Special Topics: OSE 6938
Modern Methods of Optical Spectroscopy
College of Optics and Photonics, University of Central Florida

COURSE SYLLABUS

Instructor:	Ryan Gelfand	Term:	Spring 2017
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Website:		Office Hours:	

I. University Course Catalog Description

This class will cover advanced concepts of both atomic and molecular spectroscopy, emphasizing fundamental principles and experimental design, with its primary goal being to teach students how to develop experimental techniques in order to take and interpret a variety of different spectra from atoms and molecules.

II. Course Overview

Spectroscopy, the measurement of the interaction between light with matter, has played a pivotal role in our understanding of atoms and molecules since Isaac Newton. Advances in this field have contributed to the development of LASERS, analytical chemistry techniques, single molecule sensors, telescopes for exoplanet discovery, medical devices, etc. Optical spectroscopy plays a pivotal role in biophysics, astronomy, material science, and chemistry; and recent advances in these fields continue to lead to major breakthroughs. This class will cover optical spectroscopy from theoretical foundations to experimental data taking techniques. Spectroscopy of both atoms and molecules will be explored in a variety of wavelength regimes. The class will start by introducing quantum mechanical concepts and notation relevant to this study. Then move onto atomic spectroscopy, followed by rotational, vibrational, and Raman molecular spectroscopy, finishing up with x-ray spectroscopy and finally fluorescent spectroscopy. Each topic will include theoretical concepts b experimental techniques. By the end of this course students will have a strong understanding of advanced topics in spectroscopy and the tools to apply them to further their own research.

III. Course Objectives and Outcomes

This is a graduate level course but it will be available and interesting to students from different backgrounds (chemistry, biomedical science, biology, optics, physics, engineering).

At the end of this course students will be expected to have knowledge of the newest ideas and methods in the realm of optical spectroscopy for both atoms and molecules. They will be able to sit in on any level of seminar or colloquium and know how the optical setups presented in the talk work, there advantages and disadvantages, and how to engage in discussions that include these techniques. They will also be able to understand how their own work in optics relates to the growing number of spectroscopic techniques or how their work can be improved with a deep understanding of the methods with which they work. Lastly this class will bring together students from a variety of backgrounds and a variety of research interests, they will leave the class with better tools for communicating across disciplines. This increase in communication will lead to deeper and more meaningful collaborations between optics, astronomy, chemistry, biology, engineering, etc.

IV. Course Prerequisites

Students will be encouraged to have taken Light Matter Interactions or similar (Chemistry 5580, physics 5606). Some quantum mechanics will be expected. Advanced classes in physical chemistry and biophysics will be useful for students from the life sciences. An understanding of optical scattering and optical imaging systems (microscopes, lens systems) will also be useful. This class will be accessible to students from many different disciplines, but will be geared towards those that have been exposed to light matter concepts and quantum mechanics.

V. Course Credits

3 (3,0)

VI. Required Texts and Materials

I will be putting together a course packet from the library including chapters from

Modern Spectroscopy
  by J. Michael Hollas
Condensed-Phase Molecular Spectroscopy and Photophysics
  by Anne Myers Kelley
Nonlinear Optics, Third Edition
  by Robert W. Boyd
Modern Optical Spectroscopy: With Exercises and Examples from Biophysics and Biochemistry 2nd ed.
  by William W. Parson

VII. Topics Covered

- Fundamentals
    - Interaction of Radiation with Matter
    - Absorption and Emission of Radiation
    - Beer's Law
- Atomic Spectroscopy
    - Hydrogen Atom Spectra
    - Spin Orbit Coupling
    - Experimental design and implementation
- Rotational Spectroscopy
- Vibrational Spectroscopy
    - Diatomic Molecules
    - Vibrational Modes of Polyatomic Molecules
    - Infrared Transitions
    - Vibrational Spectra
    - Experimental design and implementation
- Raman Spectroscopy
    - Classical and Quantum Models
    - Rotational Raman Effect
    - Vibrational-Rotation Raman Spectroscopy
    - Rayleigh and Raman Intensities
    - Experimental design and implementation
- Fluorescent Spectroscopy
    - Absorption and Emission
    - Measurement and calculation
    - Types of fluorophores (molecular, protein, quantum dot)
    - Lifetime calculations
    - Experimental design and implementation
- X-Ray Spectroscopy
    - Energy-dispersive
    - Wavelength-dispersive
    - Experimental design and implementation

VIII. Basis for Final Grade

Provide a listing of assessments and their weighting in the semester total. In addition to (or even in lieu of) tests, consider exploring “authentic” assessments, which are based as closely as possible to real world experiences.

Assessment	Percent of Final Grade
Homework	20%
Exam 1	30%
Exam 2	30%
Final Project	20%
	100%