

SYLLABUS: ECE 5530 Fundamentals of Semiconductors for Microelectronic and Photonics

Autumn 2018

Description: Crystal structure, semiconductor energy band structure, electron transport and carrier recombination, heterostructures, and optical and dielectric properties. Prereq: 3030 (432), or Grad standing in Engineering, Biological Sciences, or Math and Physical Sciences. Not open to students with credit for 730. Units: 3 credit hours.

Lecture Hours: MWF, 10:20-11:15AM, Cockins Hall 218

Learning Goals:

1. Become knowledgeable of various technologically important semiconductor materials beyond silicon
2. Learn advanced semiconductor physics
3. Learn electronic and optical properties of semiconductors and heterostructures
4. Learn about quantum effects and engineered properties of semiconductors
5. Learn how advanced properties are used in state of the art microelectronics and optoelectronics

ABET-EAC Criterion 3 Outcomes

Course Contribution	College Outcome
***	a An ability to apply knowledge of mathematics, science, and engineering.
	b An ability to design and conduct experiments, as well as to analyze and interpret data.
	c An ability to design a system, component, or process to meet desired needs.
	d An ability to function on multi-disciplinary teams.
**	e An ability to identify, formulate, and solve engineering problems.
	f An understanding of professional and ethical responsibility.
	g An ability to communicate effectively.
	h The broad education necessary to understand the impact of engineering solutions in a global and societal context.
*	i A recognition of the need for, and an ability to engage in life-long learning.
*	j A knowledge of contemporary issues.
**	k An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

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Office Hours: Tue: 11:30AM-12:30PM; Wed: 11:30AM-12:30PM CL 377

Assistant: Seung Hyun Lee, lee.8014@@buckeyemail.osu.edu 374 Caldwell Lab

Text: Required: The Physics of Low Dimensional Semiconductors, John H Davies.
Lecture Notes

References (supplemental reading):

- Solid State Electronic Devices, Ben G. Streetman and Sanjay Kumar Banerjee, 7th Edition, ISBN-13: 978-0133356038; ISBN-10: 0133356035
- Fundamentals of Semiconductor Devices, B.L. Anderson and R.L. Anderson, ISBN-13: 978-0073529561 ISBN-10: 0073529567
- Semiconductor Physics and Devices, Donald Neaman, 4th Edition, ISBN13: 9780073529585 ISBN10: 0073529583

Grading and Important Dates:

Midterm 1	20% (Wed, Oct 3 rd 2018)
Midterm 2	20% (Friday Nov 2 nd 2018)
Final Exam	30% (Tuesday, Dec 11 th 2018)
Homework	30% (Every two weeks)

You are allowed to drop one homework with the least score.

Policy on Late Homeworks: Homework is due at the beginning of class on the date shown. No late work will be accepted without prior arrangement. Late work (with arrangements) will be docked 10% per day.

Working together: Students are encouraged to work together on homework but each student should hand in his or her individual solution.

Exams: Exams are closed book. You will be allowed a single cheat sheet, 8.5" by 11", with handwritten notes only, on one side only. Scientific/graphic calculators are allowed. No internet-enabled devices are permitted. No cooperation on the examination is allowed. I am required to report any academic misconduct to the Committee on Academic Misconduct (COAM).

Missed exams: Any missed exam will result in a zero grade unless arrangements are made in advance. Suitable circumstances include illness, death in the immediate family, and situations of comparable gravity. In such cases, *if and only if arrangements are made in advance*, a make-up exam can be arranged. Midterms dates are announced will in advance, so plan your job interviews and such around them.

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Reaching me: You may reach me during office hours, or make an appointment by email if you cannot make my office hours.

FINAL EXAM:

Our final exam will be Tuesday, December 11th 2018 from 10:00-11:45AM. No make-up or early exams allowed.

Disabilities Statement

Any student who feels s/he may need an accommodation based on the impact of a disability should contact the instructor privately to discuss specific needs. Please contact the OSU Office for Disability Services for assistance in verifying the need for accommodations and developing accommodation strategies.

Academic Misconduct Statement

Any student found to have engaged in academic misconduct, as set forth in the Code of Student Conduct Section 3335-23-04, Prohibited Conduct, will be subject to disciplinary action by the university. Academic misconduct is any activity that tends to compromise the academic integrity of the university, or subvert the educational process.

Student Conduct

Students are expected to abide by the provisions in the Code of Student Conduct. The University's [Code of Student Conduct](#) and [Sexual Harassment Policy](#) are available on the OSU Web page

ECE 5530: Class and Homework Schedule (Au 2018)

DATE	Lec #	Topics To be Covered	Homework Schedule
Module 1: Course Overview and Key Concepts			
Wed, Aug 22nd 2018	1	Quantum Mechanics: Postulates, Schrodinger Equation	
Fri, Aug 24th 2018	2	Knowledge Probe Quiz	
Module 1: Semiconductor Physics Concepts			
Mon Aug 27th 2018	3	Quantum Mechanics: Operators, Charge Current Density	HW1 Assigned
Wed Aug 29th 2018	4	Crystal Structure (Bravais Lattices, Unit Cell, Directions/Planes)	
Fri Aug 31st 2018	5	Crystal Structure (Diamond, ZincBlende, Wurtzite, HCP/FCC)	
Mon Sept 3rd 2018		Labor Day No Class	
Wed Sept 5th 2018	6	Phonons (1D Monoatomic/Diatom Chain, Group Velocity)	
Fri Sept 7th 2018	7	k-space(Reciprocal lattice, lattice planes)	HW2 Assigned/HW1 Due
Mon Sept 10th 2018	8	k-space (Brillouin zone, x-ray diffraction)	
Module 2: Semiconductor Band-Structure (E-k Diagram)			
Wed Sept 12th 2018	9	Free electron model	
Fri Sept 14th 2018	10	Nearly free electron model and Bloch Theorem	
Mon Sept 17th 2018	11	Kronnig Penny Model	
Wed Sept 19th 2018	12	Degenerate Perturbation Theory	
Fri Sept 21st 2018	13	Tight Binding Model	HW3 Assigned/HW2 Due
Mon Sept 24th 2018	14	k.p model	
Wed Sept 26th 2018	15	k.p model	
Module 3: Carrier Statistics and Dynamics			
Fri Sept 28th 2018	16	Maxwell Boltzmann/Fermi Dirac Distribution	
Mon Oct 1st 2018	17	Review for Mid-Term I	
Wed Oct 3rd 2018		Mid Term I	
Fri Oct 5th 2018	18	Maxwell Boltzmann/Fermi Dirac Distribution	HW4 Assigned/HW3 Due
Mon Oct 8th 2018	19	Degenerate and Non-degenerate semiconductors	
Wed Oct 10th 2018	21	Semiconductors in equilibrium	
Fri Oct 12th 2018		Fall Break No Class	
Mon Oct 15th 2018	22	Excess Carriers: Generation and Recombination	
Wed Oct 17th 2018	23	Excess Carriers: Band to band, Trap assisted recombination	
Fri Oct 19th 2018	24	Emission Probabilities and Auger Recombination	HW5 Assigned/HW4 Due
Mon Oct 22nd 2018	25	Low level and High Level Injection	
Module 4: Junctions and Band-diagrams			
Wed Oct 24th 2018	26	PN Junction: Qualitative Description	
Fri Oct 26th 2018	27	PN Junction: Mathematical derivation	
Mon Oct 29th 2018	28	Metal-semiconductor junction	
Wed Oct 31st 2018	29	Review for Mid-Term II	
Fri Nov 2nd 2018		Schottky and Ohmic Contacts	HW6 Assigned/HW5 Due
Mon Nov 5th 2018	30	Mid Term II	
Wed Nov 7th 2018	31	Metal-oxide-semiconductor junction	
Fri Nov 9th 2018	32	Capacitance and CV Measurements	
Mon Nov 12th 2018		Veterans Day No Class	
Wed Nov 14th 2018	33	Heterojunctions	
Module 5: Carrier Transport			
Fri Nov 16th 2018	34	Boltzmann Transport Equation	HW7 Assigned/HW6 Due
Mon Nov 19th 2018	35	Field, diffusion and scattering	
Wed Nov 21st 2018	36	Ambipolar transport equation	
Fri Nov 23rd 2018		Thanksgiving/Columbus Day No Class	
Mon Dec 3rd 2018	37	Low injection and high injection transport	HW7 Due
Wed Dec 5th 2018	38	Course Review	
Tue Dec 11th 2018		Final Examination (10AM-11:45AM)	