas of places with high traffic. If this is not possible, use hand sanitizer as often as needed.

COVID-19 Testing on Campus

UTEP will test for COVID-19 in the fall. This will help us to rapidly identify individuals who have COVID-19 and do not have symptoms so they can isolate and avoid spreading it to others. The testing will focus on faculty, staff, and students who are on campus. Help us stop the spread of the corona virus and agree to participate in this voluntary testing program. Get tested when invited for testing at one of several on-campus locations.

Resources

UTEP Return to Campus Presentation [Link to Return to Campus Presentation](#)

UTEP Counseling and Psychological Services: 747-5302 or [Link to Counseling and Psychological Services](#)

UTEP Student Health and Wellness Center: [Link to Student Health and Wellness Center](#)

UTEP COVID-19 website: [Link to UTEP COVID-19 Website](#)

El Paso Strong statistics website: [Link to El Paso Strong Statistics Website](#)

El Paso COVID 19 information website: [Link to El Paso COVID-19 Information Website](#)

Ciudad Juarez COVID-19 resources website: [Link to Ciudad Juarez COVID-19 Resources Website](#)

US Centers for Disease Control and Prevention website: [Link to US Centers for Disease Control and Prevention Website](#)