Universitatea Naţională de Ştiinţă şi Tehnologie Politehnica Bucureşti
Facultatea de Electronică, Telecomunicaţii şi
Tehnologia Informaţiei

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)				Materiale pentru electronică Materials for Electronics			
2.2 Course Lecturer				S.l./Lect. Dr. Valentin Feieş			
2.3 Instructor for practical activities				S.l./Lect. Dr. Valentin Feieş			
2.4 Year of studies	1	2.5 Semester	2	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		D	2.9 Course code	04.D.02.O.014		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3.5	Out of which: 3.2 course	2	3.3 seminary/laboratory	1.5
3.4 Total hours in the curricula	49	Out of which: 3.5 course	28	3.6 seminary/laboratory	21
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.					45
Tutoring					0
Examinations					6
Other activities (if any):					0

3.7 Total hours of individual study	51.00
3.8 Total hours per semester	100
3.9 Number of ECTS credit points	4

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Completion and/or passing of the following courses: Physics 1, Chemistry, Fundamentals of Electrical Engineering 1
4.2 Results of learning	Not applicable

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

5.1 Course	The course will take place in a classroom equipped with a video projector and a blackboard.
5.2 Seminary/ Laboratory/Project	Laboratory work will take place in the materials laboratory (rooms A404 and A406). Attendance at laboratory sessions is mandatory (according to the undergraduate studies regulations at UPB).

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)*

Through this course, students become familiar with the structure of materials used in electronics and their main characteristics and properties. The course addresses the following categories of materials: conductors, dielectrics, magnetic materials, and semiconductors. The main application areas of materials in electronics are also presented.

The main objectives of the course are as follows:

- developing the skills to use various materials optimally in applications and projects;
- acquiring general knowledge regarding the influence of a material’s structure on its properties;
- gaining the ability to evaluate the characteristics of a device made from a specific material using datasheet information and accumulated knowledge about that material’s properties;
- understanding the limitations imposed by various materials for their use in the manufacture of high-performance electronic devices;
- becoming familiar with the properties of newly fabricated materials and the requirements for applying them in new devices built on their basis.

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	• Demonstrates possession of basic knowledge in the field of materials with applications in electronics • Coherently and correctly argues and analyzes the context for applying the field’s basic knowledge, using key concepts of the course and the specific methodology • Oral and written communication in Romanian: uses the scientific vocabulary specific to the field for effective written and oral communication
Transversal (General) Competences	• Works in a team and communicates effectively, coordinating efforts with others for the resolution of medium-complexity problem situations • Autonomy and critical thinking: ability to think in scientific terms, to search for and analyze data independently, as well as to derive and present conclusions /identify solutions • Capacity for analysis and synthesis: presents acquired knowledge in a synthetic manner as a result of a systematic analysis process

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.* • Mastery of fundamental concepts related to the properties of materials used in electronics • Ability to correctly define notions specific to the field of material properties • Acquisition of knowledge about the crystalline structure of materials and their symmetry classes • Ability to appropriately interpret causal relationships between a material’s type of crystalline structure and its specific properties • Acquisition of practical knowledge of specialized instrumentation for measuring material properties
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).* • Solving specific practical applications • Carrying out measurements of material properties using specialized measuring instrumentation • Ability to interpret experimentally obtained results and to formulate conclusions about them • Proper preparation of a laboratory report • Efficient performance of team-based activities
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* • Ability to select and consult bibliographic sources • Ability to learn new concepts • Ability to collaborate with colleagues in carrying out didactic activities • Ability to communicate information to other colleagues • Development of autonomy within the learning process

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.)*

Within the course, teaching activity is based on the use of the video projector (covering the communication and demonstration functions). Course lectures are presented as PowerPoint presentations using images and diagrams so that the information presented is easy to understand and assimilate. The oral communication methods used are the expository method and problem-posing method, used frontally. Teaching materials include course notes and presentations, also available in electronic format.

Regarding laboratory activity, the preferred teaching method is the expository one (covering the communication and demonstration functions) together with experimental laboratory setups. Students carry out the measurements specified in the laboratory procedure and must subsequently prepare a report with the measurement results and their interpretations, accompanied by personal comments. Teaching materials are the laboratory platforms included in the laboratory guide and available in electronic format.

The ability to work in a team to solve various learning tasks will be practiced.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**
1	BASICS OF MATERIALS STRUCTURE Atomic structure of materials. Structural states of matter. Structure of solid materials. Types of bonds in single crystals. Phonons. Electrons in the solid. Energy distribution of electrons. Exercises and problems	6
2	CRYSTALLINE SOLID MATERIALS Introduction to crystallography. Symmetry of crystalline polyhedra. Group properties of symmetry operations. Herman–Mauguin notation of crystalline symmetry groups. Crystallographic categories, systems, and classes. Crystallographic directions and planes. Reciprocal lattice. Miller index. Characterization of crystals by X-ray diffractometry. Influence of crystalline symmetry on material properties. Exercises and problems	6
3	CONDUCTIVE PROPERTIES OF MATERIALS Conductivity and Ohm’s law. Conductivity in metals, dielectrics, and semiconductors. Classical and quantum theories of conductivity. Electrical resistivity of metals. Electron mobility and carrier density in metals and nonmetals. Exercises and problems	5
4	DIELECTRIC MATERIALS Dielectric properties. Theory of polarization in dielectrics and types of polarization. Dielectric constant and its dependence on frequency and temperature. Types of dielectric materials. Conduction in dielectric materials. Dielectric breakdown. Ferroelectricity. Electrets. Piezoelectricity. Pyroelectricity. Exercises and problems	5
5	MAGNETIC MATERIALS Introduction. Basic concepts. Diamagnetism. Paramagnetism. Ferromagnetism. Antiferromagnetism and ferrimagnetism. Influence of temperature on the magnetic behavior of materials. Magnetic domains and hysteresis. Soft and hard magnetic materials. Energy losses in magnetic materials. Exercises and problems	4
6	SEMICONDUCTOR MATERIALS Intrinsic and extrinsic semiconductors. Temperature dependence of conductivity and carrier concentration in semiconductor materials. Effective masses in semiconductors. Fabrication techniques for semiconductor devices. Exercises and problems	2
	Total:	28

Bibliography:
1. Valentin-Ionel Feieş, Materiale pentru electronică, suport de curs: https://archive.curs.upb.ro/2024/mod/folder/view.php?id=183160
2. Drăgulinescu M., Manea A., *Materiale pentru electronică, vol. I+II*, Editura Matrix Rom, Bucureşti, 2006
3. Callister, W.D. Jr., *Material Science and Engineering: An Introduction*, John Wiley & Sons, New York, 2007
4. Hummel, R.E., *Electronic Properties of Materials*, 4th edition, Springer, New York, 2011
5. Mitchell, B.S., *An Introduction to Materials Engineering and Science for Chemical and Materials Engineers*, John Wiley & Sons, New York, 2004
6. Cătuneanu V.M. (coordonator), *Materiale pentru electronică*, Editura didactică şi pedagogică, Bucureşti, 1981
7. Sandu D.D., *Electronică fizică aplicată, vol. 1: Principii fizice. Dispozitive. Tehnologii*, Editura Universităţii „Al. I. Cuza”, Iaşi, 1994
8. Kittel, C., I*ntroduction to Solid-State Physics*, 8th ed., John Wiley & Sons, New York, 2005
9. Ashcroft, N.W. & Mermin, N.D., *Solid State Physics*, Harcourt College Publishers, 1976

LABORATORY

Crt. no.	Content	No. hours
1	Dielectric materials	3
2	Ferroelectric materials	3
3	Conductive properties of materials	3
4	Materials for optoelectronics	3
5	Large-signal properties of ferromagnetic and ferrimagnetic materials	3
6	Small-signal characterization of ferromagnetic and ferrimagnetic materials	3
7	Final evaluation of laboratory activity (colloquium)	3
	Total:	21

Bibliography:
1. Materiale pentru electronică, documentaţie suport pentru laborator: https://archive.curs.upb.ro/2024/mod/folder/view.php?id=116483
2. Paul Şchiopu, Adrian Manea, *Materiale pentru electronică. Îndrumar*, Seria Optoelectronică, nr. 10, Ed. Matrix ROM, Bucureşti, 2011

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 concepts - Development of skills to apply the learned theoretical notions by solving problems	Mid-semester written evaluation test	50%
	- Knowledge of fundamental theoretical concepts - Development of skills to apply the learned theoretical notions by solving problems	End-of-semester written evaluation test, in week 14	20%
11.5 Seminary/laboratory/project	- Knowledge of fundamental theoretical concepts - Development of skills to apply theoretical notions to applications and to working with various experimental setups	Evaluation of the reports prepared by students after each laboratory session (20%) Final test evaluating laboratory activity (10%)	30%
11.6 Passing conditions			
• Obtaining 50% of the total score • Obtaining 50% of the score related to laboratory activity during the semester			

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)

Through the activities carried out, students develop the skills to offer solutions to problems and to propose ideas for improving the existing situation in the electronics field, in the industrial branch of materials technology.

In the development of the course content, knowledge, aspects, and phenomena described in the specialized literature were considered.

The proposed activities aim to develop the graduate’s ability to manage practical situations that may be encountered in real life, in order to increase their contribution to improving the socio-economic environment.

Date	Course lecturer	Instructor(s) for practical activities
25.09.2025	S.l./Lect. Dr. Valentin Feieş	S.l./Lect. Dr. Valentin Feieş

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

Date of department approval	Head of department
26.09.2025	Prof. Dr. Claudius Dan

Date of approval in the Faculty Council	Dean
26.09.2025	Prof. Dr. Mihnea Udrea