

ANDHRA UNIVERSITY

M.Sc. PHYSICS, SPACE PHYSICS, TECH. ELECTRONICS AND MATERIAL SCIENCE

P 104 ATOMIC AND MOLECULAR PHYSICS

I SEMESTER

UNIT - I

30 Hrs.

One electron atoms: Quantum numbers, Term values for neutral and ionized atoms. Relation between magnetic dipole moment and angular momentum of an orbiting electron - Larmor precession. Stern - Gerlach experiment and electron spin. Spin-orbit interaction energy in Bohr model with average values from quantum theory. Fine structure of Balmer series of Hydrogen and Fowler series of ionized Helium. Lamb shift and its experimental determination. Nuclear spin and hyperfine structure of  $H\alpha$  line of hydrogen. GKS: Ch.3 Ch.7.

One valence electron atoms: Lifting of orbital degeneracy. Comparison of energy levels of alkali metals with Hydrogen - penetrating orbits. The effective quantum number and quantum defect. White: Ch.5.10, 5.11.

Many electron atoms: Building up principles Pauli's principle and its explanation based on symmetric and antisymmetric wave functions. Ground states of atoms. Residual coulombic interaction: ll coupling, ss coupling and Hund's rules. Spin-orbit interaction and order of fine structure energy levels. Equivalent and non-equivalent electrons. Determination of possible terms of  $p^2$  configuration in LS and JJ coupling approximation. Spectra of sodium, Helium and Calcium. Multiplet splitting and Lande's interval rule. Intensity rules and application to doublets of Sodium. Intercombination lines. Anomalous triplets. Eisberg and Resnick. Ch.10, GKS: Ch.5.6, Ch.6, Ch.8.

Atoms in external field: Quantum treatment of Zeeman and Paschen- Back effects. Normal Zeeman effect between  $S = 0$  levels as a special case. Calculation of Zeeman splitting in terms of magnetic field for atomic terms. Application to Sodium doublets and Calcium triplets. Stark pattern of  $H\alpha$  line of hydrogen and  $D_1$  and  $D_2$  lines of Sodium. GKS: Ch.9.6, 9.11, 9.13.

UNIT - II

20 Hrs.

Diatomic molecules: Molecular quantum numbers. Explanation of bond order for  $N_2$  and  $O_2$  and their ions. Rotational spectra and the effect of isotopic substitution. Rotation vibration spectra. Infrared and Raman vibrational spectra of simple molecules. Banwell: Ch.2.2, 2.3, 3.2, 3.3, 4.3, 6.2

Molecular vibrations: Fundamental vibrations and their symmetry. Symmetry elements and point groups. Character table of  $C_{2v}$  symmetry. Reducible representation and molecular vibrations of  $H_2O$ . Structure determination of  $AB_2$  type molecules from the observed fundamental bands of Raman and IR spectra. Raman: Ch.1.2, 3.4, 4.2, 4.4, 6.2, 6.3; Banwell: Ch.4.5.

Electronic transitions: Intensity of vibrational electronic spectra- The Franck - Condon principle. Banwell: Ch.6 1.3

Lasers: Spontaneous and stimulated emission. Einstein coefficients. Threshold condition for population inversion. Coherence and directionality. Ruby Laser and Helium - Neon Laser. Advantages of 4- level laser system over 3 - level system. Applications to Holography, Industry and Medicine. Tyagarajan & Ghatak: Ch.3.1, 3.2, 9.1, 9.2, 9.3, 9.4, 10, 14.2, 14.5.

TEXTBOOKS:

- 1 Introduction to Atomic Spectra - H.E.White
- 2 Fundamentals of Molecular Spectroscopy - C. N.Banwell
- 3 Lasers - Tyagarajan and Ghatak
- 4 Elements of spectroscopy - Gupta, Kumar, Sharma
- 5 Group Theory - K V Raman
- 6 Quantum Physics - Eisberg and Resnik