



Approved in 40th BoA Meeting (11-05-2021)

Course Number	: EP403
Course Name	: Physics of atoms and molecules
Credits	: 3-0-0-3
Prerequisites	: PH301 and/or faculty consent. Out of EP403 and PH524, a student is allowed to take only one course.
Intended for	: B.Tech.
Distribution	: Core course for B.Tech. in Engineering Physics and elective for others.
Semester	: Odd/even

Preamble: This course introduces the basic ideas of working of physics at atomic and molecular level for practical applications and is founded on the basic quantum mechanics course. It teaches students how to apply quantum mechanics and extract information from many-electrons atoms and molecules.

Modules:

1. Time-independent perturbation theory for first and second-order correction and its application; Identical particles, eigen functions for identical two particle systems. [6 Hours]
2. Time-dependent perturbation theory for two level systems and its generalization to higher level systems, its application to Fermi-Golden rule. [6 Hours]
3. Interaction of electromagnetic radiation with single electron atoms, Sinusoidal perturbation and Rabi flopping, Dipole approximation and dipole selection rules, Transition rates, Line broadening mechanisms, Incoherent perturbations, spontaneous and stimulated emissions and Einstein coefficients, selection rules for transitions [12 Hours]
4. Review of atomic structure of H, Atomic structure of two electron system-variational method, central field approximation, Slater determinant, L-S coupling, J-J coupling. [7 Hours]
5. General nature of molecular structure, molecular binding, LCAO, Born-Oppenheimer Approximation. [5 Hours]
6. Introduction to infra-red and Raman spectroscopy, Introduction to group theory and symmetry and Spectroscopy. [6 Hours]

Textbooks:

1. Atomic Physics, C. J. Foot (Oxford, First edition 2005)
2. Fundamentals of molecular spectroscopy- C. Banwell and E. Maccash (Mc Graw Hill, 2013)

References:

1. Atoms, Molecules and Photons - Wolfgang Demtroder (Springer, Second edition, 2006)

2. Group theory and Quantum Mechanics - M. Tinkham (Dover Publications, First edition, 2003)
3. Physics of atoms and molecules - Bransden and Joachain (Pearson, second edition, 2011)
4. Advances in Atomic Physics - Claude Cohen-Tannoudji and David Guéry-Odelin (World Scientific Publishing Company, 2011).
5. Introductory Quantum Mechanics, R.L. Liboff, Addison-Wesley (2002).

1. Similarity Content Declaration with Existing Courses

S.N.	Course Code	Similarity Content	Approx. % of Content
1	PH524		35-40%

2. Justification for new course proposal if cumulative similarity content is $> 30\%$:

This course has content similarity to that of course titled PH524 which is a core course for master students. However, this course is specifically intended for B.Tech. EP students and designed for that purpose with special focus on applications. A student cannot take these two course to complete his/her degree.