Birla Institute of Technology & Science, Pilani
Hyderabad Campus

FIRST SEMESTER 2020-2021

Course Handout (Part - II)

Date: 17-08-2020

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : **CHEM F412**
Course Title : **Photochemistry and Laser Spectroscopy**
Instructor-in-charge : **Amit Nag**

1. Course Description: This course is based on the exposure to theories on photophysical chemistry and LASER spectroscopy and their applications in different fields of biology/chemistry/physics. The course is normally available to students of third year onward or higher level.

2. Scope and Objective of the Course: Common photochemical and photophysical processes and mechanisms, interaction of excited states with their surroundings, photoinduced electron and excitation energy transfer, structure and function of photosynthetic reaction centers. Basic knowledge on the construction and function of LASERS, and its use in biophysics, chemistry, and diagnostics. The students will gain knowledge about modern lasers, spectrometers and detectors.

3. Text Books:

T1: K. K. Rohatgi-Mukherjee, Fundamentals of Photochemistry, John Wiley & Sons.
T2: J. R. Lakowicz, Principles of Fluorescence Spectroscopy, Springer; 3rd edition.
T3: W. T. Silvast, Laser Fundamentals, Cambridge University Press; 2nd edition.

Study Materials will be provided by IC, as and when needed.

4. Reference Books:

R1: Nicholas J. Turro, Modern Molecular Photochemistry, University Science Books, U.S.; New edition.

The syllabus also includes lectures notes.

5. Course Plan:

Lec. No.	Learning Objectives	Topics to be Covered	Learning Outcomes of the Lectures	Chapter in the Text Book
1-3	Basic Laws of Photochemistry	The laws of photochemistry, potential energy surfaces, Frank Condon Principle, absorption, Beer's law, absorption cross-section.	Understand why photochemistry is basic to the world we live in. Appreciate the relevance of photochemistry in varied applications of science and technology. The origin of life itself is a photochemical act!	T1: Chapter 1; Section 1.2 T1: Chapter 4; Sections 4.3-4.5
4-6	Photochemical Processes	Primary processes in photochemical reactions, quantum yield and lifetime.	Understand and compare the efficiency of different photochemical reactions.	T1: Chapter 7; Sections 7.1-7.2 T2: Chapter 1; Section 1.4
7-9	Electronic transitions and excited state photophysics	Excited electronic states, Jablonski diagram, radiative and non-radiative transitions, vibrational relaxation, internal conversion, intersystem crossing, fluorescence, phosphorescence, excimer and exciplex.	Learn different emission processes of a molecule from electronically excited state along with their timescale.	T1: Chapter 5; Sections 5.1-5.3 T2: Chapter 1; Sections 1.1-1.4
10-13	Electron Transfer Reactions	Electron transfer reactions and Fluorescence Resonance Energy Transfer (FRET)	Learn various aspects of FRET and know why it is a popular technique to measure nm scale distances in complex environments in biology. Why it is called spectroscopic ruler?	T1: Chapter 3; Sections 3.10.1-3.10.3 T2: Chapter 1; Section 1.6 T2: Chapter 13; Sections 13.1-13.2
14-15	Solvent Effect on electronic transitions	Solvent effect on absorption and emission, Lippert equation.	Understand why studying solvent effect on absorption and emission is so difficult.	T2: Chapter 6; Section 6.1-6.2.2.
16-19	Excited state relaxation processes	Dynamic stokes shift, dynamic and static	Understand various molecular interactions that can lead to decrease in fluorescence intensity of an	T2: Chapter 8; Sections 8.1-8.2.1.

		quenching, Stern-Volmer equation.	emitter.	
20-25	Applications of Photochemical Reactions	Examples of photochemical reactions, the solar spectrum, reaction centers, photo processes in solar cells, Metal Enhanced Fluorescence, PDT.	Learn about various applications of photochemistry in important natural processes as well as modern day applications in nanotechnology, theranostic medical applications etc.	R1: Chapter 10; Sections 10.1-10.3 Class Notes and study materials supplied by IC
26-29	Introduction to LASER	Einstein coefficients and physical principles of laser action. Stimulated emission, population inversion and light amplification.	Learn what it takes to make a laser from a material and why laser is so special.	T1: Chapter 3; Sections 3.2-3.2.1 T3: Chapter 7; Sections 7.1-7.3 Class Notes
30-35	LASER construction and functions	Construction and function of the laser, Laser types: dye lasers, continuous lasers, pulsed lasers, ultra fast lasers, semiconductor lasers. Pulsed laser: cavity dumping, Q-switching, mode locking.	Learn about different types of lasers as per their operational principles. How to build a laser?	T3: Chapter 5; Sections 5.2-5.4 Class Notes and study materials supplied by IC
36-43	LASER applications	Laser applications in molecular physics and chemical physics and diagnostic purposes	Visualize and appreciate the advancement what laser has brought into, which would not have been possible without it.	Class Notes and study materials

6. Evaluation Scheme:

Component	Duration (Min)	Weightage (%)	Date and Time	Nature of component

Test-I	30	15	September 10 –September 20 (During scheduled class hour)	Open Book
Test-II	30	15	October 09 –October 20 (During scheduled class hour)	Open Book
Test-III	30	15	November 10 – November 20 (During scheduled class hour)	Open Book
Quiz[#]	-	20	Continuous	Open Book
Comprehensive Examination[*]	120	35		Open Book

[#] **Surprise quiz; Make Up is not permissible for this evaluation component.**

7. **Chamber Consultation Hours**: To be announced through a separate notice.

8. **Notices**: Notices concerning the course will be displayed in the **CMS**.

9. Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

10. Make-up-policy: Make up would be considered only for very **genuine reasons** only.

Instructor-In charge

Amit Nag