

PHY 411 / PHY 5312 / EE 533
Quantum Optics

Instructor: Muhammad Sabieh Anwar

TA:

Year: 2024-2025

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Semester: Spring

Office Hours: Will be communicated later

Category: Undergrad/Grad

Course Code PHY 411 / PHY 5312 / EE 533

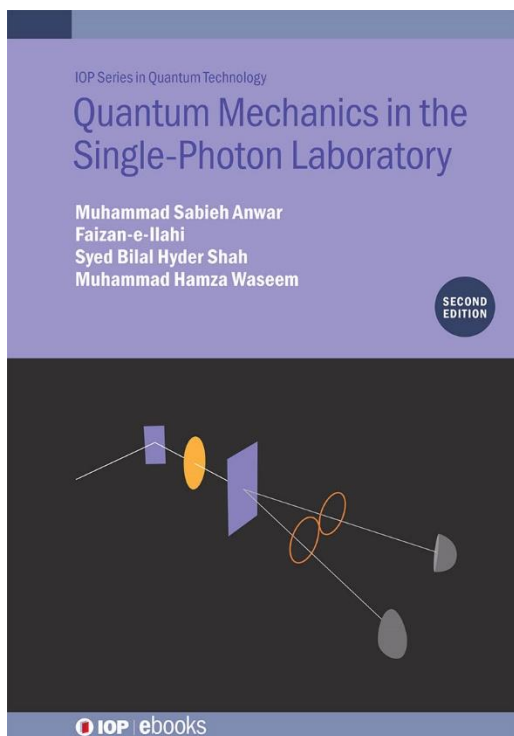
Course Title: Quantum Optics

Credit hours: 3

Class Schedule: Will be communicated later

Website: <https://physlab.org/>

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



Course Description:

This is a first introduction to quantum optics. The course is conceptually divided into two parts. The first part, before the midterm, will present a quantized view of light. The focus will be on how we describe light as a quantum field. This section will also include how light interacts with an

atom, is absorbed by and transmitted from an atom. The second part, to follow the midterm, will talk about the underlying principles behind four phenomena and four kinds of experiments, namely lasers, ion traps, cold atoms, and cavity QED. These ideas will apply knowledge learned in the first half of the course to applications and practically useful scenarios. One of my objectives is to prepare students to work with me in the single photon quantum mechanics lab (<https://physlab.org/qmlab/>) on various research projects.

Pre-requisites:

Quantum Mechanics I (for undergraduate students). Some knowledge of perturbation theory taught in Quantum Mechanics II is helpful. Students should also have a working knowledge of electromagnetism.

Textbooks:

- *Quantum Mechanics in the Single Photon Laboratory*, Muhammad Sabieh Anwar, Faizan-e-Elahi, Syed Bilal Shah, Hamza Waseem
- *Quantum Optics: An Introduction* by Mark Fox
- *Introductory Quantum Optics* by C.C. Gerry and P.L Knight

Grading scheme:

- Homeworks and computational assignments: 30% (feedback and solutions will be provided and tutorials conducted by the TA)
- Midterm Exam 30%
- Final Exam 40%
- Grading will be absolute.
- The instructor has the liberty of varying these grade assignments by 5%.

Tentative Course Schedule & Topics:

Weeks	Topic	Some Particular Ideas
1	Review of optics and quantum mechanics	Maxwell's equations, polarization, quantum state description, Bloch and Poincare spheres
2-4	Atoms as absorbers and emitters of radiation	Einstein coefficients, Rabi model full quantum mechanical Jaynes-Cummings model

5-7	Photons	Field quantization, what are photons, quantum coherence functions, photon detection statistics, coherent states, number states
8	Mid-Term week	
8-13	Experimental realizations	Lasers, ion traps, cold atoms, cavity QED
14	Final exam and review	

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.