



**Birla Institute of Technology & Science, Pilani**  
Hyderabad Campus

**SECOND SEMESTER 2021-2022**  
**COURSE HANDOUT- ATOMIC AND MOLECULAR PHYSICS**

**Date: 15.01.2022**

**Course No.** : **PHY F342**  
**Course Title** : **Atomic and Molecular Physics**  
**Instructor-in-charge :** **ASRARUL HAQUE**  
**Instructor** : **Asrarul Haque**

**1. Course Description:** Main topics to be covered in the course include: Interaction of Atoms with Electromagnetic Radiation, Fine and Hyperfine Structure of Atomic Energy Levels, Quantum-mechanical Description of Atoms with Several Electrons, Molecular Structure and Molecular Spectra.

**2. Scope and objective:** Atomic and Molecular Physics could be conceived as applications of Quantum Mechanics, Electromagnetism, and Statistical Physics to the physical phenomena occurring at atomic and molecular scales. The course mainly deals with the quantum mechanical description of atoms with one and several electrons as well as how do atoms and molecules interact with light.

The course will enable students to solve simple problems based on the laws of atomic or molecular physics exploiting the laws and techniques of Quantum Mechanics, Electromagnetism, and Statistical Physics.

**3. Text Book:** B. H. Bransden and C. J. Joachain, *Physics of Atoms and Molecules*, Pearson, 2<sup>nd</sup> ed. 2001.

**4. Reference Books:**

C.J. Foot, *Atomic Physics*, Oxford Master Series in Atomic, Optical and Laser Physics, Oxford University press, 2005.

W. Demtroeder, *Atoms, Molecules and Photons*, Springer, 2005.

Ingolf V. Hertel and Claus-Peter Schulz, *Atoms, Molecules and Optical Physics I*, Springer, 2014.

## 5. Course Plan:

Lecture Number	Learning Objectives	Topics to be Covered	Chapter in the Text Book
1-7	Interaction of Electromagnetic Field with Atoms	Transition rates, dipole approximation, Einstein coefficients, selection rules and spectrum of one electron atom, line intensities and shapes, line widths and lifetimes	4.1-4.7
8-15	One Electron Atoms	Fine and hyperfine structure interaction with external electric and magnetic fields;	5.1-5.3,6.1-6.2
16-21	Two electron atoms	Para and ortho states, level scheme, ground and excited states of two electron atoms	7.1-7.6
22-26	Many electron atoms	Central field approximation, Thomas – Fermi model, Hartree- Fock method, L-S coupling and j-j coupling	8.1-8.5
27-34	Molecular structure	Born-Oppenheimer approximation, rotation and vibration of diatomic and polyatomic molecules, electronic structure and spin	10.1-10.6
35-40	Molecular Spectra	Rotational-vibrational and electronic spectra of diatomic molecules, nuclear spin	11.1-11.5

## 6. Evaluation Scheme:

EC No.	Evaluation Component	Duration	Weight age (%)	Date, Time	Nature of Component
1.	Mid-Semester Test	90 mins.	35%	14/03 3.30pm to 5.00pm	Open Book
3.	Quiz	50 mins	25%	Will be announced in the class	Open Book
4.	Comprehensive Examination	120 mins.	40%	14/05 FN	Open Book

**7. Notices:** Notices and solutions for examination's question papers will be displayed on the physics department notice board and/or on CMS website.

**8. Make-up Policy:** Make up may be considered provided a make-up application (for a genuine health issue) forwarded by the Chief Warden is produced. There will be no makeup for Quiz.

**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.

Asrarul Haque  
**Instructor-in-charge**