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	2023/10/15
	Deans Council Approval Decision Number	265/2024/24/3/2
	The Date of the Deans Council Approval Decision	2024/1/23
	Number of Pages	06

1.	Course Title	**Atomic and Molecular Physics**
2.	Course Number	**0302462**
3.	Credit Hours (Theory, Practical)	3 theory
	Contact Hours (Theory, Practical)	3 theory
4.	Prerequisites/ Corequisites	**Quantum Mechanics-1**
5.	Program Title	BSc. In Physics
6.	Program Code	
7.	School/ Center	Faculty of Science
8.	Department	Department of Physics
9.	Course Level	Third year Students
10.	Year of Study and Semester (s)	2nd Semester 2025/2026
11.	Program Degree	BSc
12.	Other Department(s) Involved in Teaching the Course	-
13.	Learning Language	English
14.	Learning Types	☑ Face to face learning ☐Blended ☐Fully online
15.	Online Platforms(s)	☐Moodle ☑Microsoft Teams
16	Issuing Date	February 2025
17.	Revision Date	June 2025

18. Course Coordinator:

Name: Dr. Ola Hassouneh Contact hours: 10:30-11:30 Monday, Tuesday and Wednesday

Office number: Phone number: 065355000 Ext.: 22043

Email: O.hassouneh@ju.edu.jo.

19. Other Instructors:

Faculty Members of the Department of Physics

20. Course Description:

This course introduces the student to the One-Electron Atoms; Electron Spin; addition of Angular Momenta; Time-Dependent and Time-Independent Perturbation; Fine Structure; Hyperfine Structure; Interaction of One-Electron Atoms with Electromagnetic Radiation; Electric Dipole Transitions; Interaction of One-Electron Atoms with External Electric and Magnetic Fields; Two-Electron Atoms; Molecular Structure and Spectra of Diatomic Molecules.

21. 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)

SO1: Identify, formulate, and solve broadly-defined technical or scientific problems by applying knowledge of Mathematics and Science and/or technical topics to areas relevant to the discipline.

SO2: Formulate or design a system, process, procedure or program to meet desired needs

SO3: Develop and conduct experiments or test hypotheses, analyze and interpret data and use scientific judgment to draw conclusions

SO4: Communicate effectively with a range of audiences in oral or written forms and exhibit ethical and professional values.

SO5: Reflect the impact of technical and/or scientific solutions in economic, environmental, and societal contexts.

SO6: Function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.

PILO's	*National Qualifications Framework Descriptors*		
	Competency (C)	Skills (B)	Knowledge (A)
1.	☐	☐	☒
2.	☐	☐	☒
3.	☐	☐	☒
4.	☐	☐	☒

5.	☐	☐	☒
6.	☐	☐	☒

* Choose only one descriptor for each learning outcome of the program, whether knowledge, skill, or competency.

A- Aims:

The aim of this course is to guide the student through a logical development of Atomic Physics. The student begins by studying the development of atomic models. After atomic models the student is guided through a phenomenon that led to the discovery of the particle-like character of radiation and the wave nature of matter. Understanding the time independent perturbation theory including its derivation and be able to apply it to simple systems. A short introduction to Schrödinger equation for hydrogen atom will be presented in this course. This introduces the students to understand the concepts of a good quantum number including their physical significance, and quantum mechanical states of the hydrogen atom. It then covers atomic selection rules, spectral fine structure and the effects of external fields. The spectra of selected multi-electron atoms are described.

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

1. 1. An understanding of the links between classical and quantum physics.
2. The ability to apply advanced techniques of quantum mechanics to problems in atomic physics.
3. Recognizes the electronic structure and properties of atomic spectra.
4. Explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields.
5. The ability to solve a range of time-dependent quantum mechanical problems.
6. Discuss the relativistic corrections for the energy levels of the hydrogen atom and their effect on optical spectra
7. Derive the energy shifts due to these corrections using first order perturbation theory.
8. State and explain the key properties of many electron atoms and the importance of the Pauli exclusion principle

Course ILOs #	**The learning levels to be achieved**						**Competencies**
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**	
1.		✓					
2.			✓				
3.	✓	✓					
4.		✓		✓			

5.				✓	✓		✓
6.		✓			✓		
7.		✓	✓			✓	✓
8.	✓	✓					

23. The matrix linking the intended learning outcomes of the course -CLO's with the intended learning outcomes of the program -PILOs:

PILO's * / CLO's	1	2	3	4	5	6	Descriptors**		
							A	B	C
1	✓	✓					✓		
2	✓	✓					✓		
3	✓	✓					✓		
4	✓	✓					✓		
5	✓						✓		
6	✓	✓					✓		
7	✓	✓							
8	✓	✓							

***Linking each course learning outcome (CLO) to only one program outcome (PLO) as specified in the course matrix.**

****Descriptors are determined according to the program learning outcome (PLO) that was chosen and according to what was specified in the program learning outcomes matrix in clause (21).**

24. Topic Outline and Schedule:

Topic	Week	Instructor	Achieved ILOs	Evaluation Methods	Reference
-Atomic Models -Rutherford's planetary model -The Rydberg formula -The Bohr theory of the atom -The Frank-Hertz experiment -Correction for finite nuclear mass	Week 1 10/2-17/2	Dr. Ola Hassouneh	1 &2	First Exam + HW-1	Course Book
-Radiation and Matter -The nature of radiation and matter -The particle-like character of radiation -The photoelectric effect -The Compton effect -The wave nature of matter -Diffraction of electrons -De Broglie formula and the H-atom -Uncertainty principle and the Bohr atom	Week 2 18/2-25/2	Dr. Ola Hassouneh	1&2	First Exam + HW-1 + Final Exam	Course Book
-Wave Equations for Simple Quantum Systems -The Schrödinger equation -The free particle wave equation in on dimension and in three dimensions -The wave equation for a particle with a potential	Week 3 25/2-3/3	Dr. Ola Hassouneh	1 & 2& 3	First Exam + HW-1 + Final Exam	Course Book
-Perturbation Theory and Radiative Transitions -Time-independent perturbation theory -Time-dependent perturbation theory -Radiative transitions -Line width and line broadening	Week 4 + Week 5 4/3-17/3	Dr. Ola Hassouneh	1 & 2 &3 &4 &5	First Exam + HW-1 + Final Exam	Course Book

-Polarization of radiation -Worked examples					
-Quantum Theory of One-Electron Atoms -The Schrodinger equation for one-electron atoms -The ground-state of one-electron atoms -Ground state wave function and probability -Spherical excited states of 1 - e" atoms -Functions without spherical symmetry -Quantum numbers for hydrogen-like atoms -Wave functions for one-electron atoms -Geometrical details of hydrogen-like orbitals -Energy levels and spectrum of the hydrogen atom -Angular momentum of bound electrons -Spin of electrons -Coupling of states -Term symbols for one-electron atoms -Spin-orbit coupling -Some remarks on the Zeeman effect -The Stark effect -Special hydrogenic systems -Exotic atoms Worked examples	Week 6+ Week 7+ Week 8+ Week 9 18/3-20/4	Dr. Ola Hassoun eh	1 & 2 &3 &6 &7	Midterm Exam + Final Exam	Course Book
-Many-Electron Atoms -The Pauli exclusion principle -The Aufbau principle and the periodic table -Vector model of the atom -Term symbols for lighter atoms -Ground state terms, Hund's rules -Ionization potentials and electron	Week 10 24/4-2/5	Dr. Ola Hassoun eh	1&2 &3&8	Final Exam	Course Book

25. Evaluation Methods:

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

Evaluation Activity	*Mark wt.	CILO's							
		1	2	3	4	5	6	7	8
First Exam	30%	✓	✓	✓					
Second Exam	20%				✓	✓	✓	✓	
Final Exam	50%	✓	✓	✓	✓	✓	✓	✓	✓
Total 100%	100%								

*** According to the instructions for granting a Bachelor's degree.**

****According to the principles of organizing semester work, tests, examinations, and grades for the bachelor's degree.**

26. Course Requirements:

(e.g.: students should have a computer, internet connection, webcam, account on a specific software/platform…etc.): The students are expected to have internet connection and a calculator

27. Course Policies:

A- Attendance policies:

Students are expected to attend all class sessions. If a student cannot attend a class session, the teacher must be notified prior to that. For the university's rules and regulations, the student's total absences must not exceed 15 % of the total class hours. Please refer to the University of Jordan student Handbook for further explanation.

B- Absences from exams and submitting assignments on time:

a. Failure in attending a course exam other than the final exam will result in zero mark unless the student provides an official acceptable excuse to the instructor who approves a make up exam.
b. Failure in attending the final exam will result in zero mark unless the student presents an official acceptable excuse to the Dean of his/her faculty who approves an incomplete exam, normally scheduled to be conducted during the first two weeks of the successive semester.

C- Health and safety procedures:

We don't have any policy at the moment considering the safety procedures, nevertheless, the instructor in each session has to give a general safety instructions for the student.

D- Honesty policy regarding cheating, plagiarism, misbehavior:

Cheating, plagiarism, misbehavior are attempts to gain marks dishonestly and includes; but not limited to:

- Copying from another student's work.
- Using materials not authorized by the institute.
- Collaborating with another student during a test, without permission.
- Knowingly using, buying, selling, or stealing the contents of a test.
- Plagiarism which means presenting another person's work or ideas as one's own, without attribution.
- Using any media (including mobiles) during the exam.

E- Grading policy:

Mark Range	Grade
0-35	F
36-41	D-
42-47	D
48-53	D+

54-63	C-
64-66	C
67-70	C+
71-76	B-
77-82	B
83-88	B+
89-94	A-
95-100	A

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

- Faculty members website
- E-Learning website
- Audio-Visual Aids

28. References:

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

Textbook:
"Physics of Atoms and Molecules"

B. H. Bransden and C. J. Joachain, " Physics of Atoms and Molecules", 2nd edition, 2003.
edition, 2003. Third Edition. JOHN WILEY & SONS, Inc. ISBN: 0-471-63845-5

B- Recommended books, materials, and media:

1. Hertel, I.V. and Schulz, C.-P., Atoms, Molecules and Optical Physics Vol. 1: Atoms and Spectroscopy, (Springer-Verlag 2015).
2. Atomic physics, (Oxford Master Series in atomic, optical and laser physics) by Christopher J. Foot.

29. Additional information:

Name of the Instructor or the Course Coordinator:	Signature:	Date:
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: .....