

ASEN 5519. Fundamentals of Spectroscopy For Optical Remote Sensing

Syllabus, Fall 2007

Lecture: KTCH 234 Monday, Wednesday, and Friday at 2:00-2:50 pm

Instructor

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Office Hours: Monday and Wednesday at 3 - 4 pm @ CIRES 1B49 or 241

Prerequisites

The prerequisites for this class include a basic understanding of general physics and modern physics (e.g., optical and atomic physics, optical electronics, and some laser basics). These are all topics that are covered in undergraduate physics or engineering programs. If you do not have a background in one of these areas you should expect to spend some extra time on the specific material. Note – This is a graduate class and you are expected to work independently to solve problems. There are many resources, including the library, at your disposal. If you feel that you are significantly deficient in more than one of the areas listed above then you should contact the instructor.

Course Objective

Optical (especially laser) remote sensing has become one of the most important approaches in science study, environmental research, and industry application, which is not only replacing conventional sensors but also creating new methods with unique properties that could not be achieved before. However, extensive knowledge in the atomic, molecular and laser spectroscopy is needed in order to study and further advance optical and laser remote sensing technologies. One of the goals of this spectroscopy course is to provide a comprehensive preparation for the laser remote sensing (lidar) class offered at CU in the Spring Semester. It will cover the fundamental knowledge from *quantum mechanics to atomic spectroscopy, and from molecular spectroscopy to laser spectroscopy*. Meanwhile, these contents are also very important parts of modern physics and technology, so they have very wide applications in many fields. Further goals of this spectroscopy course are to expose students to these modern physics and technologies, and to prepare them with the necessary knowledge and ability to pursue research and/or applications in spectroscopy-related fields.

Objectives of the course are to:

- (1) Provide a comprehensive, yet easily understandable, up-to-date overview of the fundamentals of quantum mechanics, atomic spectroscopy, molecular spectroscopy, and laser spectroscopy.
- (2) Expose students to the spectroscopy applications in modern optical and laser remote sensing.
- (3) Teach students the fundamental knowledge and skills for learning new things.

The related lidar class can be found at the following website:

<http://cires.colorado.edu/science/groups/chu/classes/Spectroscopy2007/>

Course Content

The class contains 4 major sections:

1. FUNDAMENTALS OF QUANTUM MECHANICS

Concept of quantum,

Wave-Particle Duality

Quantum Mechanics Postulates, Principles, and Mathematic Formalism

2. FUNDAMENTALS OF ATOMIC SPECTROSCOPY

Atomic Structure

Radiative Transitions

Atomic Spectra

3. FUNDAMENTALS OF MOLECULAR SPECTROSCOPY

Molecular Structure

Molecular Spectra

4. FUNDAMENTALS OF LASER SPECTROSCOPY

How to detect atoms and molecules using spectroscopy methods?

How to obtain high detection sensitivity?

How to obtain high spectral resolution?

Texts

Textbook: Laser Spectroscopy, by Wolfgang Demtröder.

Major Reference Books for Students:

“Quantum Mechanics I, II” by Claude Cohen-Tannoudji (Nobel Laureate)

“Atomic and laser spectroscopy” by A. Corney

“Structure and Spectra of Atoms” by Richards and Scott

“Molecular Spectroscopy” by John M. Brown

“Atomic Spectra” by T. P. Softley

Instructor’s Reference Books:

“Quantum Mechanics I, II” by Claude Cohen-Tannoudji etc

“The Principles of Quantum Mechanics” by P. A. M. Dirac

“Quantum Mechanics” by Landau and Lifshitz

“The Quantum Theory of Light” By Rodney Loudon

“Atomic and laser spectroscopy” by A. Corney

“Quantum Theory of Atomic Structure I, II” by Slater

“Atomic Spectra and Radiative Transitions” by Sobelman

“The Theory of Atomic Spectra” By Condon and Shortley

“Molecular Spectra and Molecular Structure I, I, III” by Herzberg

The textbook was chosen for its comprehensive descriptions of quantum physics, lasers, and laser spectroscopy. There are many books on spectroscopy, laser, optics, and optical electronics. You can access them through CU Libraries.

Class Format

The class will be comprised of regular lectures three times per week. Reading and homework will be assigned. Guest lectures will be introduced to illustrate some novel applications of spectroscopy in modern optical and laser remote sensing. Field trips may be arranged to see the real application instruments in Chu Research Group. The class will contain three take-home exams.

Course Grading

45	Homework (11 HWK)
15	Exam 1 (Quantum Mechanics)
20	Exam 2 (Atomic Spectroscopy)
20	<u>Exam 3 (Molecular and Laser Spectroscopy)</u>
100	Total

Disabilities

If you qualify for accommodations because of a disability, please submit a letter to me from Disability Services in a timely manner so that your needs may be addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671, Willard 322, or

www.Colorado.EDU/disabilityservices

Religious Observances

Campus policy regarding religious observances requires that faculty make every effort to reasonably and fairly deal with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, all dates for exams, assignments and presentations are fixed in the course schedule. Please review the course schedule and let me know if certain dates conflict with your religious obligations. See policy details at

http://www.colorado.edu/policies/fac_relig.html

Classroom behavior

Students and faculty each have responsibility for maintaining an appropriate learning environment. Students who fail to adhere to behavioral standards may be subject to discipline. Faculty have the professional responsibility to treat students with understanding, dignity and respect, to guide classroom discussion and to set reasonable limits on the manner in which students express opinions.

See policies at

<http://www.colorado.edu/policies/classbehavior.html> and at
http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code

Academic Honor Code

As a student at the University of Colorado you are bound by an academic code of honor. The purpose of an Honor Code at the University of Colorado at Boulder is to secure an environment where academic integrity, and the resulting behavior, can flourish. The Honor Code recognizes the importance of honesty, trust, fairness, respect, and responsibility and wishes these principles to be a defining part of the CU-Boulder campus. The Honor Code allows all students to have responsibility for, and the ability to attain, appropriate recognition for their academic and personal achievements. A student-run Honor Code is necessary because research indicates that these institutions are highly successful in alleviating indiscretions and promoting an academically honorable community. In addressing any proven student violations regarding the Honor Code, the student leadership of the Honor Code Council applies only non-academic sanctions, and the faculty applies academic sanctions.

- Academic Dishonesty: Any of the following acts, when committed by a student at the University of Colorado at Boulder, shall constitute academic dishonesty:
 - i. Plagiarism: Portrayal of another's work or ideas as one's own;
 - ii. Cheating: Using unauthorized notes or study aids, allowing another party to do one's work/exam and turning in that work/exam as one's own; submitting the same or similar work in more than one course without permission from the course instructors;
 - iii. Fabrication: Falsification or creation of data, research or resources, or altering a graded work without the prior consent of the course instructor;
 - iv. Aid of Academic Dishonesty: Intentionally facilitating plagiarism, cheating, or fabrication;
 - v. Lying: Deliberate falsification with the intent to deceive in written or verbal form as it applies to an academic submission;

- vi. Bribery: Providing, offering, or taking rewards in exchange for a grade, an assignment, or the aid of academic dishonesty;
- vii. Threat: An attempt to intimidate a student, staff, or faculty member for the purpose of receiving an unearned grade or in an effort to prevent the reporting of an Honor Code violation.

Violations of the Honor Code are acts of academic dishonesty and include but are not limited to: plagiarism, cheating, fabrication, aid of academic dishonesty, lying to course instructors, lying to representatives of the Honor Code, bribery or threats pertaining to academic matters, or an attempt to do any of the aforementioned violations. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-725-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). **Any act of academic dishonesty will result in an F for this course** and will become a permanent part of the student's academic record. For more information about the University of Colorado student honor code see

<http://www.colorado.edu/policies/honor.html> and at <http://www.colorado.edu/academics/honorcode/>

Plagiarism

This course includes a research project and final written report. In constructing the research paper it is expected that ideas and concepts will come from specific reference material. It must be demonstrated that this material supports the original premise of your research project and is properly referenced. Please examine the following guidelines to avoid committing plagiarism:

[What is Plagiarism?](#), Georgetown University

[How to avoid Plagiarism](#), Northwestern University

[Plagiarism: What it is and how to recognize and avoid it](#), Indiana University

Sexual Harassment Policy

The University of Colorado Policy on Sexual Harassment applies to all students, staff and faculty. Sexual harassment is unwelcome sexual attention. It can involve intimidation, threats, coercion, or promises or create an environment that is hostile or offensive. Harassment may occur between members of the same or opposite gender and between any combination of members in the campus

community: students, faculty, staff, and administrators. Harassment can occur anywhere on campus, including the classroom, the workplace, or a residence hall. Any student, staff or faculty member who believes s/he has been sexually harassed should contact the Office of Sexual Harassment (OSH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the OSH and the campus resources available to assist individuals who believe they have been sexually harassed can be obtained at:

<http://www.colorado.edu/sexualharassment/>

Other Policies

Please be respectful of others during class time. This includes turning off your cell phone before class and not talking during class unless you have the floor. Details about all of the university policies can be found on the web at <http://www.colorado.edu/policies/index.htm>