



## PEP/NANO/EE/MT 503 Solid State Physics

*School of Engineering and Science*

*Spring 2018*

Meeting Times: Mon. 4:00-5:40 PM; Fri. 10:00-10:50 AM  
Classroom Location: Mondays Burchard 715 and Fridays Babbio 320  
Instructor: Stefan Strauf  
Contact Info: B724, [strauf@stevens.edu](mailto:strauf@stevens.edu), x5639  
Office Hours: Mondays/Fridays 11AM-noon or by appointment  
Prerequisite(s): PEP242(PEP201) and PEP331 (or their equivalents)  
Cross-listed with: NANO/EE/MT/PEP 503

### COURSE DESCRIPTION

This course introduces simple physical models to understand the electric, acoustic, thermal, and optical properties of matter in the solid-state. It discusses basic crystal structures, X-ray diffraction and dispersion curves for phonons and electrons in reciprocal space. It provides an introduction to the theory of energy bands and introduces the various material classes and properties of metals, insulators, semiconductors, and superconductors. The course is suitable for upper-level undergraduate students in science and engineering. In a broader sense, this course provides a solid foundation to more advanced topics in photonics, microelectronics, and nanotechnology.

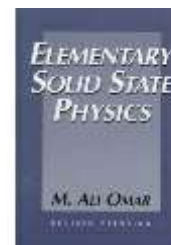
### FORMAT AND STRUCTURE

This course is comprised of two weekly lectures. Each lecture includes a brief recitation of the content of the previous lecture.

### COURSE MATERIALS

#### Textbook(s):

Most of the lectures will be based on the textbook Elementary Solid State Physics (Principles and applications), by M. Ali Omar, Addison-Wesley Publishing Company (ISBN 0-201-60733-6). Compared to many other books, the text by Omar does a nice job on introducing topics with easy to understand examples and good qualitative explanations.



#### Other Readings:

There are many text books on Solid State Physics, each of them with different emphasis on theory or experiment and with various levels of difficulty. The three books below are thus a personal choice of books which I have read as a student. The first two are more into experiment and the third is more into theory.

1. **Introduction to Solid State Physics** by Charles Kittel (Wiley, ISBN-13: 978-0471415268)
2. **Solid-State Physics: An Introduction to Principles of Materials Science**, by Harald Ibach, (Springer, ISBN-13: 978-3540438700)
3. **Solid State Physics** by Ashcroft and Mermin (Brooks Cole, ISBN-13: 978-0030839931)

## COURSE REQUIREMENTS

<b>Attendance</b>	Poor attendance will have in most cases a negative effect on your grade. Make sure to sign the attendance sheet.
<b>Homework</b>	Weekly homework's will be handed out. There will be about 10 HWs, one every week but no HWs before midterm, final or spring break. The HW is due within one week, typically on Mondays, unless specified otherwise. HW count 45% towards your final grade, i.e. about 4.5% each.
<b>Midterm</b>	We will have one in-class midterm test – typically just before spring break – see schedule. The midterm test counts 15% towards the total grade.
<b>Exams</b>	There will be one in-class exam in this course. It counts 40% of the total grade.

## GRADING PROCEDURES

Grades will be based on:

<b>Homework</b>	<b>(45 %)</b>
<b>Midterm</b>	<b>(15 %)</b>
<b>Exam</b>	<b>(40 %)</b>

## ACADEMIC INTEGRITY

### Undergraduate Honor System

Enrollment into the undergraduate class of Stevens Institute of Technology signifies a student's commitment to the Honor System. Accordingly, the provisions of the Stevens Honor System apply to all undergraduate students in coursework and Honor Board proceedings. It is the responsibility of each student to become acquainted with and to uphold the ideals set forth in the [Honor System Constitution](#). More information about the Honor System including the constitution, bylaws, investigative procedures, and the penalty matrix can be found online at <http://web.stevens.edu/honor/>

The following pledge shall be written in full and signed by every student on all submitted work (including, but not limited to, homework, projects, lab reports, code, quizzes and exams) that is assigned by the course instructor. No work shall be graded unless the pledge is written in full and signed.

*“I pledge my honor that I have abided by the Stevens Honor System.”*

### Reporting Honor System Violations

Students who believe a violation of the Honor System has been committed should report it within ten business days of the suspected violation. Students have the option to remain anonymous and can report violations online at [www.stevens.edu/honor](http://www.stevens.edu/honor).

### Graduate Student Code of Academic Integrity

*All Stevens graduate students promise to be fully truthful and avoid dishonesty, fraud, misrepresentation, and deceit of any type in relation to their academic work. A student's submission of work for academic credit indicates that the work is the student's own. All outside assistance must be acknowledged. Any student who violates this code or who knowingly assists another student in violating this code shall be subject to discipline.*

All graduate students are bound to the Graduate Student Code of Academic Integrity by enrollment in graduate coursework at Stevens. It is the responsibility of each graduate student to understand and adhere to the Graduate Student Code of Academic Integrity. More information including types of violations, the process for handling perceived violations, and types of sanctions can be found at [www.stevens.edu/provost/graduate-academics](http://www.stevens.edu/provost/graduate-academics).

### Special Provisions for Undergraduate Students in 500-level Courses

The general provisions of the Stevens Honor System do not apply fully to graduate courses, 500 level or otherwise. Any student who wishes to report an undergraduate for a violation in a 500-level course shall submit the report to the Honor Board following the protocol for undergraduate courses, and an investigation will be conducted following the same process for an appeal on false accusation described in Section 8.04 of the Bylaws of the Honor System. Any student who wishes to report a graduate student may submit the report to the Dean of Graduate Academics or to the Honor Board, who will refer the report to the Dean. The Honor Board Chairman will give the Dean of Graduate Academics weekly updates on the progress of any casework relating to 500-level courses. For more information about the scope, penalties, and procedures pertaining to undergraduate students in 500-level courses, see Section 9 of the [Bylaws of the Honor System](#) document, located on the Honor Board website.

### EXAM ROOM CONDITIONS

The following procedures apply to midterm and exams for this course. As the instructor, I reserve the right to modify any conditions set forth below by printing revised Exam Room Conditions on the midterm or exam.

1. Students may use the following devices during midterm and exams. Any electronic devices that are not mentioned in the list below are not permitted.

Device	Permitted?	
	Yes	No
Laptops		x
Cell Phones		x
Tablets		x
Smart Watches		x
Google Glass		x
Other ( <b>Nonprogrammable calculator</b> )	x	

2. Students may use the following materials during midterm and exams. Any materials that are not mentioned in the list below are not permitted.

Material	Permitted?	
	Yes	No
Handwritten Notes <i>Conditions: <b>one 8x10 sheet (front and back) is permitted</b></i>	x	
Typed Notes		x
Textbooks		x
Readings		x

3. Students are not allowed to work with or talk to other students during quizzes and/or exams.

## **LEARNING ACCOMODATIONS**

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. Student Counseling and Disability Services works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, and psychiatric disorders in order to help students achieve their academic and personal potential. They facilitate equal access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from SCDS staff. The SCDS staff will facilitate the provision of accommodations on a case-by-case basis. These academic accommodations are provided at no cost to the student.

### ***Disability Services Confidentiality Policy***

Student Disability Files are kept separate from academic files and are stored in a secure location within the office of Student Counseling, Psychological & Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

For more information about Disability Services and the process to receive accommodations, visit <https://www.stevens.edu/sit/counseling/disability-services>. If you have any questions please contact: Lauren Poleyeff, Psy.M., LCSW - Disability Services Coordinator and Staff Clinician in Student Counseling and Disability Services at Stevens Institute of Technology at [lpoleyef@stevens.edu](mailto:lpoleyef@stevens.edu) or by phone (201) 216-8728.

## **INCLUSIVITY STATEMENT**

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in education and innovation. Our community represents a rich variety of backgrounds, experiences, demographics and perspectives and Stevens is committed to fostering a learning environment where every individual is respected and engaged. To facilitate a dynamic and inclusive educational experience, we ask all members of the community to:

- be open to the perspectives of others
- appreciate the uniqueness their colleagues
- take advantage of the opportunity to learn from each other
- exchange experiences, values and beliefs
- communicate in a respectful manner
- be aware of individuals who are marginalized and involve them
- keep confidential discussions private

## TENTATIVE COURSE SCHEDULE

Class Date	Topic(s)	Chapter
Jan. 19, Fri	1. Intro, Crystal Structure	1
Jan 22, Mon.	2. Interatomic forces	2
Jan.26, Fri.	3. Structure analysis by x-ray diffraction	2
Jan. 29, Mon.	4. Structure analysis by x-ray diffraction	2
Feb. 2, Fri.	5. Elastic waves, density of states	3
Feb. 5, Mon.	6. Specific heat Einstein/Debye model	3
Feb. 9, Fri.	7. Phonons, 1D monoatomic lattice	3
Feb. 12, Mon.	8. Diatomic lattice, Brillouin zone, Thermal cond.	3
Feb. 16, Fri.	9. Free electron model, conductivity, relaxation time	4
<b>Feb. 20, Mon.</b>	<b>No class, President's day</b>	
<b>Feb. 21, Wed.!</b>	10. Heat capacity, Thermal conductivity	4
Feb. 23, Fri.	11. Periodic Potential, Energy bands in solids	5
Feb. 26 Mon.	12. NFE-model, Metals, Insulator, Semiconductors	5
Mar. 2, Fri.	13. e-DOS, Fermi surface	5
Mar. 5, Mon.	14. Bloch electrons, Effective mass	5
<b>Mar. 9, Fri.</b>	<b>Midterm in class!</b> See syllabus for class room conditions	
<b>Mar. 11-18</b>	<b>Spring break!!</b>	
Mar. 19, Mon.	15. Semiconductors, holes, intrinsic conductivity	6
Mar 23, Fri.	16. Extrinsic conductivity, doping	6
Mar.26, Mon.	17. Carrier mobility, hot electrons	6, 7
<b>Mar. 30, Fri.</b>	<b>Good Friday – no class</b>	
Apr. 2, Mon.	18. Gunn effect and Gunn diode	6,7
Apr. 6, Fri.	19. The pn-junction, carrier diffusion, diode	7
Apr. 9, Mon.	20. Injection currents, transistor, FET	7
Apr. 13, Fri.	21. Optical properties of dielectrics, Polarizability	3, 4, 8
Apr. 16, Mon.	22. AC conductivity, plasmons	3,4,8
Apr. 20 Fri.	23. Optical properties of Semiconductors, excitons:	6,7
Apr. 23 Mon.	24. Photoconductivity, Photodiode, Laser,	6,7
Apr. 27 Fri.	25. Magnetism in atoms	9
Apr 30, Mon.	26. Magnetism in solids	9
<b>May 3, Thu!</b>	27. <b>Last class:</b> Superconductivity	10