

Name of the Course: T. Y. B. Sc. Physics Major Course 14
MJ - 14: Atomic and Molecular Physics (2 Credits)

Sr. No.	Heading	Particulars
1	Description the course (Including but Not limited to)	: Introduction, relevance, Usefulness, Application, interest, connection with other courses, demand in the industry, job prospects etc.
2	Vertical	: Major /Minor/Open Electives /Skill Enhancement / Ability Enhancement/Indian Knowledge System
3	Type	: Theory
4	Credits	: 2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	Hours Allotted	: 30 Hours
6	Marks Allotted	: 50 Marks
7	Course Objectives (CO): The students are expected to	
	CO 1.	develop a clear understanding of the structure of atoms and molecules, including one- electron and multi- electron systems, and the quantum mechanical basis of their behavior.
	CO 2.	understand how atoms and molecules interact with external static and dynamic fields (electric, magnetic) and the consequences such as Zeeman effect for atomic and molecular spectra.
	CO 3.	learn the theory and apply the methods of atomic and molecular spectroscopy (discrete energy levels, rotational, vibrational, electronic transitions, molecular spectra) to analyze them.
	CO 4.	develop problem-solving skills in applying quantum mechanical tools to atomic and molecular systems
	CO 5.	Bridge theory with applications: relate the principles of atomic & molecular physics to practical experiments and modern technologies
8	Course Outcomes (OC): After successful completion of this course, the students will be able to	
	OC 1.	explain the quantum mechanical model of atoms, the origin of quantized energy levels, and the significance of quantum numbers.
	OC 2.	describe the effects of external fields (Zeeman effect) on atomic spectra.
	OC 3.	apply vector model of atom and coupling schemes (LS and jj coupling) to determine the total angular momentum and term symbols of atomic states.
	OC 4.	interpret rotational, vibrational, and electronic spectra of diatomic molecules
	OC 5.	develop problem-solving skills in applying approximation methods to atomic and molecular systems.
9	Modules / Units: - There will be One Module / Unit Per Credit	
	Module I / Unit I: Hydrogen Atom and Spin Orbit Coupling (15 Hours)	

	Unit I (15 periods) 1. Hydrogen atom: Schrödinger’s equation for Hydrogen atom, Separation of variables, Quantum Numbers, Angular momentum, Stern Gerlach Experiment (Review), Pauli Exclusion principle, Symmetric and Anti-symmetric wave functions B: 9.1, 9.2, 9.3, 9.8, 10.1, 10.3 2. Spin orbit coupling, Total angular momentum, Vector atom model: L-S and j-j coupling, the normal Zeeman effect, Quantum theory of Zeeman Effect, Anomalous Zeeman effect, The Lande g – factor (Review) B: 10.2, 10.7, 10.8, 10.9, SA: 9.14, 9.15, 9.16, 9.17 Unit II (15 periods) 1. Molecular spectra (Diatomic Molecules): Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibrational spectra, Electronic Spectra & the Franck Condon principle Infrared spectrometer B: 14.1, 14.3, 14.5, 14.8 GA: 7.16 2. Raman effect: Quantum Theory of Raman effect, Pure Rotational Raman spectra of linear molecules, Raman activity of vibrations, Experimental set up of Raman Effect BM: 4.1, 4.1.1, 4.2.1, 4.3.1 GA: 8.6		
10	Reference Books: 1. B: Perspectives of Modern Physics: Arthur Beiser (McGraw Hill) 2. SA: Introduction to Atomic & Nuclear Physics: H. Semat & J. R. Albright (5th Ed.) Chapman & Hall 3. GA: Molecular structure and spectroscopy: G Aruldas (2nd Ed) PHI learning Pvt Ltd. 4. BM: Fundamentals of Molecular Spectroscopy: C. N. Banwell & E. M. McCash (TMH) (4th Ed.) Additional References Books: 1. Atomic Physics (Modern Physics): S. N. Ghoshal. S. Chand Publication		
11	Internal Continuous Assessment: 40% (20 Marks)	External Assessment, (60%) (30 Marks)	
12	Continuous Evaluation through: Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc. (at least 3)		Evaluation: through Exam at the End of the Semester / Term.
13	Format of Question Paper for Semester End Examination Total Marks: 30 Marks Duration: One Hour		
	Module I / Unit-I 15 Marks	Q.1 A) Attempt any Two (Each carry 05 Marks) i) Theory ii) Theory iii) Theory iv) Theory	10 Marks

		Q.1 B) Attempt any One (Each Carry 05 Marks) i) Problem / Theory ii) Problem	05 Marks
	Module II / Unit-II 15 Marks	Q.2 A) Attempt any Two (Each carry 05 Marks) i) Theory ii) Theory iii) Theory iv) Theory	10 Marks
		Q.2 B) Attempt any One (Each Carry Marks) i) Problem / Theory ii) Problem	05 Marks