Semester 5 Major

Course- 351T

Major Course – 4 Credits

Semester: 5	**Course No.: 351(T)**	**Course Code:** PHM 351(T) **Course Title- Atomic physics-Classical mechanics - plasma Physics**
Credits: 4	1 Session = 1 hour	**Course Category: Major Paper**

Course Objectives:

By the end of this course, students will:

1. Gain insight into molecular structures and interactions through vibrational and rotational spectral analysis.
2. Understand the theoretical foundations and experimental techniques related to molecular spectroscopy and Raman scattering.
3. Explore and apply classical mechanics principles using Lagrangian formulations to solve complex physical systems.
4. Learn the fundamental characteristics of plasma and the physics governing its behavior in both natural and laboratory settings.

Course Outcomes: On successful completion of the course the learner will be able to

CO	COURSE OUTCOMES	Bloom's Verb
CO-1	Clear understanding of cause of rotational and vibrational of diatomic molecules and theoretical understanding on the basis of quantum theory is developed in detail. More realistic picture of rotational – vibrational spectra also becomes clear. Sufficient numbers of problems of rotational spectroscopy and rotational vibrational spectroscopy are also covered.	**Apply** **Analyze** **Evaluate**
CO-2	Clear understanding of cause of Raman spectra, theoretical understanding of classical Raman theory and quantum theory is developed. Classification of Molecular Electronic States gives insight of understanding of molecular orbitals. Sufficient numbers of problems on the topics are also covered.	**Apply** **Analyze**
CO-3	Revise the knowledge of the Newtonian mechanics and Learn to define generalised coordinates, generalised velocities, generalised force and write Lagrangian for mechanical system in terms of generalised coordinates. Apply D'Alembert's principle to obtain Lagrange's equations, describe Lagrangian formulations, the ability to formulate Lagrangian dynamics to solve complex problems, apply Lagrange equations to analyse mechanical systems, understand the relationship between symmetries and conservation laws.	**Apply** **Analyze** **Evaluate**
CO-4	Apply the knowledge of electromagnetics to understand and analyze the motion of charge particle in electric and magnetic field which leads to the different kind of drifts in plasma. Also apply the knowledge of these drifts to understand the naturally formed Van Allen radiation belt by trapping the charged particles approaching earth from solar or galactic origin.	**Apply** **Analyze**

Unit No.	Unit Contents	Sessions Allotted
1	**Molecular Spectroscopy** **Pure Rotational Spectra:** Salient features of Rotational spectra, Molecular requirement for rotation spectra, experimental arrangement, Molecule as a rigid rotator : explanation of rotational spectra (without the process of solving Schrodinger equation to get energy formula), the non-rigid rotator, Isotope effect on rotational spectrum . Problems on pure rotational Spectra	**15 Hours**

	Vibrational - Rotational Spectra: salient features of vibrational - Rotational spectra, Molecule as a harmonic oscillator, Molecule as anharmonic oscillator, Vibrational frequency and force constant for anharmonic oscillator, Fine structure of Infrared bands: Molecule as vibrating rotator,Diatomic molecule as symmetric top. Problems on Vibrational Rotational Spectra.	
2	**Raman Spectroscopy** Nature of the Raman spectra, experimental arrangement for Raman spectra, Classical theory of Raman effect, Quantum theory of Raman effect , Raman Spectra and Molecular Structure , Infrared Spectra versus Raman Spectra. Problems on Raman Spectroscopy. Classification of Molecular Electronic States	**15 Hours**
3	**Classical Mechanics** **Lagrangian Formulation:** Introduction, Constraints, holonomic and non-holonomic constraints, scleronomous and rheonomous constraints, generalized coordinates, D'Alembert's principle, Lagrange's equations, a general expression for kinetic energy, Symmetries and the laws of conservation, Cyclic or ignorable coordinates (including illustrations), Velocity dependent potential of electromagnetic field, Rayleigh's dissipation function.	**15 Hours**
4	**Plasma Physics:** **Motion of charged particles in Magnetic & Electric field:** Microscopic & Macroscopic description, Maxwell's equation & charge conservation, Motion of a charged particle in electric & Magnetic fields, Uniform magnetic field & Oscillating electric field, Drift velocity in a gravitational field, Magnetic field varying in space & time : adiabatic variance of the magnetic moment, Inhomogeneous magnetic field : gradient drift & curvature drift, peculiarity of drift motions, Converging magnetic field : magnetic mirror, Longitudinal adiabatic invariant, Periodic magnetic field : Gyro relaxation effect, Motion of magnetic lines of force.	**15 Hours**

For Unit-1 Text Book: Atomic and Molecular Spectra: Laser by Rajkumar. Published by Kedar nath Ram Nath. Chapter 18: Article Nos: 1 – 6, Chapter 19: Article Nos:1 – 4, 6 – 7

Reference book: Modern atomic and nuclear physics by Dr. A. B. Gupta, Books and allied (P)Ltd. July-2008,1st edition

Modern Physics by G. Aruldhas and P. Rajgopal; PHI publications. January 2013(5th edition)

For Unit-2 Text Book: Atomic and Molecular Spectra: Laser by Rajkumar. Published by Kedar Nath Ram Nath. Chapter 20 , Chapter 24

Reference book: Modern atomic and nuclear physics by Dr. A. B. Gupta, Books and allied (P)Ltd. July-2008 1st edition Modern Physics by G. Aruldhas and P. Rajgopal; PHI publications. January 2013(5th edition)

For Unit -3Text Book: Introduction to Classical Mechanics by R. G. Takawale and P. S. Puranik, Tata McGraw-Hill Publishing Co. Ltd. Chapter 8: Article Nos: 8.1 to 8.9

Reference Book:

1. Classical Mechanics by A. B. Bhatia, Narosa Publication.
2. Classical Mechanics by H. Goldstein, Addison Wesley.
3. Classical Mechanics by J. C. Upadhyaya, Himalaya publications

Unit-4 Plasma Physics: Text book: Elements of Plasma Physics by S. N. Goswami, first edition 1995, New Central Book Agency (P) Ltd. Chapter-2: Article Nos.: 2.1 – 2.12

Reference Book:

Introduction to Plasma Physics by F.F. Chen, Plenum Press, 2nd ed Plasma physics by S. N. Sen, Pragati Prakashan, 9th edition 2012.