MANGALORE UNIVERSITY

Department of physics

MSc Physics

PHH 501: ATOMIC AND MOLECULAR PHYSICS (52 Hrs.)

Course Outcome

CO1 On completion of this course, students should be able to usespectroscopy as a tool for studying the structures of atomsand molecules.

CO2 Student be able to identify analytical methods for findingthe constituents in material having unknown chemical composition.

CO3 The knowledge can be used in astronomy to study spectral emission lines of distant galaxies in order to understand rapidly expanding universe.

CO4 The course definitely makes the candidate to have the skill to get employed in various laboratories, for carrying out research and developmental activities using spectroscopic techniques.

Unit I Spectra of single and multi electron atoms: Review of atomic models. Simple spectra of hydrogen and hydrogen like ions - energy levels, quantum numbers, electron spin, Stern - Gerlac experiment, fine structure, total angular momentum, Spin-orbit coupling, hydrogen energy levels, relativistic correction, radiation corrections, transition rates, selection rules.

Exclusion principle, ground state of multi electron atoms, periodic table. Spectra of two valence atom - alkali spectra, term values, doublet structure, transition and intensity rules. Spectra of alkaline earth elements, triplet structure, penetrating and non-penetrating orbitals: LS and jj coupling. Simple spectra of trivalent atom (qualitative). Quantum mechanical treatment of fine and hyperfine structure. Zeeman effect (classical & quantum mechanical treatment) Paschen-Back effect, Stark effect.

[13 hrs]

Unit II X-ray Spectra and Resonance spectroscopy: Review of emission & absorption of X-ray spectra (critical voltage, absorption coefficient, edge, filters) regular and irregular doublet law, Auger spectra.

Spin and an applied field, nuclear magnetic resonance [both hydrogen nuclei and other than hydrogen] techniques & instrumentation, structural study, electron spin resonance spectroscopy. **[13 hrs]**

Unit III Microwave spectra, infra red spectra and Raman spectroscopy: Theory of rotational spectra of diatomic molecules - Experimental technique – Microwave spectrometer, structural information. Microwave oven.

Theory of vibrating rotator, vibration - rotation spectra, IR spectrometer. Application in chemical analysis.

Quantum theory of Raman effect. Rotational and vibrational Raman spectra. Raman spectrometer. Laser Raman studies. F T Raman spectroscopy. F T Raman spectrometer. **[13 hrs]**

Unit IV Electronic spectroscopy: Electronic spectra of diatomic molecules - coarse structure - Frank-Condon principle - rotational fine structure - formation of band head and shading of bands - determination of I, r and band origin.

Fluorescence and phosphorescence: mirror image symmetry of absorption and fluorescence bands. Basic principles of photoelectron spectra. Instrumentation. Determination of ionization potential.

Mossbauer spectroscopy: Principles of Mossbauer spectroscopy. Mossbauer spectrometer. Applications. **[13 hrs]**

Text Books:

1 Ghoshal S N, 'Atomic and Nuclear Physics', Vol. I & II (S Chand & Company, 1994)
2 Beiser A, `Concept of Modern Physics' V Edn. (Tata McGraw Hill, 1997)
3 Banwell C N and E M McCash, 'Fundamentals of Molecular Spectroscopy', IV Edn. (Tata McGraw Hill, 1994)

Reference books:

1. Kuhn H G, 'Atomic Spectra', III Edn. (Benjamin, 1977)
2. Haken H & Wolf H C, 'Atomic and Quantum Physics', V Edn. (Springer-Verlag, 1997)
3. Henry Semat& John R AlBright, 'Introduction to Atomic and Nuclear Physics' V Edn. (Chapman & Hall, 1972)
4. Chatwall Gurdeep, 'Spectroscopy', III Edn. (Himalayas, 1994)
5. Robert Eisberg& R Resnick, 'Quantum Physics of Atoms, Molecules, Solids, Nuclei & Particles', II Edn. (John Wiley & Sons)
6. Straughan B P and Walker S, 'Spectroscopy', Vol. I, II and III (Chapmann& Hall, 1976)
7. Svanberg S, 'Atomic and Molecular Spectroscopy', II Edn. (Springer Verlag, 1992)
8. Herzberg, 'Molecular Spectra and Molecular Structure', Vol. I, II & III (Van Nostrand Co., 1966).