REVISED SYLLABUS ACCORDING TO CBCS NEP2020 SECOND-YEAR OF MASTER OF SCIENCE IN PHYSICS

COURSE TITLE:- ATOMIC AND MOLECULAR PHYSICS
SEMESTER - IV
W.E.F. 2024 - 2025

RECOMMENDED BY THE BOARD OF STUDIES IN PHYSICS
AND
APPROVED BY THE ACADEMIC COUNCIL

Devrukh Shikshan Prasarak Mandal's
Nya. Tatyasaheb Athalye Arts, Ved. S. R. Sapre Commerce, and Vid. Dadasaheb Pitre Science College (Autonomous), Devrukh.
Tal.Sangmeshwar, Dist. Ratnagiri-415804, Maharashtra, India

Academic Council Item No: **dated 19 April 2024**

Name of the Implementing Institute	:	Nya. Tatyasaheb Athalye Arts, Ved. S. R. Sapre Commerce, and Vid. Dadasaheb Pitre Science College (Autonomous), Devrukh. Tal. Sangmeshwar, Dist. Ratnagiri-415804,
Name of the Parent University	:	University of Mumbai
Name of the Programme	:	Master of Science
Name of the Department	:	Physics
Name of the Class	:	Second Year
Semester	:	Fourth
No. of Credits	:	04
Title of the Course	:	Atomic and Molecular Physics
Course Code	:	S609PHT
Name of the Vertical in adherence to NEP 2020	:	Major
Eligibility for Admission	:	Any student admitted to Second year of M.Sc, degree programme in adherence to Rules and Regulations of the University of Mumbai and Government of Maharashtra.
Passing Marks	:	40%
Mode of Assessment	:	Formative and Summative
Level	:	PG
Pattern of Marks Distribution for SEE and CIA	:	60:40
Status	:	NEP-CBCS
To be implemented from Academic Year	:	2024 - 2025

Syllabus for First Year of Master of Science in Physics

(With effect from the academic year 2024 - 2025)

SEMESTER - IV **Paper No.– Physics Paper – I**

Course Title: Atomic and Molecular Physics **No. of Credits - 04**

Type of Vertical: Major **COURSE CODE: S609PHT**

Learning Outcomes Based on BLOOM's Taxonomy:

After completing the course, the learner will be able to…

Course Learning Outcome No.	Blooms Taxonomy	Course Learning Outcome
CLO-01	Understand	Understand effects in one and two electron atoms
CLO-02	Understand	Understand Hartee theory and couplings in multi electron atoms
CLO-03	Understand	Understand interaction of one electron atoms with electromagnetic radiation
CLO-04	Understand	Understand the Born-Oppenheimer approximation
CLO-05	Understand	Understand rotational, vibrational and electronic spectra of molecules
CLO-06	Apply	Solve problems related to the theory of the paper

Syllabus for First Year of Master of Science in Physics

(With effect from the academic year 2024 - 2025)

SEMESTER - IV **Paper No.– Physics Paper – I**

Course Title: Atomic and Molecular Physics **No. of Credits - 04**

Type of Vertical: Major **COURSE CODE: S609PHT**

COURSE CONTENT			
Module No.	**Content**	**Credits**	**No. of Lectures**
Unit 1	**Review** of one-electron eigen functions and energy levels of bound states, Probability density, Virial theorem. Fine structure of hydrogenic atoms, Lamb shift. Hyperfine structure and isotope shift. (ER 8-6) Linear and quadratic Stark effect in spherical polar coordinates. Zeeman effect in strong and weak fields, Paschen-Back effect. (BJ, GW) Schrodinger equation for two electron atoms: Identical particles, The Exclusion Principle. Exchange forces and the helium atom (ER), independent particle model, ground and excited states of two electron atoms. (BJ)	**01**	**15**
Unit 2	The central field, Thomas-Fermi potential, the gross structure of alkalis (GW). The Hartree theory, ground state of multi-electron atoms and the periodic table (ER), The L-S coupling approximation, allowed terms in LS coupling, fine structure in LS coupling, relative intensities in LS coupling, j-j coupling approximation and other types of coupling (GW)	**01**	**15**
Unit 3	Interaction of one electron atoms with electromagnetic radiation: Electromagnetic radiation and its interaction with charged particles, absorption and emission transition rates,dipole approximation. Einstein coefficients, selection rules.Lineintensities and life times of excited state, line shapes and line widths. X-ray spectra. (BJ)	**01**	**15**
Unit 4	Born-Oppenheimer approximation - rotational, vibrational and electronic energy levels of diatomic molecules, Linear combination of atomic orbitals (LCAO)and Valence bond (VB) approximations, comparison of valence bond and molecular orbital theories (GA, IL) - Page **50** of **86** **A)** Rotation of molecules: rotational energy levels of rigid and non-rigid diatomic molecules, classification of molecules, linear, spherical, symmetric and asymmetric tops. **B)** Vibration of molecules: vibrational energy levels of diatomic molecules, simple harmonic and anharmonic oscillators, diatomic vibrating rotator and vibrational	**01**	**15**

	rotational spectra. **c)** Electronic spectra of diatomic molecules: vibrational and rotational structure of electronic spectra. (GA, IL) Quantum theory of Raman effect, Pure rotational Raman spectra, Vibrational Raman spectra, Polarization of light and the Raman effect, Applications General theory of Nuclear Magnetic Resonance (NMR). NMR spectrometer, Principle of Electron spin resonance ESR. ESR spectrometer. (GA, IL)		
	Total	**04**	**60**

Reference Books:-

1. Robert Eisberg and Robert Resnick, Quantum physics of Atoms, Molecules, Solids, Nuclei and Particles, John Wiley & Sons, 2nded, (ER)
2. Bransden & Joachain, Physics of atoms & molecules, Pearson Education 2nd ed, (BJ)
3. G.K.Woodgate, Elementary Atomic Structure, Oxford university press, 2nd ed, (GW).
4. G.Aruldhas, Molecular structure & spectroscopy, PHI 2nd ed, 2002 (GA)
5. Ira N. Levine, Quantum Chemistry, Pearson Education, 5th ed, 2003 (IL)

Access to the Course

The course is available for all the students admitted for Master of Science in Physics.

Methods of Assessment

The assessment pattern would be 60:40, 60% for Semester End Examination (SEE) and 40% for Continuous Internal Assessment (CIA). The structure of the SEE and CIA would be as recommended by the Board of Studies and approved by the Board of Examination and the Academic Council of the college.

Pattern of Evaluation

The Examination/Evaluation pattern shall be framed by the Board of Examination with its final approval from the Academic Council of the College.