BACHELOR 'S PROGRAMME
1st YEAR OF STUDY, 1st SEMESTER

COURSE TITLE	PHYSICS OF NUCLEUS & ELEMENTARY PARTICLES PHYSICS
COURSE CODE	
COURSE TYPE	full attendance
COURSE LEVEL	1st cycle (bachelor's degree)
YEAR OF STUDY, SEMESTER	1st year of study, 1st semester
NUMBER OF ECTS CREDITS	6
NUMBER OF HOURS PER WEEK	7 (3 lecture hours + 4 seminar hours)
NAME OF LECTURE HOLDER	Conf. dr. Catalin-Gabriel BORCIA
NAME OF SEMINAR HOLDER	Lect. dr. Adeline CIOCAN
PREREQUISITES	Advanced level of English

A	GENERAL AND COURSE-SPECIFIC COMPETENCES

General competences:

- → Achievement of professional tasks efficiently and responsibly, in compliance with the field-specific deontology legislation, with qualified assistance.
- → Elaboration of a specialty or licence work, respecting the objectives, proposed deadlines and norms of professional ethics.
- → Application of efficient work techniques in a multi-disciplinary team, on various hierarchical levels.
- → Realization of a project/ team activity and identification of specific professional roles
- → Effective use of information sources and communication resources and assisted professional training, both in Romanian and in a foreign language.
- → Elaboration, drafting and presentation in Romanian and/ or in a language of international circulation of a specialty work on a current topic in the field.

Course-specific competences:

- → Identification and proper use of the main laws and physical principles in a given context.
- → Derivation of working formulas for calculations with physical quantities using appropriate principles and laws of Physics.
- → Description of physical systems, using specific theories and tools (experimental and theoretical models, algorithms, schemes, etc.)
- → Application of the principles and laws of Physics in solving theoretical or practical problems, under qualified assistance conditions.
- → Correct application of methods of analysis and of criteria for choosing the appropriate solutions to achieve the specified performances.
- → Comparative assessment of the theoretical results offered by literature and of an experiment conducted in the framework of a professional project.
- → Solving of Physics problems in given conditions, using numerical and statistical methods.
- → Proper use of numerical methods and mathematical statistics in the analysis and processing of specific physical data
- → Elaboration of graphs and reports for explaining and interpreting physical results obtained by statistical methods.
- → Correlation of statistical analysis methods on a given topic (realization of measurements/calculations, data processing, interpretation).
- → Assessing the reliability of the results and comparing them with bibliographical data or calculated theoretical values, using statistical validation methods and/ or numerical methods.
- → Elaboration of a project using the principles and methods of mathematical statistics and/ or numerical methods in a given physical context.
- → Application of Physics knowledge in given situations in related fields, as well as in experiments, using standard laboratory equipment.
- → Application of Physics knowledge both in given situations in related fields and in experiments, using standard laboratory equipment.
- → Explanation and interpretation of physical phenomena by formulating assumptions and operationalizing key concepts and proper use of laboratory equipment.
- → Identification of Physics and Informatics methods, techniques and tools; Design of Physics experiments using specific laboratory methods and equipment.
- → Critical assesment of the results obtained by employing a physical model, including the degree of uncertainty of the obtained experimental results.
- → Implementation, improvement and extension of a physical model utilisation. Making experimental devices capable of validating a physical model.

	→ Interdisciplinary approach of Physics-related topics. → Make of necessary connections to use physical phenomena, using basic knowledge from close domains (Chemistry, Biology, etc.) → Responsible performing independent work tasks and interdisciplinary approach of topics.
B	LEARNING OUTCOMES
	Upon successful completion of this discipline, students will be able to: • Identify and adequately use the main laws and physical principles in a given context • Resolve physics problems under imposed conditions using numerical and statistical methods • Apply knowledge in the field of physics both in concrete situations in related fields and in experiments using standard laboratory equipment • Analyze and interpret data obtained from numerical measurements or simulations • Efficiently use information sources and communication resources and assisted training in English
C	LECTURE CONTENT
	• Chap. I. General properties of the atomic nucleus: charge, mass, bonding energy, stability, electrical and magnetic moments • Chap. II Radioactivity: types, laws, characteristic quantities • Chap. III Interaction of nuclear radiation with substance. The case of electrically charged radiation • Chap. IV Interaction of nuclear radiation with substance. Cases of photons and neutrons • Chap. V Radiation detectors: gas detectors • Chap. V Radiation detectors: scintillation detector, semiconductor detectors • Chap. VI Nuclear models: liquid drop model of the nucleus, nuclear shells model • Chap. VI Nuclear forces. Properties of nuclear forces • Chap. VII Types of decay alpha beta gamma • Chap. VIII Nuclear Reactions: Conservation laws: conservation of charge, energy, impulse, kinetic momentum and parity. Types of nuclear reactions. • Chap. IX Nuclear reactions: Reaction mechanisms. Artificial radioactivity. Transuranic elements. • Chap. IX Nuclear reactions used as energy sources. Fission. Nuclear fusion. • Chap. X Particle accelerators. Cyclic accelerators and linear accelerators • Chap. X Elementary particles: classification, properties
D	RECOMMENDED READING FOR LECTURES
	1. E. Lozneanu, Fizică nucleară, Ed. Universităţii „Al. I. Cuza” Iaşi (2003) 2. A. Das, T. Ferbel, Introduction to Nuclear and Particle Physics, World Scientific, Singapore (2003) 3. Glenn Knoll "Radiation Detection and Measurement" Ed.John Wiley & Sons, New-York (1989) 4.Emilio Segre „Nuclei and Particles” Ed. W.A. Benjamin, Inc. (1977) 5.Helmut Wiedemann , Particle Accelerator Physics, Springer-Verlag Berlin Heidelberg (2007)
E	SEMINAR / LABORATORY CONTENT
	LABORATORY CONTENT • Rules for work safety and protection • Methods and software for modeling the interaction of ionizing radiation with the substance • Methods of obtaining and processing the results of measurements in nuclear physics (Part I) • Methods of obtaining and processing the results of measurements in nuclear physics (Part II) • Statistical fluctuations in radioactivity measurements • Methods of determining the activity of radioactive sources • Study of beta-ray absorption in various materials • Study of interaction of gamma radiation with substance • Processing of data obtained from previous work, discussions, analysis of results, partial evaluation of students. • Study of the Geiger-Muller counter • Determining the energy of alpha particles • Determination of the maximum energy of beta particles with a complex spectrum • Gamma spectrometry – study of the single-channel analyzer • Gamma spectrometry – study of the multi-channel analyzer • Processing of data obtained from previous work, discussions, analysis of results, final evaluation of students. SEMINAR CONTENT • General properties of the atomic nucleus, calculating the binding energy, methods of determining the properties of the nuclei, applications. • Radioactivity: types, laws, characteristic quantities • Interaction of nuclear radiation with substance. Case of electrically charged radiation, applications. • Interaction of nuclear radiation with substance. Cases of photons and neutrons. Applications . • Gas detectors, applications • Scintillation detector, semiconductor detectors, applications in nuclear spectrometry • The drop model of the atomic nucleus, applications. Nuclear shell model, applications for calculating magnetic moments of nuclei. • Nuclear forces. Properties of the nuclear forces

	• Types of decays: alpha, beta and gamma; applications. • Nuclear reactions: conservation laws, applications. • Nuclear reactions: Reaction mechanisms. Artificial radioactivity, methods of obtaining artificial radionuclides, applications. • Nuclear reactions used as energy sources. Fission. Nuclear fusion • Particle accelerators: linear accelerator, betatron, cyclotron, applications. • Final review.
F	RECOMMENDED READING FOR SEMINARS
	1. D. Mihăilescu, E. Lozneanu, Lucrări practice de fizică nucleară, Ed. Univ. Al. I. Cuza Iaşi, 2001. 2. G. Ioniţă, E. Lozneanu, E. Tereja, D. Alexandroaie, Culegere de probleme de fizică nucleară, Ed. Univ. Al. I. Cuza Iaşi, 1984. 3. Yung-Kuo Lim, Problems and Solutions on Atomic, Nuclear and Particle Physics, World Scientific Publishing Co. Ltd., Singapore 2000 4. Ahmad A. Kamal, 1000 Solved Problems in Modern Physics, Springer-Verlag, Berlin Heidelberg 2010
G	EDUCATION STYLE
LEARNING AND TEACHING METHODS	Lecture, thematic debates, applications Discussion, practical work Dialogue, explanation, demonstration, problem solving
ASSESSMENT METHODS	Exam Laboratory reports
LANGUAGE OF INSTRUCTION	English