OPTICAL SPECTROSCOPY AND MICROSCOPY: FUNDAMENTALS OF OPTICAL MEASUREMENTS AND INSTRUMENTATION

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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

INTENDED AUDIENCE : Life Science, Photonics, Instrumentation
INDUSTRIES APPLICABLE TO : Carl Zeiss, Leica, DSS Image Tech, Olympus, Nikkon, Optica, Holmarc

COURSE OUTLINE :
In this course, the foundations of spectroscopy from the viewpoint of light matter interaction is taught. Also demonstration of the working of these instruments in a lab setting on how to build some of these systems is carried out. It is a unique course in which theoretical foundation as well as practical aspects of the building a scientific equipment from ground up is covered.

ABOUT INSTRUCTOR :
Prof. Balaji Jayaprakash is Assistant Professor, Centre for Neuroscience, Indian Institute of Science Research: Learning and Memory Post Doctoral Fellow with Prof. Silva, Department of Neurobiology, UCLA, Los Angeles, July 2007- Dec 2011 Post Doctoral Fellow with Prof. Ryan, Department of Biochemistry, Weil Medical College of Cornell University, New York, NY - 10021. USA, 2005 - 2007 Tata Institute of Fundamental Research, Visiting Fellow, 2004 - 2005 Tata Institute of Fundamental Research, Ph.D. (Chemistry), 2004

COURSE PLAN :

Week 1**:** Essential Quantum Mechanics: Uncertainity Principle, Probabilistic nature of measurement, postulates of qmech, Stern Gerlach equivalent in light, Photon picture (PMT response), Linear Vector Space.

Week 2: Time dependent perturbation theory, Fermi Golden Rule, Transition probability in light matter interaction, Beer Lambert relation, Einestin's phenomenolgical treatment, A and B coefficients, Spontaneous emission, Origins of fluorescence

Week 3: Nature of Fluorescence, Emisson spectrum, Absorption spectrum

Week 4: Second quantaisation, creation and anhilation operators, Fock states

Week 5: Spontaneous emission orgin

Week 6: Laser emission, two state, three state and four state laser systems

Week 7: Real world lasers, Characteristics of laser emission

Week 8: Laser induced fluorescence, optical components and their working principles

Week 9: Intro to optical hardware, common opto-mechanical assemblies

Week 10: Principles of photo detection, QE, Dynamic range shot noise, photodetectors – PMTs, photodiodes, photo resistors, understanding common metrics and specs. Detection electronics – preamps, A2Ds

Week 11: Area detectors, CCDs, emCCDs, sCMOS, comparison, read noise, speed and other sensor charecteristics. Theory of Image formations – widefiled microscopy, bright field, phase contrast, DIC and fluorescence microscopy

Week 12: Scanning system