R O M Â N I A
MINISTERUL EDUCAȚIEI ȘI CERCETĂRII
Universitatea din Craiova
FACULTATEA DE ȘTIINȚE/ DEPARTAMENTUL DE CHIMIE
Craiova, Str. Calea București, nr. 107I
Tel/ fax: 0251597048, e-mail: chimie@ucv.ro

Subject Description

1. Program information

1.1. Institution	University of Craiova
1.2. Faculty	Science
1.3. Department	Chemistry
1.4. Study field	Chemistry
1.5. Study level	Master
1.6. Type of education	full-time
1.7. Study program	Advanced Chemistry

2. Subject information

2.1. Subject			**Hybrid materials**				
2.2. Course coordinator			Prof.dr. Mihaela Mureșeanu				
2.3. Application coordinator			Prof.dr. Mihaela Mureșeanu				
2.4. Year of study	I	2.5. Semester	1	2.6. Type of evaluation	E	2.7. Subject type	DS/DOB

3. Total estimated tipe (hours/semester)

3.1. Number of hours per week	4	from which: 3.2 course	2	3.3. seminar/lab	2
3.4. Total hours in curriculum	56	from which: 3.5 course	28	3.6. seminar/lab	28
Time allocation – hours/week					
Study using textbooks, course materials, bibliographies, and notes					25
Additional documentation in the library, on specialized electronic platforms, and in the field					20
Preparation of seminars/labs, assignments, reports, portfolios, and essays					15
Tutoring					5
Examinations					4
Other activities.....					
3.7. Total hours of individual study					69
3.8. Total hours per semester					125
3.9. Number of ECTS					5

4. Preconditions (if the case)

4.1. of curriculum	• Knowing the basic concepts of general and inorganic chemistry
4.2. of competences	• Presentation and interpretation of experimental results from laboratory work

5. Conditions (if the case)

5.1. for course	• Lecture hall equipped with computer, video projection system, and internet connection
5.2. for labs	• Laboratory equipped with the materials, equipment, and reagents necessary to carry out experimental work

6. Course objectives - expected learning outcomes achieved by completing and passing the course

Knowledge	1. Graduates define, understand, explain, and apply advanced knowledge of chemistry from specialized literature in practice. 2. Graduates select and use appropriate experimental and theoretical methodologies to investigate complex scientific problems, assessing their impact on the environment and society. 3. Graduates write analysis and scientific reports, presenting the results of their research and experiments, in line with professional ethics and standards. 4. The graduate describes and integrates interdisciplinary knowledge into the implementation of research projects.
Skills	1. Graduates apply major concepts in analytical, inorganic, organic, and physical chemistry to chemical practice. 2. Graduates evaluate and analyze experimental techniques to conduct and design experiments, analyze and test (qualitatively and quantitatively) chemical elements and substances; design, coordinate, and conduct chemical experiments. 3. Graduates apply critical thinking, following the structure and principles of scientific writing to develop and present scientific reports. 4. Graduates apply interdisciplinary methods to solve complex theoretical and practical chemical problems in their professional and research activities.
Responsibility and authonomy	1. Graduates are able to adapt major scientific concepts in the field of chemistry to conduct research, improve or develop new concepts, knowledge, theories, and operational methods, products, and services in order to apply them in specific activities for product and process quality control. 2. Graduates use classical laboratory instruments/techniques and modern equipment independently, design experiments, and interpret and analyze the obtained results accurately. They design learning situations focused on developing experimental techniques and methods specific to chemical laboratories. 3. Graduates prepare and present scientific reports in line with ethical standards for collecting and interpreting results. 4. Graduates assume responsibility for managing interdisciplinary collaborations and coordinating activities within work and research teams..

7. Table of contents

7.1. COURSE	Mode of operation	Teaching methods	Allocated time (hours)
1. Introduction to hybrid materials • Definition and classification • Interaction of organic and inorganic components • Properties and applications	On site (week 1)	Lecture, explanation and interactive presentation, heuristic conversation, problem solving	2
2. Type of hybrid materials • Organic-inorganic hybrids • Polymer-ceramic hybrids • Metal-organic frameworks (MOFs) • Bio-hybrids materials • Carbon-based hybrids (graphene, CNTs +polymers) • Functional hybrids (smart, responsive)	On site (week 2)	Lecture, explanation and interactive presentation, heuristic conversation, problem solving	2
3. Synthesis and characterization of hybrid materials • In situ formation of hybrid materials	On site (week 3-6)	Lecture, explanation and interactive presentation, heuristic conversation, problem solving	8

• Sol–gel processing • Formation of organic polymers in preformed inorganic matrix • Simultaneous formation of both components • Organic/inorganic building blocks • Characterization technique (XRD, SEM/TEM, AFM and surface analysis, FTIR/Raman, UV-Vis, photoluminiscence, thermal analysis)			
4. Porous hybrid materials • Definition and terms • Matrices of porous materials (Microporous-Zeolites, Mezoporous -M41S and FSM, Metal-Organic Frameworks-MOFs) • General methods for hybrid porous material synthesis by the type of interactions between the two components • Properties and applications of porous hybrid materials	On site (weeks 7-8)	Lecture, explanation and interactive presentation, heuristic conversation, problem solving	4
5. Hybride biomaterials • Inorganic and organic building blocks • Biominerals • Bioinspired hybride materials (Natural and artificial hybrid materials) • Responses, biological performance and evaluation of biomaterials	On site (week 9-11)	Lecture, explanation and interactive presentation, heuristic conversation, problem solving	4
6. Medical applications of hybrid materials • Tissue engineering scaffolds • Drug delivery • Antimicrobial hybrid coatings	On site (weeks 11-12)	Lecture, explanation and interactive presentation, heuristic conversation, problem solving	4
7. Hybrid materials for optical, electronic and electrochemical applications • Light-emitting, solid-state dye lasers, photochromic and photovoltaic devices • Electrochemical sensors, dye-sensitized solar cells, electrochromic windows	On site (week 13)	Lecture, explanation and interactive presentation, heuristic conversation, problem solving	2
8. Safety, ethics, sustainability and circular design • Environmental impact and recycling of hybrid materials • Green synthesis of hybrid materials • Life-cycle assessment (LCA)	On site (week 14)	Lecture, explanation and interactive presentation, heuristic conversation, problem solving	2

References:
1. Kickelblick G. (Editor): Hybrid Materials. Synthesis, Characterization, and Applications. Wiley-VCH 2007. ISBN 978-3-527-31299-3
2. Ajayan, P., Schadler, L. S., Braun, P. V., Nanocomposite Science and Technology, Wiley-VCH 2003. ISBN 3-527-30359-6
3. P. Gomez-Romero, C.Sanchez (Editors). Functional Hybrid Materials, Wiley-VCH 2004. ISBN 3-527-30484-3
4. Lecture notes, 2025

7.2. Lab	Mode of operation	Teaching methods	Allocated time (hours)
1. Safety rules in Hybrid Materialss lab	On site (week 1)	Experiment, explanation, discussion, debate, and questioning	4
2. Synthesis and characterization of mesostructured silicas of the MCM-41 type	On site (week 3)	Experiment, explanation, discussion, debate, and questioning	4
3. Synthesis and characterization of mesostructured silicas of the SBA-15 type	On site (week 5)	Experiment, explanation, discussion, debate, and questioning	4
4. Functionalization and characterization of mesoporous silicas with various organic functions (-NH_2, -Cl, -Br, -COOH, etc.)	On site (week 7)	Experiment, explanation, discussion, debate, and questioning	4
5. Synthesis of organic/inorganic hybrid materials by immobilization of metal complexes with organic ligands	On site (week 9)	Experiment, explanation, discussion, debate, and questioning	4
6. Synthesis of organic/inorganic hybrid materials by the immobilization of enzymes on functionalized organic/inorganic supports or by direct synthesis (sol-gel process)	On site (week 11)	Experiment, explanation, discussion, debate, and questioning	4
7. Lab Verification	On site (week 13)	Experiment, explanation, discussion, debate, and questioning	4
References:			
1. Lab work presentations, 2025.			

8. Corrrelation of the discipline content with the expectations of representatives of the epistemic community, professional associations, and representative employers in the field related to the program

The content of the course is in line with those of similar courses at universities in Romania and abroad, while also meeting the expectations of professional associations and representative employers in the field.

9. Evaluation

Activity	9.1. Evaluation criteria	9.2. Evaluation method	9.3. Contribution to final score
9.4. Course	theoretical concepts and mechanisms, critical analysis of literature or design of a hybrid materials	Written Exam	50%
		Portofolio	20%
9.5. Lab	synthesis, characterization, data interpretation	Project Work	30%
9.6. Minimum performance standard			
• Basic understanding of core concepts. • Knowledge of main types of hybrid materials. • Elementary understanding of synthesis methods. • Simple correlation between structure and properties for specific applications. • Completion of practical/project tasks			

Date
22.09.2025

Course coordinator,
Prof. dr. Mihaela Mureseanu

……

Date of approval
25.09.2025

Head of Department,
Conf.dr. Nicoleta Cioateră