ULTRAFAST LASER SPECTROSCOPY

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TYPE OF COURSE : Rerun | Elective | PG
COURSE DURATION : 12 weeks (24 Jan' 22 - 15 Apr' 22)
EXAM DATE : 23 Apr 2022

PRE-REQUISITES : A basic course in Molecular Spectroscopy

INTENDED AUDIENCE : Chemistry, Physics, Materials Science, Biological Sciences, Chemical Engineering Students

COURSE OUTLINE :

The course introduces students to laser spectroscopy, with an emphasis on ultrafast spectroscopy. It deals with fundamentals of instrumentation, data analysis and contemporary research in the field. The syllabus is as follows: Basics. Electronic absorption, fluorescence and phosphorescence. Fluorescence quantum yields and lifetimes. Solvent effects. FRET, fluorescence anisotropy. Tools. Fundamentals of instrumentation. Photon counting vs. analog detection. Time correlated single photon counting, Fluorescence upconversion, Transient absorption, Stimulated Raman spectroscopy. Temperature and pH jump experiments. Fluorescence Lifetime Imaging Microscopy. Applications. Ultrafast dynamics of the chemical bond, Solvation dynamics, Ultrafast dynamics of aqueous systems, Photoisomerization, Light harvesting antennae, Protein folding, Time resolved spectroscopic techniques in DNA sequencing, Ultrafast dynamics in nanomaterials and other novel fluorophores, Photoinduced electron transfer dynamics in Dye Sensitized Solar Cells. Time and space resolved spectroscopy of perovskites.

ABOUT INSTRUCTOR :

Prof. Datta is a Professor of Chemistry in IIT Bombay, with research interest in ultrafast spectroscopy and time resolved fluorescence microscopy. He has teaching experience of 17 years. 14 Ph. D. students have graduated from our laboratory. Eight more are working towards their degree. He received Excellence in Teaching Award from the institute in 2017 and has taught two NPTEL courses: one on Molecular Spectroscopy and another on Symmetry in Chemistry.

COURSE PLAN :

Week 1**:** Introduction, Steady state spectroscopy, Spectrophotometers Lab visit: Spectrophotometers

Week 2**:** TCSPC theory Lab visit: TCSPC TCSPC data analysis

Week 3**:** Streak Camera Femtosecond Optical Gating Lab visit: Femtosecond Optical gating

Week 4**:** Pump probe technique: Theory Lab visit: Pump probe Impulsive Raman spectroscopy

Week 5**:** How are ultrashort pulses produced and amplified? Optical parametric Amplification

Week 6**:** Nonlinear optics

Week 7**:** Fluorescence depolarization and its time evolution: basics and application

Week 8**:** Forster Resonance Energy Transfer

Week 9**:** Application of ultrafast laser spectroscopy in basic science: How much time does it take for a bond to break? What is the mechanism of acid base reaction?

Week 10**:** Solvation dynamics, Hydrogen bond dynamics

Week 11**:** Ultrafast processes in materials science

Week 12**:** Ultrafast processes in life sciences