Institutional Name- University of Wisconsin- Madison

Syllabus for Chemistry 623

Experimental Spectroscopy- This 2-credit class meets each week for two 50-minute lectures. Over the course of the semester, students are expected to do at least 90 hours of learning activities, which includes class attendance, reading, studying, preparation, problem sets, and other learning activities. The course is based on a complete set of notes, research publications, and computer programs that simulate fundamental spectroscopic principles. Python is required for all homework.

Course Description- The theory behind current spectroscopic methods employed in chemical analysis with applications in atomic and molecular absorption spectroscopy, infrared and Raman vibrational spectroscopy, fluorescence and light scattering. **Requisites:** Chem 562 or consent of instructor

Course Designation: Breadth - Physical Science. Course counts toward the Natural Science requirements.

Instructional mode: face-to face

Level – Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

Repeatable for Credit: No

Course Instructor- Professor John C. Wright, office 3209 Chemistry, Office Hours 10-11 AM on Mondays and Tuesdays, phone is 608-262-0351, wright@chem.wisc.edu.

Course Website URL- https://canvas.wisc.edu/courses/76146

Two weekly lectures-8:50-9:40 AM on Tuesday and Thursday in room 2372

Course objectives- This course's objectives are to present complete coverage of all of the topics that are required for a Ph.D. level experimental spectroscopist. The course covers the nature of the electronic and vibrational spectra of atoms, molecules, and materials; the nature of light; a quantitative and fundamental theoretical treatment of light-matter interactions; and how they provide a complete and unified description of all spectroscopic properties; a rigorous treatment of experimental optics, diffraction, interference, monochromators, conventional light sources, lasers, detectors, and electronics. The course requires students to quantitatively master the theoretical foundations underlying the topics listed above using Python software.

Course Outcomes- Students finishing this course will have the knowledge and skills to perform state-of-the-art spectroscopy.

Requirements and Evaluation- Students will do weekly assignments that require development of theoretical simulations of spectroscopic theory and experimental methodologies, and read and analyze current spectroscopic research publications. Students will deliver their work to the course website dropbox, present their work to the class at weekly homework discussion sections and the individual students will grade their own work.

The lecture schedule appears below:

CHEMISTRY 623 **EXPERIMENTAL SPECTROSCOPY** **SPRING, 2018**

DATE	LECTURE TOPIC
1/23	Atomic Spectroscopy, Ions in Crystals, Materials Spectroscopy
1/25	Molecular Spectroscopy
1/30	Molecular Spectroscopy and Dynamics
2/1	Vibrational spectroscopy; Nature of Light
2/6	Time dependent perturbation Theory
2/8	Spectroscopic Theory
2/13	Spectroscopic Theory
2/15	Physical Optics; Interference; Diffraction; two slits; N slits
2/20	Finite slits; Gaussian Beam Propagation; Diffraction Grating Theory
2/22	Gaussian Optics; Focusing Lasers
2/27	Interferometers, Interference Filters, Holographic Filters
3/1	Mode Locking; Group and Phase Velocity; Ultrafast Lasers
3/6	Fundamentals of Lasers
3/8	Laser Theory
3/13	Threshold Conditions; Slope Efficiency; Laser Cavities, Optical Modes, Single Mode Lasers
3/15	Examples of lasers- Nd:YAG; Ti:Sapphire;Ar and Kr Ion
3/20	Cavity Design; Diffraction Loss; Cavity Ring Down Spectroscopy
3/22	Q switching, Mode Locking, and Femtosecond Spectroscopy
3/27	SPRING BREAK
3/29	SPRING BREAK
4/3	Nonlinear Optics
4/5	Frequency Doubling; Sum and Difference Frequency Mixing; Phase Matching; Optical Parametric Oscillators and Amplifiers
4/10	Fundamentals of Monochromators- dispersion; Free Spectral Range; Grating Blaze; Monochromator Design
4/12	Use of Monochromators; Double Monochromators; Instrument Functions; Ultimate Resolution
4/17	Geometric Optics; Image Formation; Magnification; Solid Angle; Brightness; Intensity; Aberrrations
4/19	Photomultipliers
4/24	Use of Photomultipliers; Noise Considerations; Lock-In Detection; Photon Counting; Time Correlated Single Photon Counting;
4/26	CCD Detector Fundamentals
5/1	CCD Quantum Efficiency; Noise; Practical Considerations;
5/3	Applications- Molecular Spectroscopy- Electronic & Vibrational States; Configuration Coordinates; Franck-Condon principle; M
5/8	Final Examination- 7:45AM