هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission

T-104
2022

# Course Specification

| | |
|---|---|
| Course Title: | **Modern Physics II** |
| Course Code: | **441 PHYS** |
| Program: | **Physics** |
| Department: | **Physics** |
| College: | **Science** |
| Institution: | **Jazan University** |
| Version: | **2022** |
| Last Revision Date: | **20 December 2022** |

# Table of Contents:

# A. General information about the course:

| Course Identification | | | | | |
|---|---|---|---|---|---|
| **1. Credit hours:** | 4 | | | | |
| **2. Course type** | | | | | |
| a. | University ☐ | College ☐ | Department☒ | Track☐ | Others☐ |
| b. | Required ☒ | Elective☐ | | | |
| **3. Level/year at which this course is offered: Level 12/ Year 4** | | | | | |
| **4. Course General Description**<br>This is an advanced and continued Modern Physics I course offered to the 8-level undergraduate senior students at Jazan University. Molecular Spectroscopy, Modern Methods of Optical Spectroscopy, Cosmology, and the Progress in Quantum Physics are the main chapters to be covered in this course. Students learn the theory of molecular bonding, their properties and spectroscopy by means of vibration, rotation, and the selection rules of molecules. In optical spectroscopy, students learn about quantum beats, Doppler-free saturation spectroscopy and two-photon absorption and finally the level-crossing spectroscopy. Students then move to learn about the Universe by means of its origin, evolution, and ultimate fate. Last but not least, students learn about the major advancement of quantum physics, e.g., quantum computers, entanglement etc. Students are also required to perform practical classes (labs) concerning the course contents. | | | | | |
| **5. Pre-requirements for this course (if any):**<br>342Phys | | | | | |
| **6. Co- requirements for this course (if any):** | | | | | |
| **7. Course Main Objective(s)**<br>**This course is designed to provide students with the following:**<br>● The fundamentals of molecular spectra, optical spectroscopy, modern cosmology and advance in quantum physics.<br>● Analyzing the molecular spectrum, explaining optical spectroscopy, and developing their ideas about modern cosmology and the advances in the quantum world (e.g., quantum computing).<br>● Demonstrate concepts concerning the course by means of practical classes.<br>To become familiar with the advanced and leading-edge current research fields in physics. | | | | | |

## 1. Teaching mode (mark all that apply)

| No | Mode of Instruction | Contact Hours | Percentage |
|---|---|---|---|
| 1. | Traditional classroom | 60 | 91% |
| 2. | E-learning | | |
| 3. | Hybrid<br>● Traditional classroom<br>● E-learning | 6 | 9% |
| 4. | Distance learning | | |

## 2. Contact Hours (based on the academic semester)

| No | Activity | Contact Hours |
|---|---|---|
| 1. | Lectures | 30 |
| 2. | Laboratory/Studio | 33 |
| 3. | Field | |
| 4. | Tutorial | 3 |
| 5. | Others (specify) | |
| | Total | 66 |

## B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

| Code | Course Learning Outcomes | Code of CLOs aligned with the program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| 1.0 | Knowledge and understanding | | | |
| 1.1 | **Define** Relativistic Doppler shift, Resolving power, Covalent bond, Ionic bond, Bonding state, Antibonding state, Homonuclear bonding, Gravitational lensing, Einstein-Podolsky-Rosen (EPR) Paradox, Bell Inequalities | **PLO1.1** | Lectures, blackboard and visualization, group and interactive guided discussion, Interactive discussion | **Direct:** (formative and summative): In class interactive questioning, quizzes, and written exams. **Indirect:** student survey |
| 1.2 | **Describe** Cosmological Principle, Big Bang Hypothesis, the condition of laser frequency used in the Doppler-free saturation spectroscopy, Rotational and vibrational selection rules of molecules, Hubble law, The factors which determine the relative number of neutrons and protons according to the Big Bang hypothesis, the presence of dark matter and its types | **PLO1.1** | Lectures, blackboard and visualization, group and interactive guided discussion, Interactive discussion | **Direct:** (formative and summative): In class interactive questioning, quizzes, written exams. **Indirect:** student Survey |
| 1.3 | **Discuss** Entanglement, Bose-Einstein Condensates, Laser Cooling of Atoms, and Quantum Computing. | **PLO1.2** | Lectures, blackboard and visualization, group and interactive guided discussion, Interactive discussion, | **Direct:** (formative and summative): In class interactive questioning, quizzes, written exams. **Indirect:** Student Survey |
| 2.0 | Skills | | | |
| 2.1 | **Solve** the ionizing energy problems for molecules, coulomb energy of molecules, effective force constant calculation, vibrational energy, vibrational spacing, rotational energy, rotational spacing, distance galaxy, change in wavelength, universe age, universe temperature | **PLO2.1** | Lectures, blackboard and visualization, brainstorming, group and interactive discussion, Interactive illustration, Problem-based Learning, | **Direct:** (formative and summative): In class interactive questioning, quizzes, and written exams **Indirect:** Student Survey. |

| Code | Course Learning Outcomes | Code of CLOs aligned with the program | Teaching Strategies | Assessment Methods |
|---|---|---|---|---|
| | | | Using Excel Sheet for problem solving | |
| 2.2 | **Demonstrate** Doppler broadening represents an obstacle to measure a narrow spectral line, $P_y$ states are less effective in binding the molecules than the $P_x$ states, The measured bond angle for $H_2O$ molecule is greater than the expected value (90°), at the universe age greater than 250 s, the formed $^3H$ and $^3He$ nuclei do not break apart and why. | **PLO2.2** | Lectures, blackboard and visualization, group and interactive guided discussion, Interactive discussion. Movies | **Direct:** (formative and summative): In class interactive questioning, quizzes, and written exams. **Indirect:** Student Survey. |
| 2.3 | **Perform** experiments using different analog and digital devices and plot the characteristics of different types of devices, competencies in communication, critical thinking and reporting during lab work, interactive discussion and group assignments. | **PLO2.3** | Lectures, blackboard and visualization, brainstorming, group and interactive discussion, Interactive illustration, Problem-based Learning | **Direct:** (formative and summative): In class interactive questioning, quizzes, and written exams. **Indirect:** Student Survey. |
| 2.4 | **Develop** the basic idea of the laser cooling, the two photons absorption process, The problem of Doppler broadening, quantum entanglement, Lamb dip effect, quantum computing paradigm. | **PLO2.4** | Lectures, blackboard and visualization, brainstorming, group and interactive discussion, Interactive illustration, Problem-based Learning | **Direct:** (formative and summative): In class interactive questioning, quizzes, and written exams. **Indirect:** Student Survey. |
| 3.0 | Values, autonomy, and responsibility | | | |
| 3.1 | **Show** the paradigm of collaboration with effective collaboration, demonstrating the important skills of working in groups, while taking responsibility for individual tasks during group assignments and lab work and practice safety awareness in the lab. | **PLO3.1** | Interactive and Group discussion, expository and discovery teaching | **Direct:** (formative and summative): In class interactive questioning, quizzes, and written exams. **Indirect:** Student Survey. |

## C. Course Content

| No | List of Topics | Contact Hours |
|---|---|---|
| 1. | **Molecular Physics:** The Hydrogen molecule ion, Hydrogen molecule and covalent bond, Other covalent bonding molecule (pp covalent bonds, sp covalent bonds, sp hybrid states), Ionic bonding e.g. NaCl and calculation of bonding energy, Molecular vibrations, Molecular rotations, Selection rules, Molecular spectra | **9** |
| 2. | **Cosmology:** The origin of the universe, Expansion of the universe, Cosmic microwave background radiation, General Theory of Relativity, Test of General Theory of Relativity, Dark Matter and Black Holes, Big Bang cosmology, Formation of Nuclei and atoms, and Future of the universe | **9** |
| 3, | **Modern Methods of Optical Spectroscopy:** Classical method, Quantum beats, Doppler effect, Doppler –free saturation spectroscopy, Doppler-free two –photon absorption, Level-crossing spectroscopy, and Laser cooling of atoms | **8** |
| 4. | **Progress in Quantum Physics:** Quantum entanglement, Einstein-Podolsky-Rosen (EPR) Paradox, Bell's Inequalities, Introduction to quantum computers (History, Review of digital computers, Basic concept of the quantum computers), and Bose-Einstein Condensation. | **7** |
| Total | | 33 |

### Experimental Part:

| No | List of Topics | Contact Hours |
|---|---|---|
| 1 | Millikan's Oil-Drop Experiment | **3** |
| 2 | Determination of the specific Charge of the Electron (e/m) by the Deflection of Electrons in Thomson Tube | **3** |
| 3 | Determination of (e/m) from the full circular path of the electron moving in a magnetic field | **6** |
| 4 | Photoelectric Effect | 3 |
| 5 | Investigating the energy spectrum of an X-ray tube as a function of the high voltage | **3** |
| 6 | Investigating the energy spectrum of an X-ray tube as a function of the emission current | **3** |
| 7 | Duane-Hunt relation and determination of Planck's Constant | **3** |

| | | |
|---|---|---|
| 8 | Rutherford Scattering: measuring the scattering rate as a function of the scattering angle and the atomic number | **3** |
| 9 | Fine structure of the characteristic X-radiation of a molybdenum anode | **3** |
| 10 | Compton Effect: verifying the energy loss of the scattered X-ray quantum | **3** |
| **Total** | | 33 |

## D. Students Assessment Activities

| No | Assessment Activities * | Assessment timing (in week no) | Percentage of Total Assessment Score |
|---|---|---|---|
| 1. | **Homework assignment- Contribution to interactive discussion** | **3** | **2% (2)** |
| 2. | **Quiz 1** | **4** | **2% (2)** |
| 3. | **Mid-term exam** | **7** | **15% (15)** |
| 4. | **Homework assignment- Contribution to interactive discussion** | **8** | **2% (2)** |
| 5. | **Quiz 2** | **9** | **2% (2)** |
| 6. | **Homework assignment- Contribution in interactive discussion- Group work-essay or Project discussion** | **11** | **2% (2)** |
| 7. | **Laboratory Exam** | **11** | **25% (25)** |
| 8. | **Final Exam** | | **50% (50)** |

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

# E. Learning Resources and Facilities

## 1. References and Learning Resources

| | |
|---|---|
| Essential References | 1. **Modern Physics**; K. S. Krane, Wiley, John &Sons, Inc., 1995.<br>2. **The Physics of Atoms and Quanta**; H. Haken and H.C. Wolf, Springer, 6th edition 2000. |
| Supportive References | 1. Concepts of Modern Physics; Arthur Beiser, McGraw-Hill Book Co., 1987.<br>2. Modern Physics, P. A. Tipler, and R. A. Llewellyn, Freeman, 4th edition 2002. |
| Electronic Materials | |
| Other Learning Materials | |

## 2. Required Facilities and equipment

| Items | Resources |
|---|---|
| facilities<br>(Classrooms, laboratories, exhibition rooms, simulation rooms, etc.) | Classroom |
| Technology equipment<br>(Projector, smart board, software) | Multimedia Projector |
| Other equipment<br>(Depending on the nature of the specialty) | Modern Physics Laboratory |

# F. Assessment of Course Quality

| Assessment Areas/Issues | Assessor | Assessment Methods |
|---|---|---|
| Effectiveness of teaching | Students, Peers, and Program Leader | Indirect (CES)- Indirect peer evaluation |
| Effectiveness of students assessment | Students, Program assessment committee | Direct/Indirect |
| Quality of learning resources | Instructor | Direct/Indirect |
| The extent to which CLOs have been achieved | Students, Faculty members | Indirect (CES)- Indirect peer evaluation |
| Other | | |

**Assessor** (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

**Assessment Methods** (Direct, Indirect)

# G. Specification Approval Data

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|---|---|
| COUNCIL /COMMITTEE | DEPARTMENT BOARD |
| REFERENCE NO. | PHYS2304 |
| DATE | 28/2/2023 |