NATIONAL UNIVERSITY OF ENGINEERING

COLLEGE OF SCIENCES

PHYSICS PROGRAM

CF561 – NUCLEAR PHYSICS I

I. GENERAL INFORMATION

CODE	: CF561 – Nuclear Physics I
SEMESTER	: 9
CREDITS	: 05
HOURS PER WEEK	: 07 (Theory – Practice)
PREREQUISITES	: CF451 Quantum Mechanics II CF482 Atomic and Molecular Physics
CONDITION	: Mandatory

II. COURSE DESCRIPTION

Study the fundamentals of nuclear structure, nuclear disintegrations and reactions, as well as their applications.

III. LEARNING UNITS

1. **Atomic nucleus: Physical properties, Elastic dispersion**

   Size and distribution of nuclear charge / Nuclear radius measurement methods / Mass and nuclear components / Angular momentum, spin and parity / Magnetic moment and nuclear electric quadrupole moment / Hyperfine structure.

2. **Nuclear mass, semi-empirical formulas of nuclear mass and stability**

   The nucleus as Fermi gas / Liquid drop model and nuclear stability / Ligation energy. Masses semi-empirical formula / Masses parabola.

3. **Radioactivity and nuclear disintegration**

   Law of radioactive decay / Dosimetry and units / Quantum theory of radioactive decay / Natural radioactivity and methods of radioactive dating.

4. **Nuclear forces**

   Data on nuclear forces / Range and saturation / Isospin / Deuteron; properties and wave function / Nucleon-nucleon dispersion / Nuclear forces and their independence regarding the electric charge / Isospin formalism.

5. Alpha disintegration.

Energy balance / Geiger-Nuttal's rule / Gamow model of alpha decay / Probability of alpha decay.

6. Beta disintegration

Beta decay / Energy relations and types of beta decay / Theory of time-dependent disturbances: The shape of the spectrum and the beta decay half-life / Electronic capture / Neutrino in beta decay / Violation of parity in beta decay.

7. Theory of gamma disintegrations

Multipolar development / Weisskopf estimators / Selection rules and internal conversion / Energy balance in gamma disintegrations / Mössbauer effect and its applications.

8. Nuclear Structure and Nuclear Models

Layer model: Nuclei without deformation and nuclei with deformation / Nilsson's diagrams / Inclusion of residual interactions / Collective movement / Collective excitations and high spin states.

9. Nuclear reactions

Nuclear reactions kinematics / Conservation laws / Type of reactions / Complex nuclear reactions / Optical model.

10. Fission and Fusion

Fission process / Controlled fission reaction and fission reactors / Nuclear fusion / Solar fusion and solar neutrinos.

IV. BIBLIOGRAPHY

- K. Heyde, Basic Ideas and Concepts in Nuclear Physics, IOP Publishing Ltd. 2004.
- A. Ferrer Soria, Física Nuclear y de Partículas, Universitat de València, 2003.
- W.N. Cottingham y D.A., Greenwood, An Introduction to Nuclear Physics, Cambridge University Press, 1986.
- G.A. Jones, The Properties of Nuclei, Clarendon Press, Oxford, 1987.
- W.E. Burcham, Nuclear Physics, An Introduction, Longman, London, 1973.