**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 | **Applied Electronics and Information Engineering** |
| 1.4 Domain of studies | Electronic Engineering, Telecommunications and Information Technology |
| 1.5 Cycle of studies | Bachelor/Undergraduate |
| 1.6 Programme of studies | Applied Electronics |

## 2. Date despre disciplină

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|---|---|---|---|---|---|---|---|
| 2.1 Course name (ro)<br>(en) | | | | Materiale pentru electronică | | | |
| 2.2 Course Lecturer | | | | Conf. Dr. Andrei Drăgulinescu | | | |
| 2.3 Instructor for practical activities | | | | Ş.l. Dr. Ionuţ-Romeo Şchiopu | | | |
| 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)

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|---|---|---|---|---|---|
| 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<br>Supplemental documentation (library, electronic access resources, in the field, etc)<br>Preparation for practical activities, homework, essays, portfolios, etc. | | | | | 45 |
| Tutoring | | | | | 0 |
| Examinations | | | | | 6 |
| Other activities (if any): | | | | | 0 |

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| 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)

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| 4.1 Curriculum | Physics 1, Physics 2, Chemistry, Fundamentals of Electronic Engineering 1, Fundamentals of Electrotechnical Engineering 2 |
| 4.2 Results of learning | Knowledge of Physics, Chemistry and fundamentals of Electrotechnical Engineering |

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

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| 5.1 Course | Not applicable. |
| 5.2 Seminary/ Laboratory/Project | Mandatory attendance to the laboratories (according to the regulation for licence studies in PUB). |

**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)*

Course: the discipline studies the most important types of materials used in electronics and presents their applications.
It also familiarizes students with the specific parameters of devices based on these materials for specific applications. Laboratory: Laboratory applications familiarize students with various materials used in electronics and with various electronic devices that contain them or that are used to characterize these materials. Also considered are the simulation of these electronic and optoelectronic devices, as well as the processing and interpretation of the results obtained from experiments and simulations, respectively. It also familiarizes students with the practical use of these devices.

**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.)*

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| **Specific Competences** | Demonstrate basic/advanced knowledge of materials used in electronics.<br>Correlate knowledge.<br>Apply knowledge in practice<br>Apply standardized methods and tools, specific to the field, to carry out the evaluation and diagnosis process of a situation, depending on the identified/reported problems, and identifies solutions.<br>Argue and analyze coherently and correctly the context of application of the basic knowledge of the field, using key concepts of the discipline and specific methodology. |
| **Transversal (General) Competences** | Work in a team and efficient communication, coordinating efforts with others to solve problem situations of medium complexity.<br>Autonomy and critical thinking: the ability to think in scientific terms, search and analyze data independently, and draw and present conclusions / identify solutions.<br>Ability to analyze and synthesize: presents the acquired knowledge in a synthetic way, as a result of a process of systematic analysis.<br>Respect the principles of academic ethics: correctly cite the bibliographic sources used in the documentation activity.<br>Puts elements of emotional intelligence into practice in the appropriate social-emotional management of real-life/academic/professional situations, demonstrating self-control and objectivity in decision-making or stressful situations. |

**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.)*

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| **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.*<br>• acquisition of fundamental concepts about the main classes of materials,<br>• acquiring knowledge about the main electronic devices based on them,<br>• acquiring general knowledge regarding the influence of the material structure on its properties,<br>• acquiring the knowledge to create and analyze an experimental montage based on these materials,<br>• acquiring the knowledge to simulate an electronic montage,<br>• acquisition of working knowledge with specialized measurement instrumentation,<br>• knowledge of the limitations imposed on various materials in order to use them in the manufacture of high-performance electronic devices,<br>• knowledge of the properties of new recently manufactured materials and the requirements for their application in new devices made on their basis |
| **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).*<br>• the ability to optimally use various materials in applications and projects;<br>• the ability to evaluate from catalog data the characteristics of a device built from a specific material;<br>• the ability to analyze and simulate an electronic assembly based on different classes of materials,<br>• the ability to make an electronic montage,<br>• the ability to validate the results of simulations in specialized simulation programs,<br>• the ability to make measurements with the help of specialized measurement instrumentation,<br>• the ability to interpret and communicate experimental results,<br>• the ability to prepare a laboratory report,<br>• the ability to work effectively in a team. |
| **Responsability and autonomy** | *The student's capacity to autonomously and responsably apply their knowledge and skills.*<br>• the ability to select and browse bibliographic sources,<br>• the ability to learn new concepts,<br>• the ability to collaborate with other colleagues,<br>• the ability to communicate information with other colleagues,<br>• the development of autonomy in 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.)*

In the course, the teaching activity is based on an interactive presentation of knowledge about the materials used in electronics. The presentations include diagrams and application problems, so that the information presented is easy to understand and assimilate. The oral communication methods used are the expository method and the problematization method, used head-on. Teaching materials cover course notes and presentations, with all materials available in electronic format.
Within the laboratory activity, the teaching activity is based on the use of experimental laboratory setups. The oral communication method used is the problematization method, used head-on. At the beginning of the laboratory activity, there is a short lecture designed to provide theoretical notions to help the realization and understanding of the laboratory work. Students use experimental setups and laboratory devices to make specific measurements. The didactic materials are the laboratory platforms contained in the laboratory guide, all materials being available in electronic format.

Practicing active listening and assertive communication skills, as well as feedback construction mechanisms, will be considered as ways of behavioral regulation in various situations and adapting the pedagogical approach to the students' learning needs.
Teamwork skills will be practiced to solve different learning tasks.

**10. Contents**

| **COURSE** | | |
|---|---|---|
| **Chapter** | **Content** | **No. hours** |
| 1 | STRUCTURE OF SOLID MATERIALS<br>1.1Introduction<br>1.2Order in Materials<br>1.3Metallic Crystalline Structures<br>1.4Fundamental Types of Lattices<br>1.5Crystallographic Planes<br>1.6Crystallographic Directions<br>1.7Interplanar Spacings<br>Crystalline Structures for Elemental and Compound Materials and for Alloys<br>Reciprocal Lattice<br>1.10 Problems and Applications | 4 |
| 2 | DISTRIBUTION OF ELECTRONS IN A CRYSTAL<br>2.1Fermi Energy and Fermi Surface<br>2.2Density of States Function<br>2.3Fermi-Dirac Distribution Function<br>Occupancy of Electronic States (Population Density of Electrons) and Calculus of the Fermi Energy<br>2.5Effective Mass of an Electron in a Solid<br>2.6Position and a More Rigorous Calculus for the Fermi Energy<br>2.7Problems and Applications | 4 |
| 3 | CONDUCTIVE PROPERTIES OF MATERIALS<br>3.1Conductivity and Ohm’s Law<br>3.2Conductivity in Metals, Dielectrics and Semiconductors<br>3.3Conductivity in Metals – Classical Theory of Free Electrons<br>3.4Conductivity in Metals and Nonmetals – Quantum Theory<br>3.5Electrical Resistivity of Metals and Alloys<br>3.6Electron Mobility and Carrier Density in Metals and Nonmetals<br>3.7Problems and Applications | 4 |
| 4 | DIELECTRIC MATERIALS<br>4.1Dielectric Properties<br>4.2Theory of Polarization in Dielectrics<br>4.3Types of Polarization<br>4.4Dielectric Constant and Its Dependence on Frequency and Temperature<br>4.5Types of Dielectric Materials<br>4.6Ferroelectricity<br>4.7Piezoelectricity<br>4.8Electrostriction. Pyroelectricity<br>4.9Problems and Applications | 4 |

| | | |
|---|---|---|
| 5 | SEMICONDUCTOR MATERIALS<br>5.1 Intrinsic Semiconductors<br>5.2Extrinsic Semiconductors<br>Temperature Variation of Conductivity and Carrier Concentration in Semiconductor Materials<br>Effective Masses in Semiconductors<br>Fabrication Techniques of Semiconductor Devices<br>5.6Problems and Applications | 4 |
| 6 | MAGNETIC MATERIALS<br>6.1Introduction<br>6.2Basic Concepts<br>6.3Diamagnetism<br>6.4Paramagnetism<br>6.5Ferromagnetism<br>6.6Antiferromagnetism and Ferrimagnetism<br>6.7Influence of Temperature on the Magnetic Behaviour of Materials<br>Magnetic Domains and Hysteresis<br>Soft and Hard Magnetic Materials<br>Energetic Losses in Magnetic Materials<br>6.11 Problems and Applications | 4 |
| 7 | SUPERCONDUCTOR MATERIALS<br>7.1Introduction<br>7.2General Properties of Superconductor Materials<br>BCS Theory of Superconductors<br>Type II Superconductors<br>Josephson Superconducting Tunneling<br>High-Temperature Superconductors<br>7.7 Problems and Applications | 4 |
| | **Total:** | 28 |

**Bibliography:**

1. Drăgulinescu, Andrei, „Materials for Electronics”, online on the Moodle platform: https://archive.curs.upb.ro/2023/course/view.php?id=13638
2. Drăgulinescu, Andrei, „Materials for Electronics and Optoelectronics”, Ed. Matrix ROM, Bucureşti, 2015.
3. Callister, William D. Jr. şi David G. Rethwish, „Fundamentals of Materials Science and Engineering”, Tenth Edition, John Wiley & Sons, New York, 2018.
4. Hummel, Rolf E., „Electronic Properties of Materials”, Fourth Edition, Springer, New York, 2011.
5. Irene, Eugene A., „Electronic Materials Science”, John Wiley & Sons, 2005.
6. Kalyani, N. Thejo, Hendrik Swart, S. J. Dhoble, „Principles and Applications of OLEDs”, Woodhead Publishing, Cambridge, 2017.
7. Naito, Hiroyoshi, „Organic Semiconductors for Optoelectronics”, John Wiley & Sons, New York, 2021.
8. Sun, Sam-Shajing, Larry R. Dalton, „Introduction to Organic Electronic and Optoelectronic Materials and Devices”, Second Edition, CRC Press, Boca Raton, 2017.

**LABORATORY**

| Crt. no. | Content | No. hours |
|---|---|---|
| 1 | Solid dielectric materials | 3 |

| | | |
|---|---|---|
| 2 | Ferroelectric materials | 3 |
| 3 | Conductive properties of materials | 3 |
| 4 | Optoelectronic materials | 3 |
| 5 | Properties of ferromagnetic and ferrimagnetic materials at high signal | 3 |
| 6 | Characterization of ferromagnetic and ferrimagnetic materials at small signal | 3 |
| 7 | Final laboratory test | 3 |
| | **Total:** | 21 |

**Bibliography:**

1. Drăgulinescu, Andrei, „Materials for Electronics”, online on the Moodle platform: https://curs.upb.ro/2021/course/view.php?id=8958.
2. Drăgulinescu, Andrei, „Materials for Electronics and Optoelectronics”, Ed. Matrix ROM, Bucureşti, 2015, ISBN: 978-606-25-0193-8.
3. Şchiopu, Paul, Adrian Manea, „Materiale pentru electronică. Îndrumar”, Ed. Matrix ROM, Bucureşti, 2011, ISBN: 978-973-755-703-2.

**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; Knowing how to apply theory to specific problems | Preliminary test | 50% |
| | Knowledge of fundamental theoretical notions; Knowing how to apply theory to specific problems | Final verification | 20% |
| 11.5 Seminary/laboratory/project | Knowledge of fundamental theoretical notions; Knowing how to apply theoretical concepts to applications and working with different experimental setups | Attendance<br><br>Four tests taken during the semester<br><br>Laboratory reports<br><br>Final oral colloquium (practical)<br><br>Final written colloquium | 30% |
| 11.6 Passing conditions | | | |
| • Obtaining 50% of the total score.<br>• Obtaining 50% of the score related to the laboratory activity. | | | |

**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 skills to offer solutions to problems and to propose ideas for improving the existing situation in the electronic field, the industrial branch of materials technology.
• In the development of the content of the discipline, knowledge, aspects and phenomena described by specialized literature and in own published research were taken into account.
• Through the proposed activities, the development of the graduate's skills to manage practical situations that he may face in real life is considered in order to increase his/her contribution to the improvement of the socio-economic environment.

| Date | Course lecturer | Instructor(s) for practical activities |
|---|---|---|
| 25.09.2025 | Conf. Dr. Andrei Drăgulinescu | |

| Date of department approval | Head of department |
|---|---|
| 26.09.2025 | Conf. Dr. Bogdan Cristian Florea |

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