Clemson University
Department of Electrical and Computer Engineering
***ECE 893,* High-Power Lasers and Their Applications**
Spring, 2023

Professor:
Dr. Liang Dong, 203 AMRL, Dong4@clemson.edu

Text (recommended):
W. Koechner, Solid-State Laser Engineering, Springer
L. Dong and B. Samson, Fiber Lasers, CRC Press

Prerequisites: Introductory courses in optics and introductions to lasers.
Co-requisites: None

Class Hours: 3:30 to 4:45pm Tuesdays and Thursdays, RIGGS 301

Office Hours: email to arrange

Students should use email for routine questions about course materials, notes, homework, or course mechanics.

Goals of the Course:
This course covers key physics and technologies in high-power lasers and their applications.

Attendance:
Students are required to be present during class hours. This is without exception unless prior arrangements are made. All course materials will be posted on the Blackboard. Some lectures may cover material not found in the course materials. It is the responsibility of each student to make up any deficiencies that result from a missed class. If the instructor does do not arrive within 15 minutes of the start of a class and no prior arrangements have been made, class will be canceled for that day.

Important Administrative Dates: TBA

Testing Procedures:

Assignments and tests.

Grading:
Final grades will be from a weighted overall performance where each student's work will be weighted according to the following (subject to revisions):

1. Attendance: 10%
2. Assignments: 65%
3. Final test: 25%
4. A final grade assigned based on the scale
   90-100 -> A
   80-90 -> B
   70-80 - >C
   60-70 -> D
   <60 -> F.

Any assignment or test missed will be given a grade of zero and there is no policy of dropping the lowest grades.

Testing:
Assignment will be posted on Canvas.

Academic Integrity:
No cheating will be tolerated. Collaboration on homework assignments is acceptable if it is a shared effort. The official statement on Academic Integrity is as follows:

"As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty distracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form."

Course Outline:

Topics Covered

- I. Laser fundamentals
  - i. Introduction
    - a. Course introduction
    - b. Background
    - c. Key performance
    - d. Characterizations
  - ii. Optical gain
    - a. Optical amplification
    - b. Stimulated transitions
    - c. Population inversion
    - d. Rate equations
    - e. Active ions
    - f. Gas lasers
    - g. Chemical lasers
    - h. Host materials
  - iii. Laser oscillators
    - a. Threshold conditions
    - b. Gain saturation
    - c. Output power
  - iv. Optical Resonator
    - a. Transverse modes
    - b. Resonator configurations
    - c. Stability and diffraction losses
    - d. Mode selection
    - e. Longitudinal modes
  - v. Laser modeling
    - a. Two-level system
    - b. Three-level system
    - c. Overlap of dopants and optical modes
    - d. Amplified spontaneous emission
    - e. Numerical modeling
- II. High-power Lasers
  - i. Fiber lasers
    - a. Components
    - b. Thermal and nonlinear limits
    - c. KW ytterbium laser and amplifier architectures
    - d. Thulium fiber lasers
  - ii. Solid-state lasers
    - a. Introduction
    - b. Think-disc lasers
- III. Pulsed High-power Lasers
  - i. Long pulsed lasers
    - a. Basic structure
    - b. Operation of Q-switched lasers
  - ii. Ultrafast lasers
    - a. Introduction
    - b. Active mode-locking
    - c. Passive mode locking
- IV. Further power scaling
  - i. Coherent combining
  - ii. Spectral combining
- V. Applications of High-power Lasers
  - i. Industrial applications
  - ii. Scientific applications
  - iii. Medical applications
  - iv. Defense applications

Updated 1/6/2022