

PHY 332/ PHY 532: Condensed Matter Physics

Instructor: Muhammad Sabieh Anwar

Year: 2012-13

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Semester: Spring

Office Hours:

Category: Undergrad and Graduate

Course Code: PHY 332

Course Title: Condensed Matter Physics / Advanced Condensed Matter Physics

Credits: 3

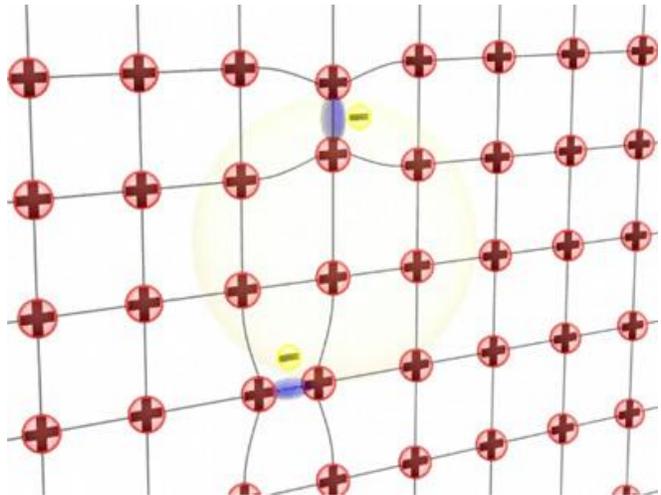
Website: <https://physlab.org/class-teaching/condensed-matter-physics-spring-2021/>

Lecture format: Two 75 minutes lectures per week.

For Harassment policy and honor code, see the last sections of this outline.

Course Description:

The purpose of the course is to introduce students to the structure of the solid phase of matter and how the properties can be derived from a quantum understanding of electrons, phonons and their interactions, modulated by the periodic arrangement of atoms. Emphasis will be made on the band structure and methods to determine the same. There will be special focus, towards the end, on the burgeoning field of low-dimensional materials as well as the ubiquitous semiconductors. After the course, the students will be familiar with the basics of condensed matter physics, enabling them to take more advanced courses focusing on unique materials properties in the electronic, optical, magnetic, thermal, and acoustic regimes as well as specialized courses on mesoscopic physics and devices.



Pre-requisites:

PHY 112 (Quantum Mechanics-I) for undergraduates.

Text books:

The Oxford Solid State Basics by Steven H. Simon

Selected topics from: *Band Theory and Electronic Properties of Solids* by J. Singleton (Oxford University Press) 2006.

Grading scheme:

- Homeworks: 40% (will include optional face-to-face discussion and cross examination of the submitted homeworks)
- Mid-Term 30% (will include an optional oral exam)
- Final Exam 30%
- Grading will be absolute.
- The instructor has the liberty of varying these grade assignments by 10%.
- Graduate students may get extra work.

Tentative Course Schedule & Topics:

Lectures	Topic	Some Particular Applications
1-6	Crystal Structure: symmetry, lattice, crystal systems, crystal structures, identifying planes, directions, point and space groups	Correlation between structure and solid properties (ferroelectricity, High- T_c superconductors, graphite and graphene)
7-10	Reciprocal Lattice: reciprocal lattice, Brillouin zones, Fourier analysis of the basis	Determining crystal structure using X-ray and electron diffraction
11-14	Free electron Fermi gas: free electron gas in three dimensions, heat capacities due to free electrons, electrical conductivity, thermal conductivity, thermoelectric effect	Liquid He ³ , Fermi gases in astrophysics, classic Hall effect, magneto-resistance and GMR sensors
15	Review and Mid-Term	
16-20	Effect of the periodic potential: Bloch's theorem,	Difference between metals,

	nearly free electrons, Bloch functions, Kronig-Penney model, effective masses, tight-binding model	insulators and semiconductors, band gap engineering, photoconductivity and optical properties
21-24	Semiconductors: electrons and holes, electrical conductivity, intrinsic and extrinsic behaviors, equilibrium and non-equilibrium carrier densities	Basic semiconducting heterostructures (diodes, junction field-effect transistors, metal-oxide semiconducting FET's), semiconducting heterostructures, molecular beam epitaxy, semiconductor laser action
25-28	Magnetism: diamagnetism, paramagnetism, exchange interaction, ferromagnetism, anti-ferromagnetism, spin waves	Ferromagnetic domains and Kerr microscopy, superconductors are perfect diamagnets
29	Final Exam	

Harassment Policy Harassment of any kind is unacceptable, whether it be sexual harassment, online harassment, bullying, coercion, stalking, verbal or physical abuse of any kind. Harassment is a very broad term; it includes both direct and indirect behaviour, it may be physical or psychological in nature, it may be perpetrated online or offline, on campus and off campus. It may be one offense, or it may comprise of several incidents which together amount to sexual harassment. It may include overt requests for sexual favours but can also constitute verbal or written communication of a loaded nature. Further details of what may constitute harassment may be found in the LUMS Sexual Harassment Policy, which is available as part of the university code of conduct. LUMS has a Sexual Harassment Policy and a Sexual Harassment Inquiry Committee (SHIC). Any member of the LUMS community can file a formal or informal complaint with the SHIC. If you are unsure about the process of filing a complaint, wish to discuss your options or have any questions, concerns, or complaints, please write to the Office of Accessibility and Inclusion (OAI, oi@lums.edu.pk) and SHIC (shic@lums.edu.pk) —both of them exist to

help and support you and they will do their best to assist you in whatever way they can. To file a complaint, please write to harassment@lums.edu.pk.

Honor Code This course and all our interactions are based on the premise that students and I (Sabieh Anwar) will not resort to any means of taking unfair advantage of one another. I will not penalize any student unfairly and will not unduly advantage another. I will stick to norms of decency and mutual respect to my students. Similarly, students will also stick to an honor code---they will not cheat or help others cheat or plagiarize. I will not actively go out looking for plagiarism or cheating. However, if something comes to my notice, I will immediately refer this case to the School's Disciplinary committee for subsequent attention. I will not invigilate exams. I expect students to make their conscience their invigilator. Grading in this course will be absolute.