

Optical Spectroscopy and Microscopy

A Graduate course in Chemical Sciences, Tata Institute of Fundamental Research
Fall 2021

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Tutor/Grader: Debsankar Saha Roy

Schedule

Monday, Wednesday, Friday 930-1100 AM on Zoom and in AG 80 (as appropriate)

First Lecture: Friday, August 20, 2021, Final Exam: Wednesday, Dec. 15, 2021

Syllabus

PART I: INTRODUCTION

A) Molecular Spectroscopy: What it can tell us, its limitations, basic introduction to various forms of optical spectroscopy

B) Microscopy: What it can tell us, its limitations, basic introduction to Optics and Imaging

PART II: OPTICS, LASERS AND MICROSCOPY

A) Lasers and amplifiers, non-linear optics

B) Ultrafast spectroscopy

C) Properties of light, Maxwell's equations, fiber optics

D) Diffraction theory

E) Microscopy: Theory of Image formation, Confocal and multiphoton microscopy

F) Super-resolution microscopy

G) Single molecule microscopy

PART III: OPTICAL SPECTROSCOPY

A) Light matter interactions: perturbation theory, second quantization

B) Two level systems: Density matrix formalism, Concepts of weak/strong perturbation, dephasing and Coherence.

C) Molecular spectroscopy: Born Oppenheimer approximation, motion on potential energy surfaces, non-radiative decay

D) Brief introduction to UV/VIS, Vibrational, Raman and Circular Dichroism spectroscopy

E) Fluorescence spectroscopy

F) Fluorescence lifetime, TCSPC technique, Quenching, FRET, Anisotropy

G) Fluorescence correlation spectroscopy