Course Title	Course Code	Number of Study Hours			Year	Level	Prerequisites
		Theoretical	Laboratory	Credit			
Modern Physics 2	441PHYS	3	2	4	4th	8th	342PHYS

(1) Brief Course Description

This is an advanced and continued Modern Physics I course offered to the 8 level undergraduate senior students at the 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 the 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 it's 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 the practical classes (labs) concerning to the course contents.

(2) Course Objectives

This course is designed to provide students with:

- The fundamental of molecular spectra, optical spectroscopy, modern cosmology and advance in quantum physics.
- Analyzing the molecular spectrum, explaining the optical spectroscopy, developing their ideas about modern cosmology and the advances in quantum world (e.g. quantum computing).
- Demonstrate concepts concerning the course by means of practical classes.
- Familiar with the advanced research fields in Physics.

(3) Course Contents

Theoretical Part:

- **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
- **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
- **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
- **Progress in Quantum Physics:** Quantum entanglement, Introduction to quantum computers (History, Review of digital computers, Basic concept of the quantum computers), and Bose-Einstein Condensation

Experimental Part:

- Millikan experiment and measurements of the electric charges of oil droplet.
- Determination of specific charge of electron using Thomson tube.
- Determination of specific charge of electron using calibrated Helmholtz coils.
- Determination of Planck's constant using Photo- electric effect
- Investigating the energy spectrum of an X-Ray tube as a function of the high Voltage
- Investigating the energy spectrum of an X-Ray tube as a function of the emission Current
- Determination of Planck's constant using Duane-Hunt relation using X-ray emission
- Rutherford scattering: Measuring the scattering rate as a function of the scattering angle and the Atomic Number.
- Fine structure of the characteristic x-radiation of a molybdenum anode.
- Compton effect: verifying the energy loss of the scattered x-ray quantum.

(4) Assessment Criteria

- Periodic Exams: 15%
- Oral, Student Activity and Essay: 10%
- Laboratory Work: 25%
- Final Exam: 50%

(5) Course Teaching Strategies

- Lectures, Reports and Essay Assignments, Homework, and Web-based Assignments.

(6) Text Book

- Modern Physics; K. S. Krane, Wiley, John &Sons, Inc., 1995.
- The Physics of Atoms and Quanta; H. Haken and H.C. Wolf, Springer, 6th edition 2000.

(7) Reference Books

- Concepts of Modern Physics; Arthur Beiser, McGraw-Hill Book Co., 1987.
- Modern Physics, P. A. Tipler, and R. A. Llewellyn, Freeman, 4th edition 2002.