

ECH 4905: Electron Transport Phenomena in Semiconductors

Class Periods: Monday, Wednesday, Friday, Period 7 (1:55 – 2:45 pm)

Class Location: Online

Academic Term: Fall 2020

Instructor

Prof. Charles Hages

Assistant Professor, Chemical Engineering Department, University of Florida

Office: ChE Room 417

E-mail address: c.hages@ufl.edu

Office telephone: 352-294-7002

Office hours: TBD

Web site: UF course Canvas web site

Course Description

Application of fundamental Chemical Engineering concepts of transport phenomena (e.g. fluid, heat, and mass) to the principles of electron transport in solid-state semiconductors. Special emphasis will be placed in relating electronic transport to fundamental chemical and material properties. An overview of basic semiconductor physics will be given, followed detailed derivation of the principles of electron drift and diffusion. Applications of electron transport to functional devices will be discussed, with special consideration for designing unique devices based on electron transport phenomena. Relevant optoelectronic characterization techniques to probe electron transport will be discussed. Lastly, the unique properties and applications of nanoscale electron transport (e.g. in nanomaterials) will be discussed.

Credit Hours: 3

Required Text

None

Required Software

Python. Can be installed for free using the Anaconda package: <https://www.anaconda.com/products/individual>

Course Schedule (Tentative)

Part (1), Introduction:

- i. Overview of basic semiconductor physics: Quantum Overview, Material – electronic structure relationship; Band theory of solids; Defects
- ii. Light/Matter Interaction: Absorption of light; Emission (Recombination) of electrons

Part (2), Drift-Diffusion of Electrons:

- i. Derivation of electron diffusion equations
- ii. Derivation of electron drift-diffusion equations
- iii. Transport mechanisms
- iv. Relationship of transport properties to material and chemical properties

Part (3), Applications

- i. Measuring electron transport: Spectroscopy and electronic measurement techniques
- ii. Electron transport for functional devices: Solar cells, Light-emitting-diodes, Thermoelectrics, etc.
- iii. Advanced design of devices based on transport phenomena
- iv. Nanoscale electron transport phenomena

Assignments

- **Homework:** Homework will be periodically assigned with at least 5 days of notice before the due date.
- **Midterm & Final**
- All assessments are cumulative. Either or both exams may be take-home exams.

Attendance Policy, Class Expectations, and Make-Up Policy

- Attendance of lectures is highly recommended, though not required.
- Course lectures will occur over Zoom, with the link available in the Canvas page for this course. In case of privacy concerns, I will not be recording any of these live lectures. Depending on the interaction/discussion during these lectures, the lectures may be supplemented or replaced with recordings you can view of the lecture material, with course time reserved for questions/discussion.
- Dates for the midterm will be announced at least 2 weeks in advance. The final exam schedule is predetermined by the registrar.
- Make-up assignments and excused absences can only be considered for those students who missed due to an acceptable reason (illness, family emergencies, military obligation, religious holidays, participation in official university activities, etc.) as listed in the undergraduate catalog. It is required that, whenever possible the student notifies the instructor about the situation in advance.
<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>
- Students arriving late for an exam will be given only the balance of time remaining to complete their work unless an acceptable reason (see above) is provided.

Evaluation of Grades

Assignment	Percentage of Final Grade
Homework	30%
Midterm	30%
Final	40%

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Grading Policy

Final grades will be assigned using the standard deviation (σ) method. The scale for the course will be as follows:

Percent	Grade	Grade Points
Mean - σ < Score	A	4.00
Mean + 0.67 σ < Score \leq Mean + σ	A-	3.67
Mean + 0.33 σ < Score \leq Mean + 0.67 σ	B+	3.33
Mean < Score \leq Mean + 0.33 σ	B	3.00
Mean - 0.33 σ < Score \leq Mean	B-	2.67
Mean - 0.67 σ < Score \leq Mean - 0.33 σ	C+	2.33
Mean - σ < Score \leq Mean - 0.67 σ	C	2.00
Mean - 1.33 σ < Score \leq Mean - σ	C-	1.67
Mean - 1.67 σ < Score \leq Mean - 1.33 σ	D+	1.33
Mean - 2 σ < Score \leq Mean - 1.67 σ	D	1.00
Mean - 2.33 σ < Score \leq Mean - 2 σ	D-	0.67
Score \leq Mean - 2.33 σ	E	0.00

More information on UF grading policy may be found at:
<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Instructor may lower the threshold for attaining the letter grades specified above (to the benefit of the students), but will not raise the threshold.

Communication

- The preferred method of communication with the instructor is via a message through Canvas.
- Public messages to the class regarding lecture material can also be posted on Canvas.
- Technical issues can be resolved via the helpdesk website or by calling 352-392-4357
<https://helpdesk.ufl.edu/>

Students Requiring Accommodations

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor in this class.

Student Privacy

Online lectures will not be recorded. There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](#), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.