

EE 506 - Semiconductor Physics

12:30-1:50 pm Tue, Thu

GFS 223

Semiconductor devices in the form of Si integrated circuits have revolutionized our life by facilitating communications, computation and control of most aspects our daily living. The emergence of new semiconductor materials and devices are now enabling another revolution in energy, visual display, lighting, personal wireless communications and a myriad of other technologies. This course provides a unified understanding of the physical origins of semiconducting materials properties and device characteristics that enable these new applications. This is done by exploring the relationship between atomic properties and bonding in semiconductors, the crystalline structure and the energy band structure of materials more diverse than Si and the thermal, electronic transport and optical properties that are characteristic of these materials. Finally, we will discuss interfaces between materials and the properties of heterojunctions made from them. Heterojunctions will lead us to discuss artificially structured materials and quantum structures. This journey will take us from atoms to crystals and back to artificial atoms. During this time we will constantly expand our understanding of the influence of the atoms that make up a semiconductor on the resulting crystals and develop a methodology for designing new device concepts.

Prerequisite: Solid State Physics; Quantum Mechanics

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Office Hours: Tuesday and Thursday 3:00 PM – 4:30 PM by appointment

Text Book: *“Electronic and Optoelectronic Properties of Semiconductor Structures, 1st Edition”*

by [Jasprit Singh](#) ; ISBN-13: 978-0521035743; ISBN-10: 0521035740

Prerequisites: Quantum Mechanics – EE 471 or equivalent

Solid State Physics - EE 338 as a minimum, preferably EE / MASC 501

Grading: Homework 30%

Midterm Exam 35%

Final Exam 35%

Outline:

Week	Dates	Topic	
1	Aug 21 - 23	Atomic Structure, Bonding and Crystalline structure	Singh Chap 1 and Handouts HW 1 Assign
2	Aug 28 – Aug 30	Crystalline Structures and Symmetry	Singh Chap 1 and Handouts HW #1 Due Aug 30
3	Sept 4 - Sept 6	Covalent Bonding and Energy Bands	Singh Chap 2 and Appendix C HW 2 Assign
4	Sept 11 - Sept 13	Energy Bands in Semiconductors	Singh Chap 2 and Handouts HW 2 Due Sept 13
5	Sept 18 - Sept 20	Tight Binding Approximation	Singh Chap 2 and Handouts HW 3 Assign
6	Sept 25 – Sept 27	$k \cdot P$ Formalism for band structure calculations	Singh Chap 2 and Handouts HW 3 Due Sept 27
7	Oct 2- Oct 4	Band structure of alloys and the effect of strain and polarization	Singh Chap 3 and Handouts HW 4 Assign
8	Oct 9 - Oct 11	Intrinsic and extrinsic carrier densities; Midterm	Handout Notes Homework 4 Due Oct 11
9	Oct 16 - Oct 18	Boltzmann transport equation; Impurity scattering	Singh Chaps 4 & 5 and Handouts; HW 5 Assign
10	Oct 23 – Oct 25	Phonon dispersion and phonon scattering	Singh Chap 6 and Handouts HW 5 Due Oct 25
11	Oct 30 - Nov 1	High field transport	Singh Chap 7 and Handouts HW 6 Assign
12	Nov 6 – Nov 8	Optical Properties- interband transitions in 2- and 3-D materials	Singh Chap 9 and Handouts HW 6 Due Nov 8
13	Nov 13 – Nov 15	Excitonic states and optical properties	Singh Chap 10 and Handouts HW 7 Assign
14	Nov 20 – Nov 22	Heterojunctions; Thanksgiving	Notes
15	Nov 27 – Nov 29	Quantum Wells	Notes; HW 7 Due Nov 29
	Dec 11, 2018	Final Exam	

Statement for Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

Statement on Academic Integrity

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *Scampus*, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: <http://www.usc.edu/dept/publications/SCAMPUS/gov/>. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: <http://www.usc.edu/student-affairs/SJACS/>.