

ELEC 7970 QUANTUM OPTICS FALL 2024

Classroom:	306 Broun Hall	Class Time:	TR 11:00 am - 12:15 pm
Instructor:	Zihe Gao	Email:	zzg0036@auburn.edu
Office:	422 Broun Hall	Phone:	(334) 844-1629

Course Objectives: The course is designed for students who have had basic training in quantum mechanics and optics (or electromagnetic waves). It provides a quantum description of light, light-matter interactions, and an introduction to quantum information and sensing systems.

Prerequisites:

- Quantum mechanics (preferably senior undergraduate level or graduate level). For example: PHYS 4100, ELEC 7970 Applied Quantum Systems, PHYS 7300, or similar. You should be familiar with:
 - The Schrödinger equation
 - Properties of wave functions and the Hilbert space
 - Measurements, commutators, the uncertainty principle
 - Quantum mechanical description of harmonic oscillators (the energy levels, and hopefully creation and annihilation operators)
- Optics (e.g., ELEC 5970/6970 Optoelectronics, PHYS 5300/6300 Optics, or similar). Courses on electromagnetic waves probably count too. You should be familiar with:
 - Maxwell's equations
 - Diffraction and interference
 - Polarization

Office Hours: Tentatively set to Wed 4-5pm. (In addition to the office hours, you can find me after class, or by appointment, or post your questions in the forum provided for this purpose on Canvas.)

Course Outline:

1. Review of classical optics and quantum mechanics
2. Quantization of electromagnetic field and photon statistics, multi-photon interference
3. Density matrix formalism of quantum mechanics, quantum tomography
4. Light-matter interaction
5. Introduction to quantum information and sensing systems

Grading Policy: Homework 40%; Mid-term Exam 30%; Final Project 30%

Course Materials and Recommended Text(s):

- Required Material: just the Lecture Notes
- Recommended Text(s):
 - Scully and Zubairy, *Quantum Optics*, Cambridge, 1997.
 - Nielsen and Chuang, *Quantum Computation and Quantum Information*, Cambridge, 2010.

Supplementary Text(s):

- Sakurai, *Modern Quantum Mechanics*, Addison-Wesley, 1984.
- Fox, *Quantum Optics An Introduction*, Oxford University Press, 2006.

Course Communications: Course materials and announcements will be posted on Canvas. Students are advised to visit Canvas regularly.

Course Project: To be announced so that the scopes are appropriate based on the number of enrollments.

Student's with Special Needs: In accordance with the Americans with Disabilities Act, students with bona fide disabilities will be afforded reasonable accommodation. The Office of Accessibility will certify a disability and advise faculty members of reasonable accommodations. If you have a specific disability that qualifies you for academic accommodations, please notify the instructor/professor and provide certification from the Office of Accessibility as early as possible. (The Office of Accessibility is located at 1228 Haley Center, phone: 334-844-2096).

Changes in Course Requirements: Since all classes do not progress at the same rate (and it's my first time teaching this course), I may wish to modify the above requirements or their timing as circumstances dictate. However, students will be given adequate notification of any changes. If such modification is needed, it will be in writing and conform to the spirit of this policy statement.