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)				Chimie Chemistry			
2.2 Course Lecturer				Prof. Dr. Cristian Pirvu			
2.3 Instructor for practical activities				Prof. Dr. Cristian Pirvu			
2.4 Year of studies	1	2.5 Semester	I	2.6. Evaluation type	V	2.7 Course regime	Ob
2.8 Course type		F	2.9 Course code	04.F.01.O.006		2.10 Tipul de notare	Nota

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

3.1 Number of hours per week	3	Out of which: 3.2 course	2	3.3 seminary/laboratory	1
3.4 Total hours in the curricula	42	Out of which: 3.5 course	28	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.					29
Tutoring					0
Examinations					4
Other activities (if any):					0

3.7 Total hours of individual study	33.00
3.8 Total hours per semester	75
3.9 Number of ECTS credit points	3

4. Prerequisites (if applicable) (where applicable)

4.1 Curriculum	Chemistry taught in high school; Physics (molecular and thermodynamics, atomic physics, radiation, electricity); Algebra and mathematical analysis
4.2 Results of learning	Performing calculations, skill in handling basic instruments and equipment specific to the chemistry laboratory;

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

5.1 Course	The existence of a suitably equipped amphitheater (with writing board and video projector) that ensures at least 1 m2/student
5.2 Seminary/ Laboratory/Project	The existence of a suitably equipped laboratory with power supplies, multimeters, electrodes, electrodeposition baths, pH meters, conductometers, computers, etc.

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)*

The Chemistry course intended for electronics students aims to build a fundamental scientific basis necessary to understand the chemical processes underlying the materials, devices, and technologies used in electronics and telecommunications. By integrating general chemistry concepts with applications relevant to electronics and telecommunications (semiconductors, insulators, corrosion processes, metallic and polymeric materials, electrochemical processes), the course seeks to develop students' scientific thinking and offers them reference points for correlating chemical principles with technical problems specific to the specialization. The main topics addressed include notions of structure and properties of molecules, types of chemical bonds and intermolecular interactions, physicochemical properties of materials, electrochemical processes and corrosion phenomena, as well as elements of the chemistry of semiconductors, dielectrics, and insulators. The emphasis is on understanding the principles underlying the operation and reliability of materials and electronic components. The course is included in the curriculum to provide students with essential knowledge about materials and chemical processes in electronics and telecommunications. These competencies allow understanding and correlating chemical properties with the performance of electronic devices, preventing material degradation, and grounding an interdisciplinary vision necessary for training the modern engineer.

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 chemical and physical properties of materials used in electronics;applying chemical principles in the fabrication of electronic components; selecting and evaluating materials by stability, conductivity, and compatibility;integrating chemical knowledge in solving practical problems in electronic engineering
Transversal (General) Competences	Critical thinking and data analysis; solving practical problems; effective teamwork;clear and coherent communication; responsibility and professional ethics; autonomy in learning and adaptability.

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.* Structure and properties of materials (atomic structure, types of bonds, physicochemical properties of materials); Chemistry of electronic materials (understands the behavior of conductors, semiconductors, and insulators under various conditions); chemical reactions and technological processes (redox reactions underlying energy sources, acid/alkali surface cleaning, electrochemical deposition, corrosion and anti-corrosion protection)
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).* Applies chemistry knowledge to analyze and optimize electronic materials; performs and interprets laboratory experiments; selects suitable materials for electronic components; identifies and solves practical problems related to materials and chemical processes;integrates chemical knowledge in the context of electronic engineering
Responsability and autonomy	*The student's capacity to autonomously and responsably apply their knowledge and skills.* Professional responsibility (observes safety rules in the laboratory); autonomy in learning (assumes personal development, seeks additional information, and adapts to new technologies and materials); proactive attitude (shows interest in solving practical problems)

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, exposition) and interactive conversational methods, based on discovery learning models facilitated by direct and indirect exploration of reality (experiment, demonstration, modeling), as well as action-based methods such as exercise, practical activities, and problem solving. Teaching will use lectures based on PowerPoint presentations or various videos made available to students. Each class will begin with a recap of previously covered chapters, emphasizing the concepts from the last class. Problem-based learning will also be used: students receive a practical problem related to electronic applications of chemistry (e.g., corrosion of electrical contacts, batteries, semiconductors, etc.) and must identify the chemical concepts and propose solutions. The presentations use images and diagrams so that the information presented is easy to understand and assimilate. This discipline covers information and practical activities designed to support students' learning efforts and the development of optimal relationships of collaboration and communication in a climate favorable to discovery learning. Emphasis will be placed on practicing active listening and assertive communication skills, as well as mechanisms for constructing feedback as ways to regulate behavior in various situations and to adapt the pedagogical approach to students' learning needs. In practical work, collaborative learning will be used — the ability to work in a team to solve different experiments will be practiced.

10. Contents

COURSE		
Chapter	**Content**	**No. hours**

1	Correlation between chemical bonding, structure and material properties. 1.1. Formation of ionic, covalent and metallic bonds. Examples of chemical compounds, with implications in electronics (crystalline, amorphous, liquid, liquid crystal states) 1.2. Surface phenomena. Adsorption. Colloids. Sol–gel processes. Micro- and nanodispersions. Membrane processes. 1.3. Influence of chemical structure on the electrical, magnetic and optical properties of substances. Applications to chemical and biochemical sensors. 1.4. Organic polymers of importance in the electronics industry. 1.5 Organic/inorganic semiconductors; Correlation between chemical bonding, structure and material properties	6
2	Thermodynamics of chemical processes 2.1. Intensive and extensive state parameters. 2.2. Thermal effects of chemical processes at constant pressure and volume. Hess’s law. Kirchhoff’s law. 2.3. Thermodynamic functions introduced by the Second Principle: entropy, free energy, free enthalpy, in correlation with chemical affinity. Chemical potential. 2.4. Chemical equilibrium. Principle of shifting chemical equilibrium. Relation between thermodynamic functions and the equilibrium constant.	6
3	Chemical reaction kinetics 3.1. Kinetic parameters: reaction rate, rate constant, reaction order, molecularity, activation energy. Simple and complex reactions. 3.2. Homogeneous chemical reactions. First- and second-order reactions. 3.3. Heterogeneous chemical reactions. Corrosion of metals and semiconductors in dry gases. Heterogeneous catalysis. 3.4. Straight and branched chain reactions. Photochemical reactions. 3.5. Molecular theories in chemical kinetics. Molecular collisions. Activated complex theory.	4

4	Electrochemistry 4.1. Scope. Electrochemical cells. Electric double layer. 4.2. Electrolytes. Ionic equilibria. Electrical conductivity of electrolyte solutions. 4.3. Electrochemical reactions. Electromotive force and thermodynamic functions of reaction. Electrode potential. Types of electrodes. Activity series of elements. Polarization at electrodes and overpotential. 4.4. General notions of bioelectrochemistry. 4.5. Chemical sources of electrical energy. Primary cells, accumulators, fuel cells. 4.6. Electrolytic processes in electronic technologies. 4.7. Corrosion in electrolyte media. Thermodynamics and kinetics of corrosion processes. Methods of protecting metals against corrosion.	12
	Total:	28

Bibliography:

B. Popescu, D. Ionita, Chemistry, Matrix Rom, 2005
C. Pirvu, General Chemistry; Fundamental Notions, Printech Publishing, 2009.
Stefan Perisanu, Chemistry for Non-Chemist Engineers, Politehnica Press, 2013
G. Hubca, M. Tomescu, C. Pirvu, Polymers Used in Electronics, Electrotechnics and Computing, Semne Publishing, 2006.
Atkins, P. W. and de Paula, J. – Physical Chemistry, Technical Publishing, 2005. Rodica Sturza, Ana Verejan, Svetlana Haritonov and others, Applied Chemistry for Engineers, Tehnica-UMT Publishing, 2021

LABORATORY

Crt. no.	Content	No. hours
1	Chemical kinetics. Determination of partial reaction order and rate constant. Determination of activation energy	2
2	Thermochemistry. Determination of neutralization enthalpy and dissolution enthalpy	2
3	Chemical equilibrium. Factors influencing chemical equilibrium. Le Chatelier's principle	2
4	Electrochemistry. Determination of electrode potential. Variation of the electromotive force of the Daniell–Jacobi cell as a function of electrolyte concentration.	2
5	Electrochemistry. Determination of corrosion potential. Methods of protection against corrosion.	2
6	Electrochemistry. Determination of the conductivity of electrolyte solutions and the dissociation constant.	2
7	Final laboratory colloquium	2
	Total:	14

Bibliography:

11. Evaluation

Activity type	11.1 Evaluation criteria	11.2 Evaluation methods	11.3 Percentage of final grade
11.4 Course	understanding and acquiring the fundamental theoretical notions from all chapters pertaining to this discipline; - knowledge of how to apply theory to specific problems;	Written verification test, during the semester, held on a date set at the beginning of the course Short tests (10 min) at the end of the main chapters; Final verification	70%
11.5 Seminary/laboratory/project	participation in all laboratory works, understanding and acquiring the knowledge corresponding to each laboratory carried out	Final laboratory colloquium (oral evaluation)	30%
11.6 Passing conditions			
Obtaining 50 points from the activities carried out 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)

Chemistry is one of the fundamental sciences, which studies substances with their structure and properties, while tracking the changes produced by chemical reactions. The electronic devices industry has progressed rapidly in recent decades, so from the first transistor to complex integrated circuits, where element dimensions drop to tens of nanometers, only a few decades have passed. This progress is due to the development of technologies for obtaining materials with reliability, longevity, precision, low weight and special properties. To achieve these performances, knowledge about the structure and properties of materials, the possibility of spontaneous evolution of some chemical or physico-chemical processes, the thermal effects accompanying these processes, and the rate at which they occur, as well as the possibility of obtaining renewable energies, are essential. The Chemistry course ensures an introduction to the main concepts needed to train an engineer capable of adapting to market requirements and new technologies. Thus, graduates are provided with skills aligned with current qualification requirements and a modern, high-quality, competitive scientific and technical education, enabling rapid employment after graduation, being perfectly aligned with the policy of the Politehnica University of Bucharest, both in terms of content and structure, and in terms of skills and the international openness offered to students.

Date | Course lecturer | Instructor(s) for practical activities

Universitatea Națională de Știință și Tehnologie Politehnica București

Facultatea de Electronică, Telecomunicații și Tehnologia Informației

26.09.2025	Prof. Dr. Cristian Pirvu	Prof. Dr. Cristian Pirvu
		PhD Candidate Alexandra Constantinescu
		Lect. Angela Paun
		Cristina Dumitriu

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