The University of Jordan

Accreditation & Quality Assurance Center

COURSE Syllabus

1	Course title	Atomic and Molecular Physics
2	Course number	0302462
3	Credit hours (theory, practical)	3 hr/week duration/semester
	Contact hours (theory, practical)	3 hr/week duration
4	Prerequisites/corequisites	Quantum Mechanics
5	Program title	Bachelor of Physics

6	Program code	
7	Awarding institution	Faculty of Science
8	Faculty	Science
9	Department	Physics
10	Level of course	Undergradute/ Bachelor
11	Year of study and semester (s)	2016/2st semester
12	Final Qualification	Bachelor
13	Other department (s) involved in teaching the course	Non
14	Language of Instruction	Mixed: English and Arabic
15	Date of production/revision	18/5/2016

16. Course Coordinator:

Office numbers, office hours, phone numbers, and email addresses should be listed.
Office: Second floor, In the Physic Department Office Hours: Sun, Tues, Wed, Thu, 11-1 pm.
Phone: 22023
Email: O.hassouneh@ju.edu.jo

18. Course Description:

This course introduces the student to the One-Electron Atoms; Electron Spin; addition of Angular Momenta; TimeDependent 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.

19. Course aims and outcomes:

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.

B- Intended Learning Outcomes (ILOs): Upon successful completion of this course students will be able to …

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

20. Topic Outline and Schedule: <u>As described in course description part</u>.

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	Chapter one
-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	Chapter one
-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	Chapter two

-Perturbation Theory and Radiative Transitions -Time-independent perturbation theory -Time-dependent perturbation theory -Radiative transitions -Line width and line broadening -Polarization of radiation -Worked examples	Week 4 + Week 5 4/3-17/3	Dr. Ola Hassouneh	1 & 2 &3 &4 &5	First Exam + HW-1 + Final Exam	Chapter two + Chapter 4
-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 Hassouneh	1 & 2 &3 &6 &7	Midterm Exam + Final Exam	Chapter 3
-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 Hassouneh	1&2 &3&8	Final Exam	Chapter 5

21. Teaching Methods and Assignments:

Development of ILOs is promoted through the following teaching and learning methods:

1. Provide us in the class rooms with good and an efficient equipment setups.
2. There were not enough possibilities in the course to get in contact with modern technology ways in science. For example, there were no computer-based equipments for showing lectures to the student in appropriate way.
3. The students should take more courses in mathematical physics also in quantum physics.

22. Evaluation Methods and Course Requirements:

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment methods and requirements: First Exam..... …..(20%) Midterm Exam…….. (30%) Homework, extra ……..(5%) Final exam……..(50%)

23. 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 handing in 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

24. Required equipment:

- Audio-Visual Aids

- Faculty member's Website
- E-Learning Website

25. 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

Recommended References:

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.

Name of Course Coordinator: Ola Hassouneh. Signature: ---------- Head

of curriculum committee/Department: ----------. Signature: ---------- Head of

Department: ----------. Signature: ---------- Head of

curriculum committee/Faculty: ----------. Signature: ----------

Dean: ---------- . Signature: ----------

Date: 18/5/2016.

Copy to:
Head of Department
Assistant Dean for Quality Assurance
Course File