Universitatea Națională de Știință și Tehnologie Politehnica București
Facultatea de Electronică, Telecomunicații și Tehnologia Informației

COURSE DESCRIPTION

1. Program identification information

1.1 Higher education institution	**National University of Science and Technology Politehnica Bucharest**
1.2 Faculty	**Electronics, Telecommunications and Information Technology**
1.3 Department	**Electronic Devices, Circuits and Architectures**
1.4 Domain of studies	Electronic Engineering, Telecommunications and Information Technology
1.5 Cycle of studies	Bachelor/Undergraduate
1.6 Programme of studies	Microelectronics, Optoelectronics and Nanotechnologies

2. Date despre disciplină

2.1 Course name (ro) (en)				Fizică 2 Physics 2			
2.2 Course Lecturer				Assoc. Prof. Dr. Octavian Danila			
2.3 Instructor for practical activities				Assoc. Prof. Dr. Octavian Danila			
2.4 Year of studies	1	2.5 Semester	II	2.6. Evaluation type	E	2.7 Course regime	Ob
2.8 Course type	F	2.9 Course code		04.F.02.O.010		2.10 Tipul de notare	Nota

3. Total estimated time (hours per semester for academic activities)

3.1 Number of hours per week	4	Out of which: 3.2 course	3	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	56	Out of which: 3.5 course	42	3.6 seminary/laboratory	14
Distribution of time:					hours
Study according to the manual, course support, bibliography and hand notes Supplemental documentation (library, electronic access resources, in the field, etc) Preparation for practical activities, homework, essays, portfolios, etc.					38
Tutoring					3
Examinations					3
Other activities (if any):					0

3.7 Total hours of individual study	44.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	General knowledge of algebra and mathematical analysis, programming, and high-school general physics.

4.2 Results of learning	Acquisition of the following knowledge: – performing basic mathematical operations; – solving first- and second-degree equations; – developing simple programs; – performing operations with vectors; – elementary dimensional analysis.

5. Necessary conditions for the optimal development of teaching activities (where applicable)

5.1 Course	The course will take place in a room equipped with a video projector and a computer.
5.2 Seminary/ Laboratory/Project	Specialized laboratory within the Department of Physics (BN030).

6. General objective *(Reffering to the teachers' intentions for students and to what the students will be thought during the course. It offers an idea on the position of course in the scientific domain, as well as the role it has for the study programme. The course topics, the justification of including the course in the currcula of the study programme, etc. will be described in a general manner)*

Students are introduced to the fundamental laws of nature and their applications in engineering. They learn to confirm theoretical results through experiment. They learn techniques for solving problems in mechanics, special relativity, electromagnetism, and optics. They become familiar with fundamental notions of the structure of matter.

Students learn to apply mathematical methods in concrete situations. They begin initiation into the methods of modern physics and the applications of physics in engineering, especially in electronics.

They apply mathematical and physical models in simple yet fundamental cases. They are initiated into scientific research methods.

7. Competences *(Proven capacity to use knowledge, aptitudes and personal, social and/or methodological abilities in work or study situations and for personal and proffesional growth. They refflect the empolyers requirements.)*

Specific Competences	Understanding the methods and results of physics and applying them in concrete situations in the activity of electronics engineers. Ability to build and apply mathematical and physical models. Applying mathematical methods to concrete situations. Developing skills for measuring physical quantities, collecting and processing experimental data, calculating measurement errors, and presenting the results of an experiment.
Transversal (General) Competences	Mastering optimal learning methods, combining theoretical and experimental results, and developing the habit of teamwork. Learning how to support an idea and conduct a scientific debate. Honorable, responsible, ethical behavior, in the spirit of the law, to ensure the profession’s reputation. Awareness of the need for continuous training; efficient use of resources and learning techniques for personal and professional development.

8. Learning outcomes *(Synthetic descriptions for what a student will be capable of doing or showing at the completion of a course. The learning outcomes reflect the student's acomplishments and to a lesser extent the teachers' intentions. The learning outcomes inform the students of what is expected from them with respect to performance and to obtain the desired grades and ECTS points. They are defined in concise terms, using verbs similar to the examples below and indicate what will be required for evaluation. The learning outcomes will be formulated so that the correlation with the competences defined in section 7 is highlighted.)*

Knowledge	*The result of knowledge aquisition through learning. The knowledge represents the totality of facts, priciples, theories and practices for a given work or study field. They can be theoretical and/or factual.* – defines physical quantities and their units of measurement specific to the chapters studied. – identifies and describes physical phenomena in nature and how they are formulated mathematically. – states principles and laws, including in their mathematical form. – formulates and checks, dimensionally, the mathematical relations that describe physical phenomena.
Skills	*The capacity to apply the knowledge and use the know-how for completing tasks and solving problems. The skills are described as being cognitive (requiring the use of logical, intuitive and creative thinking) or practical (implying manual dexterity and the use of methods, materials, tools and intrumentation).* – identifies and uses applicable principles and laws to approach various concrete situations. – works productively in a team. – experimentally verifies the connection between theory and practical applications. – solves, analytically and numerically, problems specific to the field. – appropriately interprets causal relationships. – formulates conclusions for the experiments carried out. – argues the identified solutions/methods of solving.
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* – selects appropriate bibliographic sources and analyzes them. – respects the principles of academic ethics, correctly citing the bibliographic sources used. – demonstrates receptiveness to new learning contexts. – shows collaboration with other colleagues and teaching staff in carrying out teaching activities. – demonstrates autonomy in organizing the learning situation/context or the problem situation to be solved. – demonstrates management skills for real-life situations (organizing and managing one's own time and that of the working group, collaboration vs. conflict).

9. Teaching techniques *(Student centric techniques will be considered. The means for students to participate in defining their own study path, the identification of eventual fallbacks and the remedial measures that will be adopted in those cases will be described.)*

Starting from the analysis of students' learning characteristics and their specific needs, the teaching process will explore both expository methods (lecture, presentation) and conversational–interactive methods, based on modern learning-by-discovery models facilitated by direct and indirect exploration of reality (experiment, demonstration, modeling), as well as action-based methods such as exercises, practical activities, and problem solving.

Lectures will use PowerPoint presentations or various short videos made available to students. Each class will begin with a recap of the chapters already covered, with emphasis on the notions from the previous lecture.

The presentations use images and diagrams so that the information presented is easy to understand and assimilate.

This discipline covers information and practical activities meant to support students in their learning efforts and in developing optimal collaboration and communication relationships in a climate conducive to deepening fundamental concepts and notions.

Emphasis will be placed on practicing active listening and assertive communication skills, as well as mechanisms for constructing feedback as ways of regulating behavior in various situations and adapting the pedagogical approach to students' learning needs.

It will be ensured that students work efficiently in teams to solve various learning tasks.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	Electromagnetism: electromagnetic field, fundamental experiments and laws, applications.	8
2	Elements of wave optics: electromagnetic waves, characteristics, polarization, reflection and refraction, applications. Interference, diffraction, polarization of light. Applications.	8
3	Experimental basis of quantum theory. Characteristics of quantum entities.	4
4	Principles of quantum mechanics. Schrödinger equation.	2
5	One-dimensional quantum systems: potential well, potential barrier, tunneling effect, quantum harmonic oscillator. The hydrogen-like atom. Applications.	8
6	Systems of identical particles. Fermi–Dirac and Bose–Einstein quantum statistics.	2
7	Elements of quantum solid-state physics. Energy spectrum of electrons in periodic potentials.	2
8	Applications of quantum physics in complex systems and devices	4
9	Elements of nuclear physics and ionizing radiation. Environmental radioactivity, medical and industrial uses of ionizing radiation, nuclear energy. The Standard Model of elementary particles. Elements of cosmology.	2
10	Elements of laser and plasma physics.	2
	Total:	42

Bibliography:
1. Written course on the Department of Physics platform: http://www.physics.pub.ro/Cursuri/Cursuri.htm
2. Course support on UPB's Moodle e-Learning platform: https://curs.upb.ro/2024
3. Ch. Kittel, W. D. Knight, M. A. Ruderman, A. K. Helmholz, B. J. Moyer, Berkeley Physics Course, vol. 2 – Electricity and Magnetism, vol. 4 – Quantum Physics. Didactic and Pedagogical Publishing House, 1981.
4. Ch. Kittel, W. D. Knight, M. A. Ruderman, A. K. Helmholz, B. J. Moyer, Berkeley Physics Course, Electricity and Magnetism, Quantum Physics. Cambridge University Press, 2014.
5. Halliday & Resnick, Fundamentals of Physics, 8th ed., Wiley India Pvt. Limited, 2008.
6. Ioan M. Popescu, Physics II, EDP, Bucharest, 1982.
7. T. Crețu, Physics – University Course, Technical Publishing, Bucharest, 1996.
8. I. M. Popescu, Gabriela F. Cone, Gh. A. Stanciu, "Collection of Physics Problems", EDP, Bucharest, 1981.
9. I. E. Irodov, Problems in General Physics, Mir Publisher, 1988.
10. P. A. Tipler, Physics for Scientists and Engineers, 4th ed., W. H. Freeman & Co., 1999.
11. O. Dănilă, Elements of Modern and Contemporary Physics, Matrix Publishing, 2025.

LABORATORY

Crt. no.	Content	No. hours
1	Measuring the electron's specific charge.	2
2	Determining the Rydberg constant.	2
3	Determining Planck's constant.	2
4	Poisson and Gaussian statistics.	2
5	Electron diffraction (Debye–Scherrer).	2
6	Experiment illustrating Heisenberg's principle.	2
7	Measuring the current–voltage characteristic of a tunnel diode.	2
8	Seebeck effect.	2
9	Determining the absolute activity of a radioactive source.	2
10	Franck–Hertz experiment.	2
11	Compton effect.	2
12	Determining the mass attenuation coefficient for gamma radiation.	2
13	Determining the dead time of a Geiger–Müller detector.	2
14	Study of the Hall effect in semiconductors.	2
	Total:	14

Bibliography:
1. Physics Laboratory Manual (UPB Library).
2. Lab worksheets from the Physics Laboratory.
3. Laboratory reports on the Department of Physics website:
http://www.physics.pub.ro/Cursuri/Cursuri.htm

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade

11.4 Course	– knowledge of fundamental theoretical notions – knowledge of how to apply theory to specific problems	– final exam (oral)	50%
	– knowledge of fundamental theoretical notions – knowledge of how to apply theory to specific problems	– in-semester verification test (written)	20%
11.5 Seminary/laboratory/project	Laboratory: familiarization with the basics of scientific experiments, with measurement methods, and with the processing of experimental data	– presentation of reports with measured data and calculations of relevant physical quantities – final laboratory colloquium	30%
11.6 Passing conditions			
– completion of all scheduled laboratory works, passing the laboratory colloquium, and obtaining at least 50% of the points allocated to laboratory activity. – passing the final exam and obtaining at least 50% of the total score, by adding the ongoing scores (laboratory + verification test) and the final exam score.			

12. Corroborate the content of the course with the expectations of representatives of employers and representative professional associations in the field of the program, as well as with the current state of knowledge in the scientific field approached and practices in higher education institutions in the European Higher Education Area (EHEA)

The Physics 2 course is a fundamental discipline that helps develop the student's engineer–researcher mindset. The course presents two areas in which physics has achieved remarkable results in recent decades.

It aims to create a link between mathematical models and methods and physical ones, both with applications in engineering.

It lays the groundwork for understanding subjects taught in subsequent years, such as semiconductor physics, microwaves, lasers, and optoelectronics.

Students are prepared to pursue research master's programs. Some perspectives for scientific research are opened.

Students are introduced to some modern theories in physics, such as quantum mechanics.

This course continues the practical activity begun in Physics 1, where students conduct experiments, measure physical quantities, calculate measurement errors, and obtain the final results of the experiments.

Date	Course lecturer	Instructor(s) for practical activities
29.09.2025	Assoc. Prof. Dr. Octavian Danila	Assoc. Prof. Dr. Octavian Danila

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Facultatea de Electronică, Telecomunicații și Tehnologia Informației

Date of department approval	Head of department
	Prof. Dr. Claudius Dan
Date of approval in the Faculty Council	Dean
	Prof. Mihnea UDREA