IISER Pune CHM-410 - Advanced Molecular Spectroscopy

1	Course code	CHM 629
2	Course Title	Advanced Molecular Spectroscopy
3	Credits	4
4	Course Coordinator	Dr. Mrinalini Puranik
5	Nature of Course	L- lectures alone
6	Pre requisites	Desirable: Fundamentals of Molecular Spectroscopy
7	Objectives (goals, type of students for whom useful, outcome etc)	The course will provide and introduction to modern optical spectroscopic and imaging techniques and their applications to biology and chemistry. First part of the course will be an introduction to fundamental concepts of light-matter interaction, lasers and laser systems, detectors and other relevant aspects of instrumentation necessary for spectroscopy and imaging. In the second part of the course we will discuss various modern spectroscopic techniques. Discussion of each technique will be followed by examples from classic and contemporary literature.
8	Course contents (details of topics /sections with no. of lectures for each)	**Section #1- Light and its interaction with matter** Topics: Introduction to electromagnetic radiation, Polarization of light (linearly, circularly and elliptically polarized light and how to produce them), Absorption and emission of radiation, Einstein coefficients of A and B, Time-dependent perturbation theory: Quantum description of matter, Selection rules, Line width and Line broadening. 4L **Section #2 – Instrumentation: Fundamentals of lasers and laser systems, detectors, spectrometers and microscopes** Topics: (i) Introduction to lasers, Laser resonators, Frequency and spatial properties of laser radiation, Gain in continuous-wave and pulsed lasers, Q-switching and the generation of nanosecond pulses, Mode locking and the generation of picosecond and femtosecond pulses. 6L (ii) Fixed-wavelength gas lasers: He-Ne, rare-gas ion, CO_2 and excimer lasers, Fixed-wavelength solid-state lasers: Nd:YAG laser, Tunable dye laser systems, Tunable Ti:sapphire laser

		systems, Semiconductor diode lasers, Non-linear crystal and frequency-mixing processes, Optical parametric oscillation. **Section #3: Electronic spectroscopy** Topics: Electronic states of molecules, Electronic Absorption, Fluorescence, Phosphorescence, Vibrational coarse structure, Franck-Condon Principle, Herzberg-Teller vibronic coupling. 5L **Section #4: Advanced Laser spectroscopic techniques** Topics: (i) Cavity ring-down spectroscopy, Laser induced fluorescence, Steady-state and time-resolved electronic spectroscopy, transient absorption, circular dichroism spectroscopy, fluorescence spectroscopy and microscopy, two-photon and multiphoton spectroscopy and microscopy, time-resolved infra-red spectroscopy, 2-D IR. (ii) Scattering, Steady-state and time-resolved Resonance Raman spectroscopy, Surface Enhanced Raman Spectroscopy (SERS), Coherent anti-stokes Raman spectroscopy (CARS). Stimulated Raman spectroscopy, (iii) Ultrafast spectroscopy, Laser femtochemistry. 20 L
9	Evaluation /assessment (	1. End-sem examination- 30% 2. Mid-sem examination- 30% 3. Poster/Oral Paper Presentation/Quiz – 20% 4. Assignments-20%
10	Suggested readings (with full list of authors, publisher, year, edn etc.)	Text Books 1. This is an advanced course and will draw material from contemporary and classic primary literature. These will include papers, reviews and perspectives from scientific journals. They will form essential reading material apart from the text books on each topic.

		2. Modern Spectroscopy, Jeanne McHale 3. Physical Chemistry, Atkins 4. Modern spectroscopy, J. M. Hollas (Wiley, New York, 2004) 5. High Resolution Spectroscopy, J. M. Hollas (Wiley, 2nd edition, 1998) 6. Physical Chemistry - A Molecular Approach; Donald A. McQuarrie and John D. Simon (Viva Books Private Limited, New Delhi, 1997) 7. Laser fundamentals: W. T. Silfvast (Cambridge University press, Published in South Asia by Foundation Books, New Delhi, 1998) 8. Laser Chemistry: Spectroscopy, Dynamics and Applications by H. H. Telle, A. G. Urena, R. J. Donovan (Wiley, 2007). 9. Introduction to Fluorescence Spectroscopy, Lackowitz