PH-8202 Atomic & Molecular Physics

L	T	P	C
4	1	0	5

Course Outcomes:

After successful completion of the course, the students should be able to

CO1: Understand the basic principles of electronic transitions, emission and absorption spectra

CO2: Understand the atomic structure, how atoms in molecules are related to each other and influence of external fields on spectra

CO3: Understand the vibration and rotational spectroscopy of diatomic molecules

CO4: Compare and contrast atomic and molecular spectra

CO5: Describe the meaning and consequences of absorption and emission spectroscopy

CO/PO Mapping

S-strong, M-medium and W-weak indicate the strength of correlation

COs	Programme outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	W	W	W	S	W		M	S	S	S	S
CO2	S	S	S	M	S	W	M	M	M	W		M
CO3	S	W	M	W	W	S	W	S	S	M	S	S
CO4	S	S	W		S	S	M		M	S	W	W
CO5	S	W	S	W	S		S	M			M	W

L	T	P	C
4	1	0	5

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UNIT-I

Spectra of one and two valance electron systems:
Magnetic dipole moments; Larmor theorem; Space quantization of orbital, spin and total angular momenta; Vector model for one and two valance electron atoms; Spin-orbit interaction and fine structure of hydrogen, Lamb shift, Spectroscopic terminology; Spectroscopic notations for L-S and J-J couplings; Spectra of alkali and alkaline earth metals; Interaction energy in L-S and J-J coupling for two electron systems; Selection and Intensity rules for doublets and triplets. **(14 Hrs)**

Width & intensity of spectral transitions and effects of external fields:
Natural line broadening and the factors that affect it, viz; collision broadening, Doppler broadening, Heisenberg uncertainty Principle; Basic ideas about collision damping, asymmetry & pressure shift and stark broadening; The Zeeman Effect for two electron systems; Intensity rules for the Zeeman effect; The calculations of Zeeman patterns; Basic idea on influence of nuclear spin; Paschen-Back (PB) effect; LS coupling in PB region; Lande's factor in LS coupling; Stark effect. **(16 Hrs)**

UNIT-II

Microwave and Infra-Red Spectroscopy:
Classification of molecules, Rotational spectra of diatomic molecules as a rigid and non-rigid rotator, Intensities of rotational lines, Effect of isotopic substitution, Microwave spectrum of polyatomic molecules, Microwave oven, The vibrating diatomic molecule as a simple harmonic and an-harmonic oscillator, Diatomic vibrating rotator, The vibration-rotation spectrum of carbon monoxide, Rotational-Vibrational Coupling, Techniques and instrumentation- an outline, Fourier transform spectroscopy. **(16 Hrs)**

Raman and Electronic Spectroscopy:
Quantum and classical theories of Raman Effect, Pure rotational Raman spectra for linear and polyatomic molecules, Vibrational Raman spectra, Structure determination from Raman and infra-red spectroscopy, Electronic structure of diatomic molecule (orbital theory and shapes of some molecular orbitals), Electronic spectra of diatomic molecules, Born-Oppenheimer approximation-The Franck-Condon principle, Dissociation and pre-dissociation energy, The Fortrat diagram, example of spectrum of molecular hydrogen; Techniques and instrumentation- an outline, Near-Infra-Red Fourier Transform Spectroscopy. **(14 Hrs)**

Theory: 60 Hrs **Total: 60 Hrs**

BOOKS:

1. Fundamentals of Molecular Spectroscopy: Colin N. Banwell and Elaine M. McCash- 4th Edition: Tata McGraw Hill, 1993.
2. Modern Spectroscopy: J.M. Hollas- 4th edition- 2003
3. Molecular spectra and molecular structure: Gerhard Herzberg
4. Spectra of Diatomic Molecules: Herzberg-New York, 1950.
5. Spectroscopic studies of molecular structure: G Herzberg, Nobel Lecture, December 11, 1971.
6. Introduction to Atomic Spectra: H.E. White-Auckland Mc Graw Hill, 1934.
7. Atomic and Molecular Spectroscopy by S. Svanberg, Springer Verlag
8. Spectroscopy Vol. I, II & III: Walker & Straughen
9. Introduction to Molecular Spectroscopy: G.M.Barrow-Tokyo Mc Graw Hill, 1962.
10. Molecular Spectroscopy: Jeanne L McHale-New Jersy Prentice Hall, 1999.
11. Molecular Spectroscopy: J.M. Brown-Oxford University Press, 1998.
12. Spectra of Atoms and Molecules: P.F. Bermath-New York, Oxford University Press, 1995.

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