هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

Course Specifications

Course Title:	**Atomic Physics and Spectroscopy**
Course Code:	**342PHYS**
Program:	**Physics**
Department:	**Physics**
College:	**Science**
Institution:	**Jazan University**

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A. Course Identification

1. Credit Hours: 4
2. Course type **a.** University ☐ College ☐ Department ☑ Others ☐ **b.** Required ☑ Elective ☐
3. Level/year at which this course is offered: Level 6/ Year 3
4. Pre-requisites for this course (if any)**: 312PHYS**
5. Co-requisites for this course (if any)**: NIL**

6. Mode of Instruction (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	**Traditional classroom**	**42**	**56%**
2	**Blended**	**5**	**7%**
3	**E-learning**		
4	**Distance learning**		
5	**Other**	**28**	**37%**

7. Contact Hours (based on academic semester)

No	Activity	Contact Hours
1	**Lecture**	**45**
2	**Laboratory/Studio**	**30**
3	**Tutorial**	**--**
4	**Others** (specify)	
	Total	**75**

B. Course Objectives and Learning Outcomes

1. Course Description

The course provides background knowledge of major discoveries and models relating to the atom such as Rutherford model, Bohr model and interpretation of the spectral series of the hydrogen atom, Sommerfeld model, quantum theory achievements (energy levels, Quantum numbers, electron spin and orbital angular momentum, and orbital-spin interaction). The course also covers the rules of atomic emission as well as the effect of magnetic and electric field on the atom. A series of compulsory practical exercises are undertaken to demonstrate the principals involved.

2. Course Main Objective

This course is designed to provide students with the following concepts:

- The fundamental of the atomic structure.
- The essential concepts of orbital motion, spin of the electron and fine structure.
- The effect of magnetic and electric field on the atom
- The spectral line emission and related rules.
- Practical exercises are undertaken.

3. Course Learning Outcomes

CLOs		Aligned PLOs
1	**Knowledge and Understanding**	
1.1	**State** Rutherford atom model, difficulties of Rutherford model, Bohr postulates, the failure of Bohr model, Quantum numbers, Pauli's exclusion Principle, Selection rule, effect of magnetic field on atom, effect of electric field on atom, factors affecting spectral line broadening, and detection of spectral line.	**PLO1.1**
1.2	**Discuss** Rutherford experiment for atom explanation, and Stern-Gerlach experiment, Electron spin resonance, Normal Zeeman effect, Anomalous Zeeman effect, Paschen Back effect, Stark effect.	**PLO1.2**
2	**Skills :**	
2.1	**Solve** problems related to the wavelengths of spectral lines of different series of hydrogen atom, Rydberg constant, the orbital and spin magnetic moment of an electron, Zeeman splitting, LS coupling, and wavelengths of x-ray lines.	**PLO2.1**
2.2	**Derive** the total energy for hydrogen atom based on Bohr Model, based on Sommerfeld model, radius of different orbit in Bohr atom, velocity of electron in energy levels in Bohr atom, the orbital magnetic moment of an electron for Bohr atom and reveals by quantum mechanics.	**PLO2.2**
2.3	**Perform** laboratory experiments related to atomic physics and spectroscopy	**PLO2.3**
2.4	**Develop** competencies in communication, critical thinking and reporting during lab work.	**PLO2.4**
3	**Values:**	
3.1	**Develop** abilities of team work, bear individual responsibilities on assigned tasks	**PLO3.1**
3.2	**Show** awareness of safety for own and others when dealing with lab equipment's	**PLO3.3**

C. Course Content

Part I: Theory Part:

No	List of Topics	Contact Hours
1	Atom Concept: Rutherford model, Bohr postulates and Bohr model of hydrogen atom, Spectral series of hydrogen atom (Balmer, Lyman, Paschen, Brackett and Pfund), Spectrum of hydrogen like atoms, and Sommerfeld model.	**12**
2	Orbital, Spin and Fine structure: Quantum theory achievements (energy levels - quantum numbers), Magnetic moment of the orbital motion, Spin and magnetic moment of the electron, Stern and Gerlach experiment, Spin-Orbit interaction (LS coupling) and total angular momentum, Fine structure, and Term diagram, Pauli's exclusion principle, Selection Rule, and The Lamb shift.	**12**
3	Atoms in a magnetic and Electric Fields: Electron spin resonance, Normal Zeeman effect Anomalous Zeeman effect , The Paschen Back effect, Stark effect, Factors affecting spectral line broadening (Doppler's width – Stark's width), and Detection of Spectral line.	**12**

4	**X-ray emission and internal shells:** X-ray radiation from outer shells, X-ray Bremsstrahlung spectra, X-ray characteristic radiation.	**6**
5	Review	**3**
Total		**45**

Part II: Experimental Part:

No	List of Topics	Contact Hours
1	Balmer series of hydrogen and Hg visible spectrum Experiment.	**6**
2	Grating spectrometer (Hg, Na) Experiment.	**8**
3	X–ray Emission Experiment.	**4**
4	Frank–Hertz experiment.	**4**
5	Zeeman effect Experiment.	**4**
7	Review	**4**
Total		**30**

D. Teaching and Assessment

1. Alignment of Course Learning Outcomes with Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
1.0	**Knowledge and Understanding**		
1.1	**State** Rutherford atom model, difficulties of Rutherford model, Bohr postulates, the failure of Bohr model, Quantum numbers, Pauli's exclusion Principle, Selection rule, effect of magnetic field on atom, effect of electric field on atom, factors affecting spectral line broadening, and detection of spectral line.	Lectures, blackboard and diagram illustration, group discussion, Interactive illustrations- Student contribution	**Direct** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect:** student survey
1.2	**Discuss** Rutherford experiment for atom explanation, and Stern-Gerlach experiment., Electron spin resonance, Normal Zeeman effect, Anomalous Zeeman effect, Paschen Back effect, Stark effect.	Lectures, blackboard and visualization, brain storming, group and interactive discussion, Interactive illustration – Problem based learning	**Direct** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect**: student survey
2.0	**Skills**		
2.1	**Solve** problems related to the wavelengths of spectral lines of different series of hydrogen atom, Rydberg constant, the orbital and spin magnetic moment of an electron, Zeeman splitting, LS coupling, and wavelengths of x-ray lines.	Lectures, blackboard and visualization, brain storming, group and interactive discussion, Interactive illustration – Problem based learning	**Direct** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect**: student survey
2.2	**Derive** the total energy for hydrogen atom based on Bohr Model, based on	Lectures, blackboard and visualization, brain storming, group and	**Direct** (formative and summative): In class

Code	Course Learning Outcomes	Teaching Strategies	Assessment Methods
	Sommerfeld model, radius of different orbit in Bohr atom, velocity of electron in energy levels in Bohr atom, the orbital magnetic moment of an electron for Bohr atom and reveals by quantum mechanics.	interactive discussion, Interactive illustration – Problem based learning	interactive questioning, quizzes, written exams **Indirect**: student survey
23	**Perform** laboratory experiments related to atomic physics and spectroscopy	Hands on lab demonstrations- guided discussion – guided discovery	**Direct** (formative and summative): Evaluation of assignments, Step-by-step checkpoint assessment of experiment, In lab interactive questioning, quizzes, written exams **Indirect:** student survey
2.4	**Develop** competencies in communication, critical thinking and reporting during lab work.	Lectures, blackboard and visualization, brain storming, group and interactive discussion, Interactive illustration – Problem based learning	**Direct** (formative and summative): In class interactive questioning, quizzes, written exams **Indirect:** student survey
3.0	**Values**		
3.1	**Demonstrate** abilities to work in groups and bear individual responsibility during lab work, interactive discussion and group assignments.	Interactive and Group discussion, expository and discovery teaching	**Direct** (formative and summative): In lab interactive questioning **Indirect**: student survey
3.2	**Show** awareness of safety for own and others when dealing with lab equipment's	Case study- interactive demonstration- guided discussion	**Direct** (formative and summative): In lab interactive questioning **Indirect**: student survey

2. Assessment Tasks for Students

#	Assessment task*	Week Due	Percentage of Total Assessment Score
1	**Homework assignment- Contribution in interactive discussion**	**3**	**2 (2%)**
2	**Lecture Quiz 1**	**4**	**2 (2%)**
3	**First Mid-term exam**	**6**	**10 (10%)**
4	**Homework assignment- Contribution in interactive discussion**	**8**	**2 (2%)**
5	**Lecture Quiz 2**	**9**	**2 (2%)**
6	**Second mid-term exam**	**11**	**10 (10%)**
7	**Homework assignment- Contribution in interactive discussion- Group work-essay or Project discussion**	**12**	**2 (2%)**
8	**Laboratory Exam (includes report, oral interview, and practical exam in both theory and experiments)**	**14**	**20 (20%)**
9	**Final Exam**	**16**	**50 (50%)**

***Assessment task** (i.e., written test, oral test, oral presentation, group project, essay, etc.)

E. Student Academic Counseling and Support

Arrangements for availability of faculty and teaching staff for individual student consultations and academic advice : Each group of students is assigned to a staff member who will be available for help and academic guidance office hours at specific 2h on daily basis.

F. Learning Resources and Facilities

1.Learning Resources

Required Textbooks	**The Physics of Atom and Quanta; Hermann Hacken, and Hans Christoph Wolf; 7th ed Springer-Verlage 2005.**
Essential References Materials	**- Introduction to Atomic and Nuclear Physics; H. Semat, Holt McDougal; 5th edition 1972.** **Atomic Physics; C. Foot, Oxford University Press, USA; 1st edition, 2005.**
Electronic Materials	https://en.wikipedia.org/wiki/Aomic_physics https://www.britannica.com/science/atomic-physics http://www.atomicarchive.com/Physics/Physics1.shtml https://opentextbc.ca/physicstestbook2/chapter/introduction-to-atomic-physics/
Other Learning Materials	

2. Facilities Required

Item	Resources
Accommodation (Classrooms, laboratories, demonstration rooms/labs, etc.)	Class room- if possible room for interactive discussion (round table)
Technology Resources (AV, data show, Smart Board, software, etc.)	Data show- smart board
Other Resources (Specify, e.g. if specific laboratory equipment is required, list requirements or attach a list)	Equipment to perform lab. experiments as per the Lab. manual

G. Course Quality Evaluation

Evaluation Areas/Issues	Evaluators	Evaluation Methods
Effectiveness of teaching	Students, Peer and program leader	Indirect (CES)- Indirect peer evaluation
Assessment	Students, Program assessment committee	Direct/ Indirect
Extent of achievement of course learning outcomes	Instructor	Direct/Indirect
Quality of learning resources	Students, Faculty members	Indirect

Evaluation areas (e.g., Effectiveness of teaching and assessment, Extent of achievement of course learning outcomes, Quality of learning resources, etc.)

Evaluators (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
Assessment Methods (Direct, Indirect)

H. Specification Approval Data

Council / Committee	**Department council**
Reference No.	**8**
Date	**16/4/1442**