ENG EC471 Physics of Semiconductor Devices
Course information Spring 2022

Lectures
Prof Anna Swan
Lecture: TR 1:30-3:15 pm in SOC B63
Office hour: After class, + Fridays 2-3 pm in PHO 828, Wednesdays 7:30-8:30 pm zoom.

Prerequisite: PY313 Elementary Modern Physics, PY354 Modern Physics, or equivalent.

Textbook
CC Hu Modern Semiconductor devices for integrated Circuits, Prentiss Hall. Available in the BU bookstore and online.

References:
There is a nice series of short books from Addison Wesley called the 'Modular Series on Solid State Devices" that I highly recommend if you want more in depth treatment:

1. Vol 1: "Semiconductor Fundamentals", by R. F. Pierret, Addison-Wesley
2. Vol 2: "The PN junction diode" by G. W. Neudeck and R. F. Pierret, Addison-Wesley
3. Vol.3 " The Bipolar junction transistor" by G. W. Neudeck, Addison-Wesley
4. Vol. 4 " Field effect devices" R.F Pierret, Addison-Wesley

There are many other books on SC devices for undergraduate level, for example:
"Physics of Semiconductor Devices" by S. M. Sze and Kwok K. Ng, John Wiley & Sons
"Solid State Electronic Devices", by B. G. Streetman and Sanjay Banerjee, Prentice Hall,
"Semiconductor Physics and Devices", by Donald A. Neamen, McGrawHill,
"Semiconductor Devices- Basic Principles", by Jasprit Singh, John Wiley and Sons Inc.,

Goals of the course and course outcomes
To provide you with a solid understanding of the physical principles of basic semiconductor devices, and to enable understanding of future generation devices. The course material covers semiconductor properties under thermal equilibrium and non-equilibrium conditions. You will study three fundamental device structures in detail: pn and Schottky diodes; MOSFETs and related devices; and the bipolar junction transistor. By the end of the semester you will

1. Be familiar with concepts and definitions related to band diagrams
2. Understand the physical mechanisms that guide the behavior of semiconductor devices
3. Identify important design parameters such as doping, bandgap mobility physical dimensions
4. Apply knowledge to determine relevant parameters to achieve stated design criteria.
5. Analyze the response of a device given its physical structure.
6. Qualitatively understand non-ideal behavior.

Homework (intended to keep you up to date with course material)
You will have ~10 homeoworks during the semester. A substantial fraction of your learning will come from working through the homework. We will use nanohub.org simulation tools for some homeworks where you can compare analytical solutions with simulations. You will post some HW on piazza.

Homework groups: 3 students in each group. The expectations are that you should meet 2-3 times a week to make sure everyone understands the questions, and have an idea of the path towards solving it and compare and discuss solutions. If you are ahead of the people in your group, you will solidify your understanding by explaining it; if you are confused, you will learn from your peers.

Homework grading: Only one HW per group will be graded, every group member will get that grade. **You will get 100% credit for 2/3 of the max points,** averaged over the semester. A mistake by a member will not jeopardize everyone's grade. If you turn in your HW, you are likely to get full HW credit in the end. Help each other - learn more, stress less, and have more fun. **Late Homework**– Late homework will not be accepted since I intend to make the solutions available soon after the deadline.

Google spreadsheet for forming homework groups. Please fill out this informations on the spreadsheet before Jan 18.

Electronic communication: We will use two platforms, Blackboard for posting HW and grades, and Piazza for communication. You are responsible for keeping up with announcements, etc.

Collaboration policy: You are strongly encouraged to attend office hours and discuss lectures and homework with your classmates. You will work with others on your HW, but the HW you hand in needs to be your own. Example: You need help, and a classmate has explained the whole problem to you, step by step. Afterwards, you need to formulate the problem, analyze and write the solutions on your own from beginning to end. If you cannot do it, you can ask for help again as many times as you need. However, the final work must be your own.
Copying an existing solution will give 0 credit or be brought to the Academic Conduct committee.

Absolutely no exchange of information during midterms or exams is allowed. Sharing or copying material will minimum lead to a zero for that exam and may be brought to the academic conduct committee.

Academic Conduct: see http://www.bu.edu/academics/policies/academic-conduct-code/

Quizzes: Occasional unannounced quizzes for diagnostics purpose.

Grading

Homework	10%	66.6 % of total score gives 100% credit
Midterms	60%	
Final Exam	30%	Check date and place on student link

Missed Exam Absence from an exam can be excused only for reasons stipulated by Boston University academic policies such as illness, death in the family, religious reasons, or unavoidable travel. In each case, permission of the instructor in advance is required, as well as a written authorization by a physician (in the case of illness) or other appropriate authorized signature. The student will be required to take a makeup exam.

Attendance – Attendance in lectures is considered essential but not mandator. We affirm our commitment to Policy on Religious Observance.

COVID 19 & BU Community Health Expectations

Masks are required and must always be worn over the mouth and nose when in public spaces on campus, including classrooms. All students are expected to follow all university guidelines with respect to updated vaccinations and booster shot, testing, social distancing, and mask wearing when they leave their dorm or home. For a detailed description of official BU policies regarding COVID, please visit:
http://www.bu.edu/dos/policies/lifebook/covid-19-policies-for-students/

If you miss a class due to a COVID quarantine, contact me for a recorded lecture or zoom session upon providing your COVID paperwork, per university rules.

Inclusion

I consider this classroom to be a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. All members of this class are expected to contribute to a respectful, welcoming, and inclusive environment for every other member of the class.

Accommodations for Students with Documented Disabilities

If you are a student with a disability or believe you might have a disability that requires accommodations, requests for accommodations must be made in a timely fashion to Disability & Access Services, 25 Buick St, Suite 300, Boston, MA 02215; 617-353-3658 (Voice/TTY). Students seeking academic accommodations must submit appropriate medical documentation and comply with the established policies and procedures
http://www.bu.edu/disability/accommodations/

http://www.bu.edu/academics/policies/
https://www.bu.edu/academics/policies/academic-conduct-code/
https://www.bu.edu/academics/policies/absence-for-religious-reasons/

Schedule of lectures and exams

Week	Date	Lecture	Topic	Chapter
1	1-20	1	Crystal structure- electrons and holes	Ch1
2	1-25	2	Density of states, carriers, doping	Ch 1
2	1-27	3	Drift and diffusion 1	ch 2
3	2-1	4	Drift and diffusion 2	ch2
3	2-3	5	recombination and generation, quasi fermi levels	ch2
4	2-8	6	Device fabrication	Ch 3
4	2-10	7	pn junction 1	ch 4
5	2-15	8	Midterm 1	ch 1-ch 3
5	2-17	9	MT review + pn junction 2	ch 4
6	2-22		Monday schedule	
6	2-24	10	pn junction 3	ch 4
7	3-1	11	Pn junction applications	ch 4
7	3-3	12	Metal SC junctions	ch 4
8	3-8		Spring recess	
8	3-10			
9	3-15	13	MOS capacitor I	ch 5
9	3-17	14	MOS capacitor 2	ch 5
10	3-22	15	reserve, review	
10	3-24	16	Midterm 2	Ch4-Ch5
11	4-5	17	MT 2 review, MOS transistor	Ch 6/7
11	4-7	18	MOSFETS 1	Ch 6/7
12	4-12	19	MOSFETS 2	Ch 6/7
12	4-14	20	MOSFETS 3	Ch 6/7
13	4-19	21	reserve, review	
13	4-21	22	BJTs	Ch 8
14	4-26	23	BJTs	Ch 8
14	4-28	24	BJTs	Ch 8
14	5-3	25	Final exam review	
			Final Exam, All chapters, emphasis on Ch 6-8	

February 2, 2022,	Last Day to Add Standard Courses
February 24, 2022,	Last Day to Drop Standard Courses (without a “W” grade)
April 1, 2022,	Last Day to Drop Standard Courses (with a “W” grade)
	Last Day for Undergraduate Students to Designate Standard Courses as Pass/Fail