# COURSE SYLLABUS

PHYS/ECE 4751 Laser Theory and Applications, Summer 2026
Sections QUP, 3 credit hours

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| Instructor: | Prof. Wenshan Cai |
| Class schedule: | This class will be conducted via asynchronous online video lectures, twice a week. |
| Office hours: | Tuesday 8–9 pm, US Eastern Time, via Microsoft Teams<br>Additional office hours may be available by appointment. Please send Dr. Cai an email message for appointment at least 24 hours in advance. |
| Email: | wcai@gatech.edu |
| Course webpage: | Canvas course site ECE-PHYS 4751 Summer 2026 |

Course Description:

PHYS 4751 provides an introduction to the theory and applications of laser principles and related instrumentation. Emphasis is on the fundamental principles underlying laser action. The course is cross-listed with ECE 4751.

Course Learning Outcomes:

- Analyze the propagation of an optical beam inside a free-space optical system with polarization-sensitive components.
- Analyze three-level and four-level laser systems through detailed calculation of the gain, population inversion, and cavity modes.
- Analyze and design stable mirror-based cavities for achieving single-mode or multi-mode operation; analyze the longitudinal and transverse modes and their Gaussian beam profiles in a mirror-based cavity.
- Analyze different classes of lasers; also design a stable laser with a given set of specifications using simple building blocks.
- Design active and passive Q-switched and mode-locked pulsed lasers and analyze their pulse properties.
- Analyze, explain, and compare in detail the data sheets of different commercial laser systems.
- Design simple experiments to measure the fundamental properties of a laser.
- Analyze different classes of optical detectors.
- Analyze an optical communication system formed through building blocks.
- Analyze and design Fabry-Perot-based filters and spectrometers.

Prerequisites:

It is assumed that you are acquainted with calculus (MATH 2401/2411 or equivalent), and have basic understanding of electromagnetic waves (PHYS 2212 or ECE 3025).

Required Course Materials:

Primarily online notes. Lecture slides will be posted online prior to each class.
O'Shea, Callen & Rhodes, *Introduction to Lasers and Their Applications*, Addison-Wesley, 1978.

Homework:

Six problem sets will be assigned, graded, and returned. Typically, there is 1.5 weeks between the assignment date and the due date for each homework. Late homework will not be accepted. Problem sets and solutions will be made available via the course website. Students are welcome to discuss homework with others, but all submitted work must be original.

Grading Policy and Weighting:

Homework, a midterm exam, a final exam, and instructor's discretion will be used to evaluate performance with the following weights:

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| 4.5% × 6 | + | 32% | + | 36% | + | 5% | = | 100% |
| homework | | midterm exam | | final exam | | instructor's discretion | | total |

Attendance Policy:

This course does not include scheduled class meetings. Students are expected to complete the online video lectures in a timely manner, that is, twice a week, preferably within two days after the videos are posted.

Academic Integrity:

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. Review Georgia Tech's Honor Code and the student Code of Conduct at:

https://catalog.gatech.edu/policies/honor-code/

https://catalog.gatech.edu/rules/18/

Accommodations for Students with Disabilities:

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services (404-894-2563) as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Student-Faculty Expectations Agreement:

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Student-Faculty Expectations (http://www.catalog.gatech.edu/rules/22/) articulate some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.