NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF CHEMICAL AND TEXTILE ENGINEERING

TEXTILE ENGINEERING PROGRAM

FI152 – INTRODUCTION TO MODERN PHYSICS

I. GENERAL INFORMATION

CODE	**:**	FI152 Introduction to Modern Physics
SEMESTER	**:**	5-8
CREDITS	**:**	4
HOURS PER WEEK	**:**	5 (Theory – Practice)
PREREQUISITES	**:**	FI403 Physics III
CONDITION	**:**	Elective

II. COURSE DESCRIPTION

The course prepares students in the understanding and explaining the concepts, methods and techniques of Modern Physics and its technological application. Students understand Einstein Theory of Relativity, Lorentz transformations, quantum physics and photoelectric effects, the Bohr atom model and the Frank-Hertz experiment, the quantum mechanics, the Schrodinger equation and the tunnel effect. Students apply the methods and use specialized software for solving problems in physics and engineering.

III. COURSE OUTCOMES

1. Understand the concepts and principles of electromagnetic waves, their generation, propagation in vacuum, dielectric and metals.
2. Understand the process of image formation trough geometrical optics.
3. Understand and explain Einstein postulates of Relativity Theory including Lorentz transformations.
4. Understand and explain the concepts and methods of quantum physics including the photoelectric effect.
5. Understand the Bohr atom model and the Frank-Hertz experiment.
6. Understand and explain the concepts and method of quantum mechanics including the Schrodinger equation and the tunnel effect.
7. Understand and explain quantum numbers, Zeeman effect and the Stern-Gerlach experiment.

IV. COURSE CONTENTS

1. ELECTROMAGNETIC WAVES

Wave equation / Flat electromagnetic wave in vacuum / Polarization states / Energy and intensity / Poynting vector / Momentum / Generation of electromagnetic waves / Electromagnetic spectrum / Flat waves in dielectric and metals.

2. GEOMETRICAL OPTICS

Geometrical optics / Wave optics / Quantum optics / Ray / Reflection and refraction / Fermat principle / Huygens principle and Malus theorem / Reversibility principle / Reflection and refraction in flat surfaces of a parallel beam and divergent beam / Refection and refraction in spherical surfaces / Mirrors and lens.

3. **THEORY OF RELATIVITY**
Einstein postulates / Lorentz transformations / Composition of Lorentz velocities / Length contraction / Time interval dilation / Mass and momentum / Relative energy and work / Energy-momentum transformations.

4. **QUANTUM PHYSICS**
Black hole radiation / Electronic emission: Photoelectric effect / X ray production and diffraction / Crystalline groups, Bravais networks and Miller index / Compton effect / Photon absorption.

5. **BOHR ATOM MODEL**
Atom spectrum / Bohr model / Rydberg constant and spectral series / Hydrogenoid atoms / Frank-Hertz experiment / Laser.

6. **QUANTUM MECHANICS**
Hamiltonian / Quantum operators and average values / Schrodinger equation / Tunnel effect / Tunnel effect microscope / Wave function of hydrogen atom / Radial probability and angular probability.

7. **QUANTUM NUMBERS**
Orbital quantum number / Magnetic quantum number / Normal Zeeman effect / States total number / Stern-Gerlach experiment / Spin-orbit interaction / Fine structure / Atom and molecular spectrum / Magnetic resonance.

V. LABORATORY AND PRACTICE

Laboratory 1: Special relativity – Part 1
Laboratory 2: Special relativity – Part 2
Laboratory 3: Quantum mechanics
Laboratory 4: Quantum numbers

VI. METHODOLOGY

The course consists of theory, practice and laboratory sessions. The instructor presents the concepts and physical laws using applets, videos and formulating equations using differential and integral expressions. Problems related to engineering are solved with active student participation. Laboratory experiences are carried out using specialized equipment and software simulation. For every experience, students work in group and present a report summarizing main results, analysis and conclusions. Student active participation is promoted.

VII. GRADING SYSTEM

The Final Grade (FG) is calculated with the following formula:

FG = (EP + EF + PP) / 3

EP: Mid-term exam EF: Final exam PP: Average of quizzes and laboratories

VIII. BIBLIOGRAPHY

1. **SERWAY Raymond**
Modern Physics
McGraw Hill Editions 2010

2. **SEARS Francis, ZEMANSKY Mark**
Physics, Vol. II
Wesley Longman Editions, 2010