SYLLABUS

1. Program Information

1.1 Higher education institution	Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Department of Automation
1.4 Field of study	Automation, Applied Informatics and Intelligent Systems
1.5 Cycle of studies	Bachelor
1.6 Study Programme/Qualification	Intelligent Automation Systems (dual, in English language)
1.7 Form of education	IF – full-time education
1.8 Course code	20.00

2. Course information

2.1 Course title	**Chemistry**					
2.2 Course lecturer	*Assoc.prof. Mihaela Ligia Unguresan – mihaela.unguresan@chem.utcluj.ro*					
2.3 Seminar / Laboratory / Project Lecturer	*Eng. Sav Roxana (Emerson)* *Eng. Duţă Horia (Emerson)*					
2.4 Year of study	2	2.5 Semester	3	2.6 Type of assessment		Exam
2.7 Course status	Formative category *(DF, DS, DC)*					DF
	Optionality *(DOB, DOP, DFac)*					DOB

3.Total estimated time

3.1 Number of hours per week	2	of which:	HEI	Lecture	2	Seminar	0	Laboratory	0	Project	0
			CO		0		0		1		0
3.2 Number of hours per semester	42	of which:	HEI	Lecture	28	Seminar	0	Laboratory	0	Project	0
			CO		0		0		14		0

3.3 Distribution of time allocation (hours per semester) for:	HEI	CO
(a) Study based on textbook, course support, bibliography, and notes	25	1
(b) Additional documentation in library, specialized electronic platforms, and fieldwork	9	1
(c) Preparation of seminars/laboratories, assignments, papers, portfolios and essays	4	7
(d) Tutoring	4	1
(e) Examinations	3	1
(f) Other activities:	2	0
3.4 Total individual study hours (sum (3.3(a)... 3.3(f)))	47	11
3.5 Total hours per semester (3.3+3.4)	75	25
3.6 Number of credits per semester	3	1

(HEI = Higher Education Institution, CO = Company)

4. Prerequisites (where applicable)

4.1 Curriculum Prerequisites	• Basic background in high school-level chemistry.
4.2 Competency Prerequisites	• Basic knowledge of key concepts in chemistry, mathematics, and physics from high school.

5. Conditions (where applicable)

5.1. Course Organization Conditions	• Lecture Hall Active student engagement and required reading of course materials.
5.2. Seminar / Laboratory / Project organization conditions	• Chemistry Laboratory • Attendance in the laboratory is mandatory; active student participation is required. Students must have the laboratory work

	summarized and prepared in advance, ready to be discussed and performed during the lab session.

6. Specific Competencies Acquired

Professional Competencies	• PC02 Analyse test data • PC20 Record test data • PC24 Think abstractly • PC27 Execute analytical mathematical calculations
Transversal Competencies	• TC02 Think analitically • TC05 Interpret mathematical information

7. Learning outcomes

Knowledge:	• The student will recognize the main concepts and fundamental notions of chemistry, such as atomic structure, types of chemical bonding, states of matter, and the principles of thermodynamics. • The student will identify chemical elements within the periodic table, their physico-chemical properties, the types of chemical reactions they are involved in, and will be able to construct their electronic configurations. • The student will recall the principles of chemical kinetics and the relationships between state functions in thermodynamic processes. • The student will be able to indicate physico-chemical separation methods, phase equilibria, and the factors influencing chemical equilibrium and reaction rates. • The student will exemplify the application of acquired electrochemical concepts in electrolysis, galvanization, batteries, and galvanic cells, as well as in corrosion protection processes. • The student will demonstrate how the laws of thermodynamics influence the direction and spontaneity of chemical reactions, using enthalpy, entropy, and Gibbs free energy. • The student will distinguish between ideal and real gases, between types of catalysis (homogeneous, heterogeneous, enzymatic), and between different classes of materials (metals, ceramics, semiconductors).
Skills:	• The student will anticipate the stages involved in a chemical experiment, from preparing the reactions and selecting the substances to interpreting the results and managing waste disposal. • The student will be able to apply the fundamental principles and concepts of chemistry in solving problems, performing calculations, and making specific interpretations (atomic structure, chemical bonding, equilibria, kinetics, electrochemistry, etc.). • The student will efficiently use laboratory equipment and glassware, complying with safety regulations and specific methodologies for working in a chemistry laboratory. • The student will conduct experiments and interpret the resulting experimental data, performing measurements such as pH, conductivity, electromotive force, temperature, and others.

	• The student will carry out chemical calculations (moles, concentrations, densities, volumes, enthalpies, chemical equilibrium constants, free energies, etc.) using appropriate formulas, laws, and equations.
Responsibility and autonomy:	• The student will formulate hypotheses related to the evolution of a chemical system, conclusions regarding the thermodynamic stability of metals, and the selection of methods for anticorrosive protection. • The student will differentiate and optimize experimental procedures based on the objectives pursued and the available resources. • The student will evaluate the correctness of the results obtained in the laboratory, the efficiency of chemical reactions, and the safety of the applied procedures. • The student will adapt techniques and methods to various situations (experimental/industrial). • The student will modify experimental parameters or procedures to optimize the physico-chemical process in order to achieve the desired yield and improve the quality of the final products. • The student will be able to choose appropriate methods for separation, analysis, or environmental protection, depending on the nature of the substances and the experimental conditions.

8. Course Objectives

8.1 General objective of the course	• Acquisition of knowledge related to atomic structure, chemical elements of the periodic table, their physical and chemical properties, chemical bonding, states of matter, chemical processes and separation techniques, thermodynamics and chemical kinetics, electrochemistry and corrosion. • Development of skills for solving general chemistry problems.
8.2 Specific objectives	• Development of scientific thinking, understanding of chemical principles, and awareness of chemistry's role in everyday life. • Acquisition of basic chemistry concepts: correlating structure and properties of major substances, writing chemical reactions, and performing chemical calculations. • Understanding materials relevant to automation: metals and alloys, ceramics, plastics, and semiconductors. • Mastery of physico-chemical separation methods. • Application of methods for determining chemical reaction coefficients. • In-depth study of electrolysis, galvanization, cathodic deposition, corrosion phenomena, and anti-corrosion protection techniques. • Use of laboratory equipment and glassware specific to chemistry. • Familiarization with fundamental laboratory operations. • Proficient use of chemical terminology and accurate application of discipline-specific language.

9. Contents

9.1 Lectures	No. of hours	Teaching methods	Obs.
Fundamentals – Chemistry and Society. Chemistry – a science at three levels. The branches of Chemistry. Elements and atoms. Compounds. Moles and molar masses. SI units	2		

and derived units. Mixtures and solutions. Aqueous solutions. Avogadro number. Chemical formulas. Reaction stoichiometry.		Presentation, heuristic conversation, exemplification, problem presentation, teaching exercise, case study, formative evaluation, learning by discovery	Mainly use the blackboard, the projector used only for short ppt. presentation.
Atoms: the quantum world. The electronic structure and the periodic table. The periodicity of atomic properties. Electronic configuration.	2		
Chemical bonds. Ionic bonds. Covalent bonds: Valence bond theory, Molecular orbital theory. Metallic bonds. Intermolecular forces.	2		
Gases. The properties of gases. The gas laws. Molecular motion: diffusion and effusion, the kinetic model of gases. The real gases. Liquids and liquid structure. Viscosity and surface tension. Solids. Molecular network, metallic solids, unit cells, ionic structures.	2		
Physical equilibria. Phases and phase transition. Solubility. Colligative properties. Binary liquid mixtures. Metals, alloys, liquid crystals, ionic liquids. Semiconductors and ceramic materials. Electronic conduction in solids.	2		
Chemical processes. Industrial applications (cracking, bio fiuels, water treatment, polimerization). Continous and batch processes. Ideal-mixing reactor. Plug flow reactor. Separation methods – precipitation, distillation, crystallization, extraction, chromatography, neutralization, oxidation, reduction, condensation.	2		
Separation methods in industry. Fractional distillation. Industrial extractors. Absorption columns. Chromatography (affinity, size-exclusion, ion exchange). Diafiltration. Ultrafiltration. Centrifugation (differential, density gradient).	2		
Thermodynamics: the first law. Systems, states, and energy. The second and third laws. Entropy. Global changes in entropy. Gibbs free energy.	2		
Thermochemistry: calorimetry, Lavoisier-Laplace law, Hess law. Enthalpy. The enthalpy of chemical change. Ionization enthalpy, formation enthalpy, Bohr-Haber cycle. Chemical potential.	2		
Chemical equilibria. Reactions at equilibrium. Equilibrium calculations. The response of equilibria to changes in conditions. Acids and bases. The nature of acids and bases. Weak acids and bases. The pH of solutions of weak acids and bases. Polyprotic acids and bases.	2		
Chemical Reaction Kinetics. Classification of chemical reactions from a kinetic perspective; reaction rate; molecularity, reaction order; reaction mechanism, rate law, factors influencing reaction rate, Arrhenius equation. Kinetics of Simple and Complex Reactions. Chain reactions and explosions. Catalyzed Reaction Mechanisms Homogeneous and enzymatic catalysis, Michaelis-Menten mechanism, heterogeneous catalysis, reaction inhibition. Applications in advanced materials.	2		
Introduction to Biochemistry. Types of fermentation. Types of bioreactors. Sterilization. Cell cultures and growth. Cell lysis methods. Industrial bioprocesses.	2		

Electrochemistry. Representing redox reactions. Galvanic cells. Electrolytic cells. Electrolytic dissociation; electrodes; electrolysis; Faraday's laws; electromotive force; Nernst's equation; galvanic pile; accumulators, fuel cells; solar batteries. Applications in chemical analysis of electromotive force measurements. Electrochemical sensors. Biosensors.	2		
Corrosion and protection against corrosion – fundamental knowledge. Thermodynamic stability of metals, corrosion on homogeneous or inhomogeneous surfaces. Anticorrosion protection methods - metal coatings, protective oxides, paints, enamels, protection with inhibitors, galvanic cathodic protection); Electrochemical processes for treating residues.	2		

Bibliography

1. P. W. Atkins, L. Jones, Chemical Principle, W.H. Freeman& Company, 2007.
2. R.H. Petrucci, F.G. Herring, J.D. Madura, C. Bissonnette, *General Chemistry – Principles and Applications*, 11th Ed., Pearson, 2017.
3. M.L. Ungureşan, D. M. Gligor, *General Chemistry*, Ed. UTPRESS, Cluj-Napoca, 2012.
4. M.L. Ungureşan, L. Jantschi, *Thermodynamics and Chemical Kinetics*, Ed. Mediamira, Cluj-Napoca, 2005.
5. L. Jantschi, M.L. Ungureşan, *Special Chapters of Chemistry for Automatics*, UTPRESS, Cluj-Napoca, 2002.
6. T. Coloşi, M. Abrudean, M.-L. Ungureşan, V. Mureşan, *Numerical Simulation Method for Distributed Parameters Processes using the Matrix with Partial Derivatives of the State Vector*, Ed. Springer, 2013.

9.2 Seminar / laboratory / project	Hours HEI	Hours CO	Teaching methods	Obs.
Simulation of a bioreactor – sterilization and reaction		4	Laboratory-based learning, experiential learning, inquiry-based learning, problem-based learning, computer-assisted instruction, simulation-based learning, modeling-based learning, collaborative learning.	
Simulation of a reactor.		4		
Simulation of a fractional distillation process.		4		
Sensors. Protection against corrosion.		2		

Bibliography

7601 - Mimic Dynamic Simulation

7602 - Mimic Advanced Fluid Modeling Objects

7631 - Dynamic Simulation Introduction

7632 - DeltaV Mimic Introduction

Aspen HYSYS Dynamics: Introduction to Dynamic Modeling

10. Correlation of course content with the expectations of the epistemic community representatives, professional associations, and major employers in the field related to the program

The content of the course, along with the competencies acquired, aligns with the expectations of professional bodies and employers in the field in which students carry out internships and/or pursue employment. Collaborations with: INCDTIM Cluj-Napoca.

11. Evaluation

Activity Type	Evaluation criteria	Evaluation methods	Weight in final grade
11.1 Lecture	The level of acquired theoretical knowledge and practical skills, logical coherence, and the ability to apply acquired knowledge in individual, complex tasks.	Multiple-choice test consisting of 20 questions, each with 5 answer options and only one correct answer. The exam will be open-book, allowing students access to all informational materials. Exam duration: 2 hours.	C = 50 %
11.2 Laboratory	The level of acquired competencies	Continuous formative evaluation; Seminary individual work (1 hour)	A = 50 %
11.3 Minimum Performance Standard			
C ≥ 5 ; A ≥ 5			

Date of completion:	Lecturers		Signature
15.09.2025	Course	Assoc. prof. Mihaela Ligia UNGUREŞAN	
	Applications		

Date of approval by the Department of Automation Council 24.11.2025	Director of the Department of Automation Prof.dr.ing. Honoriu VĂLEAN
Date of approval by the Faculty of Automation and Computer Science Council 28.11.2025	Dean Prof.dr.ing. Vlad MUREȘAN