

Course Name	: Atomic and Molecular Physics
Course Number	: PH524
Credits	: 3-0-0-3
Prerequisites	: Basic undergraduate physics courses, first course on Quantum Mechanics and faculty consent
Intended for	: I-Ph.D, M.Sc., B.Tech 3rd and 4th Year
Distribution	: Core for I-Ph.D. and elective for others
Semester	: Even

Preamble: This course introduces the basic ideas of atomic and molecular physics. It teaches students how to apply quantum mechanics and extract information from many-electrons atoms and molecules. Introduction to group theory is also provided.

Course outline: The course begins with a review of some of the basic concepts in quantum mechanics and then discuss the time-dependent perturbation theory and its applications. It will then proceed to many-electron atomic systems and then to molecules. Further the course discusses the ideas and concepts associated with various spectroscopy techniques and will also introduce the elementary concepts of group theory.

Modules:

1. Time-independent perturbation theory, Time-dependent perturbation theory and application Fermi-Golden rule. Interaction of electromagnetic radiation with single electron atoms, Rabi flopping, Dipole approximation and dipole selection rules, Transition rates, Line broadening mechanisms, spontaneous and stimulated emissions and Einstein coefficients [12]
2. Review of atomic structure of H, Atomic structure of two electron system-variational method, alkali system, central field approximation, Slater determinant, Introduction to self-consistent field method, L-S coupling, J-J coupling. [8]
3. General nature of molecular structure, molecular binding, LCAO, Born-Oppenheimer approximation [6]
4. Introduction to microwave, infra-red and Raman spectroscopy, NMR and ESR, Symmetry and Spectroscopy [14]

Textbooks:

1. Quantum Mechanics, Leonard Schiff, Mc Graw Hill Education; 3 edition (9 April 2010)
2. Physics of atoms and molecules - Bransden and Joachain (Pearson, second edition, 2011)
3. Fundamentals of molecular spectroscopy- C. Banwell and E. Maccash (Mc Graw Hill, 2013)
5. Introductory Quantum Mechanics, R.L. Liboff, Addison-Wesley (2002).

References:

1. Atoms, Molecules and Photons - Wolfgang Demtroder (Springer, Second edition, 2006)
2. Atomic Physics, C. J. Foot (Oxford, First edition 2005)
3. Group theory and Quantum Mechanics-M. Tinkham (Dover Publications, First edition, 2003)
4. Chemical applications of group theory-F Albert Cotton (Willey, Third edition, 2015)