SYLLABUS

1. Data about the program of study

1.1 Institution	The Technical University of Cluj-Napoca
1.2 Faculty	Faculty of Automation and Computer Science
1.3 Department	Computer Science
1.4 Field of study	Computer Science and Information Technology
1.5 Cycle of study	Bachelor of Science
1.6 Program of study / Qualification	Computer science / Engineer
1.7 Form of education	Full time

2. Data about the subject

2.1 Subject name	***Chemistry***			Subject code	**102**
2.2 Course responsible / lecturer	Associate Prof. Mesaros Amalia-Zorica - Amalia.MESAROS@chem.utcluj.ro				
2.3 Teachers in charge of seminars / Laboratory / project	Associate Prof. Mesaros Amalia-Zorica - Amalia.MESAROS@chem.utcluj.ro				
2.4 Year of study	I	2.5 Semester	2	2.6 Type of assessment (E - exam, C - colloquium, V – verification)	E
2.7 Subject category	Formative category: DF – fundamental, DS – speciality, DC – complementary				DF
	Optionality: DOB – mandatory, DOP – optional (alternative), DFA – optional (free choice)				DFA

3. Estimated total time

3.1 Number of hours per week	4	3.2 of which, course:	2	3.3 applications:	2
3.4 Total hours in the curriculum	56	3.5 of which, course:	28	3.6 applications:	28
Individual study					hours
Manual, lecture material and notes, bibliography					24
Supplementary study in the library, online and in the field					6
Preparation for seminars/laboratory works, homework, reports, portfolios, essays					6
Tutoring					3
Exams and tests					2
Other activities					3

3.7 Total hours of individual study	44
3.8 Total hours per semester	100
3.9 Number of credit points	3

4. Pre-requisites (where appropriate)

4.1 Curriculum	Basic background in Chemistry from High school
4.2 Competence	Basic knowledge and concepts specific to Chemistry, Math, and Physics from High school

5. Requirements (where appropriate)

5.1 For the course	Amphitheatre, Cluj-Napoca
5.2 For the applications	Classrooms, Cluj-Napoca (C411 laboratory, Bd. 103-105 Lab)

6. Specific competences

6.1 Professional competences	C1. To use the fundamental knowledge of Chemistry in systems engineering C1.1. To use the basic concepts, theories, and methods for the design, synthesis and analysis of materials to implement/design/solve practical problems regarding systems engineering C1.2. To explain and to argue the answers based on the understanding and application of fundamental concepts from the field of Chemistry and Materials Chemistry.
6.2 Cross competences	N/A

7. Suggested learning outcomes

Knowledge	Describes, identifies and summarises elementary concepts and methods regarding systems in general, with application to chemical systems and materials relevant to systems engineering, namely: ▪ Fundamental concepts of chemistry: atomic structure, the periodic table, electronic configuration, and types of chemical bonding (ionic, covalent, metallic, intermolecular). ▪ Properties and behavior of the states of matter: gas laws, liquid structure, classification of solid structures, phase transitions, solubility and colligative properties. ▪ Principles of chemical thermodynamics, thermochemistry and chemical equilibria: laws of thermodynamics, enthalpy, entropy, Gibbs free energy, acid–base equilibria, buffers. ▪ Foundations of chemical kinetics and electrochemistry: reaction rates and mechanisms, galvanic and electrolytic cells, the Nernst equation, Faraday's laws. ▪ Engineering-relevant materials and processes: metals, alloys, semiconductors, ceramics, electrochemical sensors and biosensors, corrosion and corrosion-protection methods.
Skills	▪ Uses specific methods to measure physico-chemical quantities and identifies the chemical nature and behavior of substances and materials of interest in engineering applications. ▪ Applies fundamental laws and principles of chemistry to solve quantitative problems involving stoichiometry, concentrations, gas behavior, thermodynamics, equilibria, kinetics and electrochemistry. ▪ Analyses chemical systems using the studied theories and interprets experimental data in correlation with theoretical models. ▪ Uses specific theories and instruments (laboratory apparatus, measurement techniques, computational tools for data analysis) for the experimental investigation of chemical and physico-chemical phenomena.
Responsibility and autonomy	▪ Carries out activities specific to laboratory work in chemistry, taking on different roles within the team and providing clear and concise descriptions, both verbally and in writing, of the experimental results obtained. ▪ Observes laboratory safety rules, demonstrates accountability for the correct and safe handling of substances and equipment, and shows awareness of the environmental and ethical implications of chemical processes.

8. Discipline objectives (as results from the *key competences gained*)

8.1 General objective	Developing the competences and knowledge related to General Chemistry useful for systems engineering. Understanding the fundamental concepts and principles common to the various branches of chemistry which deals in a systematic way with the more important elements and the structures, properties and reactions of their compounds. A balance between experiment and theory, between quantitative and qualitative aspects of the course material, and between rigor and simplification is sought.

8.2 Specific objectives	1. Understanding and manipulation of basic concepts in Chemistry and Materials Chemistry combined with Physics and Math. 2. Developing skills and abilities required for solving simple and complex problems of Chemistry. 3. Developing skills and abilities for the analysis of chemical phenomena in chemistry which are transposed as problems in the Systems Engineering domain. 4. Laboratory work emphasizes learning basic techniques, learning to manipulate the specific instruments and interpret numerical data, and learning the relationship between experimental measurement and chemical theory through guided, independent work by the student – only for on-site laboratories.

9. Contents

9.1. Lecture (syllabus)	Teaching methods	Notes
1. Fundamentals – Chemistry and Society. Chemistry - a science at three levels. The branches of Chemistry. Elements and atoms. Compounds. Moles and molar masses. SI units 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 or for presentation of some movies with recorded chemical experiments.
2. Atoms: the quantum world. The electronic structure and the periodic table. The periodicity of atomic properties. Electronic configuration.		
3. Chemical bonds. Ionic bonds. Covalent bonds: Valence bond theory, Molecular orbital theory. Metallic bonds. Intermolecular forces.		
4. Gases. The properties of gases. The gas laws. Molecular motion: diffusion and effusion, the kinetic model of gases. The real gases.		
5. Liquids and solids. Liquid structure: order in liquids, viscosity and surface tension. Solid structures: classification, molecular, network, metallic solids, unit cells, ionic structures.		
6. Physical equilibria. Phases and phase transition. Solubility. Colligative properties. Binary liquid mixtures. Colloids.		
7. Metals, alloys, liquid crystals, ionic liquids. Semiconductors and ceramic materials. Electronic conduction in solids.		
8. Chemical processes. Separation methods – precipitation, distillation, crystallization, extraction, chromatography, neutralization, oxidation, reduction, condensation. Aqueous equilibria. Mixed solutions and buffers. Titrations. Solubility equilibria.		
9. Thermodynamics: the first law. Systems, states, and energy. The second and third laws. Entropy. Global changes in entropy. Gibbs free energy.		
10. Thermochemistry: calorimetry, Lavoisier-Laplace law, Hess law. Enthalpy. The enthalpy of chemical change. Ionization enthalpy, formation enthalpy, Bohr-Haber cycle. Chemical potential.		
11. 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.		
12. Chemical kinetics. Reaction rates. Concentration and time. Reaction mechanisms. Models of reactions.		
13. 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.		

14. Corrosion and protection against corrosion – fundamental knowledge. Thermodynamic stability of metals, corrosion on homogeneous or inhomogeneous surfaces. Anti-corrosion protection methods - metal coatings, protective oxides, paints, enamels, protection with inhibitors, galvanic cathodic protection); Electrochemical processes for treating residues.		

Bibliography

1. P. W. Atkins, L. Jones, *Chemical Principles*, W. H. Freeman & Company, 2007 ISBN-13: 978-0-7167-7355-9
2. M.-L. Ungureşan, D. M. Gligor, *General Chemistry*, Ed. UTPRESS, Cluj-Napoca, 2012, ISBN: 978-973-662-707-1

9.2. Applications/Seminars	Teaching methods	Notes
1. Laboratory safely rules. Common laboratory apparatus. - 2hrs.	Didactic and experimental proof, didactic exercise, conversation, observation and analysis, individual and teamwork.	Use of white/ magnetic board, computers and computer programs for data analysis.
2. Determination of the acetic acid concentration by titration. Fe_3O_4 (magnetite) – wet chemical synthesis – 2 hrs.		
3. Hydrates: determining the chemical formula using experimental data -2 hrs		
4. Calorimetry. Determination of hydration heat for copper sulphate - 2 hrs		
5. Thermal analysis – 2 hrs.		
6. Acids and bases (pH and pOH) - 2hrs.		
7. Enthalpy, entropy, Gibbs free energy at different temperatures. Chemical kinetics for standard or complex reactions. – 2 hrs.		

Bibliography

1. A. Mesaroş, L. Bolunduţ, M.-L. Ungureşan, Experimente de Chimie Generală, Ed. Galaxia Gutenberg, Colecţia Tehne 5, ISBN: 978-973-141-228-3, 2010, pg. 197.
2. L. Bolunduţ, A. Mesaroş, M.-L. Ungureşan, Electrochimia prin experimente, Ed. Galaxia Gutenberg, Colecţia Tehne 1, 2009, pg. 110.
3. M.-L. Ungureşan, L. Jantschi, D. M. Gligor, Aplicaţii Educaţionale de Chimie pe Calculator, Ed. Mediamira, Cluj-Napoca, 2004.
4. On-line references: http://mihaela.academicdirect.ro/free/Indrumator_laborator.pdf

10. Bridging course contents with the expectations of the representatives of the community, professional associations and employers in the field

The course content and the acquired skills are in agreement with the expectations of the professional organizations and the employers in the field, where the students carry out the internship stages and/or occupy a job, and the expectations of the national organization for quality assurance (ARACIS).

11. Evaluation

Activity type	Assessment criteria	Assessment methods	Weight in the final grade
Course	The level of acquired theoretical knowledge and practical skills, logical coherence, skills of operating with acquired knowledge in individual complex activities.	Evaluation – written exam (theory and problems) – 2 hours	C = 75 %
Laboratory	The level of acquired abilities	- Continuous formative evaluation; - Seminary individual work (30 min)	A = 25 %
Minimum standard of performance: C ≥ 5 and A ≥ 5			

Date of filling in: 11.05.2026	Responsible	Title, First name Last name	Signature
	Course	Assoc. prof. Amalia Zorica MESAROS, PhD eng. chem	
	Applications	Assoc. prof. Amalia Zorica MESAROS, PhD eng. chem	

Date of approval in the department	Head of department, Prof.dr.ing. Rodica Potolea
Date of approval in the Faculty Council	Dean, Prof.dr.ing. Vlad Muresan