

SECOND SEMESTER 2022-2023

COURSE HANDOUT

**Date: 16.01.2023**

**Course No**. **: PHY F342**

# Course Title : Atomic and Molecular Physics

**Instructor-in-charge** **: : ARANYA B BHATTACHERJEE**

**Instructor**  **: Aranya B Bhattacherjee**

**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 withthe quantum mechanical description of atoms with one and several electrons as well ashow do atoms and molecules interact with light.

The course will enable students to solve simple problems based on the laws ofatomic 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, 2nd 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:**

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| --- | --- | --- | --- |
| **Lecture Number** | Learning Objectives | Topics to be Covered | **Chapter in the Text Book** |
| **1-10** | 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 |
| **11-18** | One Electron Atoms | Fine and hyperfine structure interaction with external electric and magnetic fields; | 5.1-5.3,6.1-6.2 |
| **19-24** | Two electron atoms | Para and ortho states, level scheme, ground and exited states of two electron atoms | 7.1-7.6 |
| **25-28** | Many electron atoms | Central field approximation, Thomas –Fermi model, Hartree- Fock method, L-S coupling and j-j coupling | 8.1-8.5 |
| **29-35** | Molecular structure | Born-Oppenheimer approximation, rotation and vibration of diatomic and polyatomic molecules, electronic structure and spin | 10.1-10.6 |
| **36-40** | Molecular Spectra | Rotational-vibrational and electronic spectra of diatomic molecules, nuclear spin | 11.1-11.5 |

**6. Evaluation Scheme:**

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| --- | --- | --- | --- | --- | --- |
| **EC No.** | Evaluation Component | Duration | **Weight age (%)** | **Date, Time** | **Nature of Component** |
| 1. | Mid-Semester Test | 90 mins. | 30% | 16/03 4.00 - 5.30PM | Closed Book |
| 3. | Assignment | N/A | 25% | As desired by the IC | Open Book |
| 4. | Comprehensive Examination | 180 mins. | 45% | 16/05 AN | Closed Book |

**7.Chamber consultation hour:** To be announced in the class

**8. Make-up Policy:** Make up may be considered provided a make-up application (for a genuine health issue) is submitted.

**10.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.

**Instructor-in-charge**

**PHY F342**