Form: Course Syllabus	Form Number	EXC-01-02-02A
	Issue Number and Date	2/3/24/2022/2963 05/12/2022
	Number and Date of Revision or Modification	
	Deans Council Approval Decision Number	2/3/24/2023
	The Date of the Deans Council Approval Decision	23/01/2023
	Number of Pages	06

1.	**Course Title**	Atomic and Molecular physics -2
2.	**Course Number**	0302962
3.	**Credit Hours (Theory, Practical)**	3/ Theory
	Contact Hours (Theory, Practical)	3/ Theory
4.	**Prerequisites/ Corequisites**	Atomic and Molecular physics -1
5.	**Program Title**	Phd in Physics
6.	**Program Code**	03
7.	**School/ Center**	Faculty of Science
8.	**Department**	Physics
9.	**Course Level**	Phd
10.	**Year of Study and Semester (s)**	
11.	**Other Department(s) Involved in Teaching the Course**	-
12.	**Main Learning Language**	English
13.	**Learning Types**	☐**Face to face learning** ☐Blended ☐Fully online
14.	**Online Platforms(s)**	☐**Moodle** ☐**Microsoft Teams**
15.	**Issuing Date**	1 Jan 2012
16.	**Revision Date**	11 January 2025

17. Course Coordinator:

Name:	Contact hours:
Office number:	Phone number:
Email:	

18. Other Instructors:

19. Course Description:

The course is intended for the PhD in physics student's and aims to familiarize them with basic concepts in Molecular Spectroscopy – Born-Oppenheimer approximation – Rotational spectrum of diatomic molecule – rigid rotor model – Selection rules – intensities – effect of isotropic substitution – non-rigid rotor; polyatomic molecules; vibrational spectrum of diatomic molecule; anharmonic effects; vibration – rotation spectrum – breakdown of Born-Oppenheimer approximation; electronic spectrum – intensity of vibrational – electronic spectrum; Franck-Condon principle – rotational fine structure; Raman effect – Stokes and anti-Stokes lines – application

20. Program Intended Learning Outcomes: (To be used in designing the matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program)

1. **SO1: to be able to demonstrate an advanced and comprehensive understanding of core physics concepts and specialized knowledge in a chosen field of research, contributing to the frontier of physics.**
2. **SO2: to be able to develop and execute independent, original research projects that address complex scientific problems, advancing theoretical and experimental physics.**
3. **SO3: to be able to apply advanced mathematical and computational techniques to analyze complex physical phenomena and critically evaluate scientific literature and experimental results.**
4. **SO4: to be able to effectively communicate complex physics concepts, research findings, and their significance through academic writing, presentations, and public outreach.**
5. **SO5: to be able to adhere to high ethical standards and professional responsibility in conducting research, including data integrity, ethical treatment of subjects, and the responsible use of resources.**
6. **SO6: to be able to demonstrate leadership and collaborative skills within multidisciplinary teams, contributing to the development of new scientific knowledge and promoting knowledge-sharing across disciplines.**
7. **SO7: to be able to cultivate the ability to adapt to new scientific advancements and continuously engage in professional development to contribute to innovation in the field of physics.**

SO8: to be able to master experimental and computational techniques relevant to the research field, demonstrating competency in operating and developing specialized physics instrumentation and software.

21. Course Intended Learning Outcomes: (Upon completion of the course, the student will be able to achieve the following intended learning outcomes)

1. Introduction to electronic spectroscopy of diatomic molecules.
2. Study of vibrational course structure of electronic spectra of diatomic molecules; analysis of vibrational spectra of diatomic molecules and estimation of vibrational constants, moment of inertia, force constant, etc.
3. To understand the electronic structure, course, and fine structure of energies of electronic states of diatomic molecules.
4. To understand the vibrational, rotational motions, and coupling of these motions by evaluating the vibrational and rotational constants of the electronic states.
5. To understand various coupling schemes.
6. Determination of term manifold of homonuclear and heteronuclear diatomic molecules.
7. To understand the symmetry properties of the electronic wavefunctions, the selection rules, and allowed electronic transitions.
8. To understand the basic physics of Raman scattering of diatomic/polyatomic molecules; experimental techniques of Raman spectroscopy; analysis of Raman spectra for investigating molecular structure.

Course ILOs	**The learning levels to be achieved**					
	Remembering	**Understanding**	**Applying**	**Analysing**	**evaluating**	**Creating**
1		**X**				
2	**X**	**X**	**X**			
3		**X**				
4	**X**	**X**				
5		**X**				
6	**X**		X			
7	**X**	**X**	**X**			
8	**X**	**X**	**X**			

٢٢. The matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program:

Program SOs / Course ILOs	ILO (1)	ILO (2)	ILO (3)	ILO (4)	ILO (5)	ILO (6)	ILO (7)	ILO (8)
1	x							
2	x							
3	x							
4	x							
5	x							
6	x							
7	x							
8	x							

٢٣. Topic Outline and Schedule:

Week	Lecture	Topic	ILO/s Linked to the Topic	Learning Types (Face to Face/ Blended/ Fully Online)	Platform Used	Synchronous / Asynchronous Lecturing	Evaluation Methods	Learning Resources
1	1	General nature of molecular structure	Understanding basic concepts of molecular structure	Face to Face	Classroom	Synchronous	Assignments, Participation	Bransden & Joachain (Pearson), Chapter 9.1

	2	Born-Oppenheimer separation	Grasping electronic and nuclear wavefunction separation	Face to Face	Classroom	Synchronous	Assignments	Bransden & Joachain (Pearson), Chapter 9.2
2	3	Rotation and vibration of diatomic molecules	Analyzing rotational and vibrational energy levels	Face to Face	Classroom	Synchronous	Quiz, Assignments	Bransden & Joachain (Pearson), Chapter 9.3
	4	Electronic structure of diatomic molecules	Examining electronic states and transitions	Face to Face	Classroom	Synchronous	Assignments	Bransden & Joachain (Pearson), Chapter 9.4
3	5	Structure of polyatomic molecules	Exploring molecular geometry and interactions	Blended	Online Platform	Asynchronous	Assignments, Online Discussion	Bransden & Joachain (Pearson), Chapter 9.5
	6	Rotational energy levels of diatomic molecules	Understanding rotational spectra	Face to Face	Classroom	Synchronous	Assignments	Bransden & Joachain (Pearson), Chapter 10.1
4	7	Vibrational-rotational spectra of diatomic molecules	Explaining vibrational-rotation	Blended	Online Platform	Synchronous/Asynchronous	Quiz	Bransden & Joachain (Pearson), Chapter 10.2

			al coupling					
	8	Electronic spectra of diatomic molecules	Evaluating electronic transitions	Face to Face	Classroom	Synchronous	Assignments	Bransden & Joachain (Pearson), Chapter 10.3
5	9	Electronic spin and Hund's cases	Understanding spin and coupling phenomena	Blended	Online Platform	Asynchronous	Quiz	Bransden & Joachain (Pearson), Chapter 10.4
	10	The nuclear spin	Analyzing the role of nuclear spin in spectra	Face to Face	Classroom	Synchronous	Assignments	Bransden & Joachain (Pearson), Chapter 10.5
6	11	Inversion spectrum of ammonia	Understanding inversion spectra	Blended	Online Platform	Asynchronous	Quiz, Online Discussions	Bransden & Joachain (Pearson), Chapter 10.6
	12	Problems and applications of molecular spectra	Solving related problems and understanding applications	Face to Face	Classroom	Synchronous	Problem-solving Assignments	Bransden & Joachain (Pearson), Chapters 9 & 10
7	13	Revision and Q&A	Clarifying doubts and revising content	Face to Face	Classroom	Synchronous	Participation, Peer Discussions	Bransden & Joachain (Pearson), Chapters 9 & 10

٢٤. Evaluation Methods:

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment methods and requirements:

Evaluation Activity	Mark	Topic(s)	ILO/s Linked to the Evaluation activity	Period (Week)	Platform
Midterm Exam	30%	End of tissues			
Report and Presentation	30%	Various ideas			
Final Exam	40%	All topics			

٢٥. Course Requirements:

(e.g.: students should have a computer, internet connection, webcam, account on a specific software/platform…etc.):

No special requirements.

٢٦. Course Policies:

A- Attendance policies:

Students are expected to attend all classes.

B- Absences from exams and submitting assignments on time:

C- Health and safety procedures:

D- Honesty policy regarding cheating, plagiarism, misbehavior:

E- Grading policy:

Mid exam (30 %), Report and Presentation (20 %), final (50 %)

F- Available university services that support achievement in the course:

2٧. References:

A- Required book(s), assigned reading and audio-visuals:

1. **Physics of Atoms and Molecules**, Bransden & Joachain (Pearson)
2. **Fundamentals of Molecular Spectroscopy**, C. N. Banwell (Tata McGraw-Hill

B- Recommended books, materials, and media:

- **Spectra of Diatomic Molecules** by G. Herzberg, Krieger Malbar Florida, 1950, ISBN-10: 1406738350, ISBN-13: 978-1406738357.
- **Molecular Structure and Spectroscopy** by Aruldhas, G., Second Edition, 2004, ISBN: 978-81-203-3215-7, PHI Learning.

2٨. Additional information:

Name of the Instructor or the Course Coordinator: ……	Signature: ……..……	Date: 18 -1- 2025
Name of the Head of Quality Assurance Committee/ Department …….	Signature: ……..……	Date: ……..……
Name of the Head of Department …….	Signature: ……..……	Date: ……..……
Name of the Head of Quality Assurance Committee/ School or Center …….	Signature: ……..……	Date: ……..……
Name of the Dean or the Director …….	Signature: ……..……	Date: ……..……