IIT Mandi
Proposal for a New Course

Course Number	: CY 670
Course Name	**: Fluorescence spectroscopy, microscopy and applications**
Credits	: 3-0-0-3
Prerequisites	**: NA**
Intended for	**: MSc / M. Tech / PhD in Chemistry, Physics, nanotechnology and other discipline relevant to the course content**
Distribution	**: Elective**
Semester	**: Odd/Even**

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1. **Preamble:** The main focus of this course is to provide deeper understanding on fundamentals of fluorescence spectroscopy, microscopy and its application in chemical sciences, physical sciences, life sciences and material sciences. The designed course will be extremely helpful for the students, who designed new molecules, materials for the real application.

2. **Course Modules with Quantitative lecture hours:**

Module 1: Introduction to fluorescence spectroscopy: (12)
Light matter interaction, different processes when light absorbed by matter, light scattering, Fluorescence, Phosphorescence, absorption, Transition moments and transition probabilities, Einstein's coefficients, oscillator strength, Beer-Lambert law, polarizabilities, Frank Condon Principles. Steady state fluorescence, Jablonski diagram describing the excited processes, characteristics of fluorescence spectra, Kasha and Vavilov's rule, stokes shift, radiative and nonradiative processes, overview of time and frequency domain measurement, fluorescence lifetime or decay, quantum yield and calculation, time correlated single photon counting (TCSPC), light source and electronics for TCSPC, Instrumentation of steady state and time resolved spectrophotometer such as light source, detectors etc.

Module 2: Solvent and environment effects: (4)
Effect of solvent polarity on spectral shift, general solvent effect, The Lippart Mataga equation, specific solvent effect, temperature effect, additional factors affecting the spectral shift locally excited and internal charge transfer states, excited state intramolecular proton transfer, dynamics of solvent effect, time resolved emission spectra (TRES), picosecond spectral relaxation in solvent, theory for time dependent solvent relaxation, red edge excitation shift.

Module 3: Quenching of fluorescence (6)
Reasons of fluorescence quenching, type of quenching, static and dynamic quenching, stern volmer equation, theory of static quenching, mechanism of dynamic quenching, theory of combined quenching, photo-induced electron transfer based quenching, application fo quenching in proteins, DNA dynamics, sensors, molecular beacons based quenching, effect of temperature, viscosity on the quenching,

Module 4: Fluorescence resonance Energy Transfer (FRET) (6)

Basics of energy transfer, donor acceptor pair, factors affecting the energy transfer, surface energy transfer (SET), difference between FRET and SET, comparison of quenching and FRET, distance dependent FRET, SET and quenching, metal enhanced fluorescence (MEF), mechanism of MEF, radiative decay engineering in MEF, surface plasmon coupled emission, energy transfer to multiple acceptors in one, two three dimentions.

Module 5: Fluorescence anisotropy (4)

Definition and theory of fluorescence anisotropy, relation of polarization to anisotropy, L and T format for anisotropy, effect of resonance energy transfer on anisotropy, effect of rotational diffusion on fluorescence anisotropy, time dependent anisotropy decay, rotational correlation time, applications of anisotropy on molecular interactions.

Module 6: Fluorescence microscopy and single molecule detection (10)

Basic principles and applications of wide filed fluorescence microscopy, fluorescence lifetime imaging microscopy (FLIM), confocal microscopy, laser scanning TCSPC FLIM, single molecule detection (SMD), optical configuration of SMD, SMD detectors, single molecule based FRET, total internal reflection (TIRF), Fluorescence correlation spectroscopy (FCS), effect of concentration, diffusion coefficient, duel color fluorescence cross correlation (FCCS), applications of FCS and FCCS.

3. Text book:

1. Principles of fluorescence spectroscopy by Joseph R Lakowicz, 3rd edition, 2010 (springer).
2. Handbook of single molecule biophysics by Peter Hinterdorfer, Antoine Van Oijen, 2009 (Springer).

4. References:

1. Single Molecule Spectroscopy: Nobel Conference Lectures by R. Riglet, M. Orrit, T Basche, 1st edition 2012, (Springer Series in Chemical Physics)
2. Fluorescence Spectroscopy and Microscopy by Yves Engelborghs, Antonie Visser, 2014, (springer).
3. New Trends in Fluorescence Spectroscopy: Applications to Chemical and Life Sciences By M Valeur and J. C. Brochon1st ed. 2001 (springer)
4. Fluorescence Applications in Biotechnology and Life Sciences by Ewa M. Goldys, 1st Edition, 2010(Wiley Blackwell)

5. Similarity Content Declaration with Existing Courses: NO

S.N.	Course Code	Similarity Content	Approx. % of Content
		NA	
		NA	

6. Justification for new course proposal if cumulative similarity content is > 30%:

Approvals:

Other Faculty interested in teaching this course:

Proposed by: Dr. Chayan K Nandi School: SBS

Signature: _______________ Date:

Recommended/Not Recommended, with Comments:

________________________________ Date:____________

Chairman, CPC

Approved / Not Approved

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Chairman, Senate