

Courses syllabus – MAS Applied Chemistry

No.	Course code	Course title	Specific field of study	Semester	L	E	O	RW	Other	ECTS
Mandatory courses										
1.	AC01	German in an Intercultural context / Technical Englisch	Linguistics	1	4	0	0	0	0	5
2.	AC02	Advanced Organic Synthesis	Organic chemistry	1	2	0	3	0	0	5
3.	AC03	Chemoinformatics	Theoretical chemistry	1	2	3	0	0	0	5
4.	AC04	Working Internship	/	2	0	0	0	0	6	3
5.	AC05	Master Thesis	/	2	0	0	0	20	0	22
6.	AC06	Master Seminar Defense of master thesis	/	2	0	0	0	0	4	5
Elective courses										
1.	AC07	Research Internship	/	1	1	0	4	0	0	5
2.	AC08	Instrumental Polymer Analysis	Analytical Chemistry	1	1	0	2	0	0	5
3.	AC09	Sustainable Transformation Chemistry	Environmental chemistry	1	4	0	0	0	0	5
4.	AC10	Advanced Inorganic Synthesis	Inorganic chemistry	1	2	0	3	0	0	5
5.	AC11	Coordination compounds in Pharmacy and Medicine	Inorganic chemistry	1	2	0	3	0	0	5
6.	AC12	Antioxidants	Organic chemistry	1	2	0	3	0	0	5
7.	AC13	AI in Chemistry	Theoretical chemistry	1	2	3	0	0	0	5
8.	AC14	Phytochemistry	Biochemistry	1	2	0	2	0	0	5

Study program: Master academic studies – Applied Chemistry			
Course title: German in an Intercultural Context			
Teacher(s): Valentin Cepas			
Course status: Obligatory			
Number of ECTS: 5			
Prerequisites: Enrolled in the master academic studies in Applied Chemistry. Fluency in English (B2 or higher).			
Course objective To raise cross-cultural awareness and develop intercultural competence by explaining and understanding cross-cultural phenomena, intercultural issues and critical incidents. To learn the basics of German for academic and everyday communication.			
Course learning outcomes Students will be capable of communicating successfully in international teams. They will be introduced to the basics of German language, and academic and business culture.			
Course contents Discussing your own intercultural experience and cross-cultural issues. Country specifics Germany (basic facts, customs and traditions, rules and regulations, etc.). Applying for a job or an internship in Germany. Corporate culture and important job-related issues (working hours, salary, insurance, etc.). Basics of German for everyday communication.			
Literature <i>Primary literature</i> 1. R. Camerer, J. Mader, <i>Intercultural Competence in Business English</i> , Cornelsen, 2012. 2. B. Dignen, <i>Communicating Across Cultures</i> , Cambridge University Press, 2011. <i>Additional literature</i> 1. www.elc-consult.com 2. www.study-in-germany.de 3. www.dw.com			
No. of active teaching hours	Lectures: 4 (60)		Practice: /
Teaching methods Lectures, Seminar.			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
seminar(s)	50	Oral exam	50

Study program: Master academic studies – Applied Chemistry			
Course title: Technical English			
Teacher(s): Goran Kaluderović			
Course status: Mandatory			
Number of ECTS: 5			
Prerequisites: Enrolled in the Master academic studies Applied Chemistry. English Skills at Level B2 or higher.			
Course objective Development of intercultural competence and communication. Mastering subject-specific terminology in English. Ability to conduct discussions on subject-specific topics.			
Course learning outcomes Ability to communicate successfully in an English-speaking environment. Proficiency in discussing a wide range of general, job-related, and subject-specific topics. Ability to explain technical concepts and specific processes. Understanding written and spoken information on technical issues, with a focus on chemistry, chemical, and process engineering.			
Course contents Explaining technical functions and applications. Describing and explaining tests, experiments and technical processes. Describing features and specifications. Phenomena in science and technology. Introduction to academic writing. Subject-specific terminology.			
Literature <i>Primary literature</i> 1. D. Bonamy, <i>Technical English</i> , 2 nd Edition, Level 3 & 4, Pearson, 2022. 2. M. Ibbotson, <i>Professional English in Use – Engineering</i> , Klett, 2010. 3. C. Sick, <i>TechnoPlus English</i> , Eurokey Software, 2011. <i>Additional literature</i> 1. TED Talks - www.ted.com 2. www.sciencedaily.com			
No. of active teaching hours		Lectures: 4 (60)	Practice: /
Teaching methods Lectures, seminar.			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
seminar(s)	40	Oral exam	60

Study program: Master academic studies – Applied Chemistry			
Course title: Advanced Organic Synthesis			
Teacher(s): Violeta Marković, Dragana Stevanović			
Course status: Mandatory			
Number of ECTS: 5			
Prerequisites: Enrolled in the Master academic studies Applied Chemistry			
Course objective Deep understanding of the reactivity and properties of organic compounds, covering modern synthetic methods, stereoselective synthesis, and reaction mechanisms. Mastering the use of synthetic tools for the functional group interconversion and carbon-carbon and carbon-heteroatom bond formation. Developing the ability to design synthetic routes to complex molecules, such as drugs and natural products, through a problem-solving approach.			
Course learning outcomes Students will be able to solve advanced organic chemistry problems using mechanistic reasoning, propose appropriate synthetic strategies on the basis of retrosynthetic analysis, evaluate organic reactions with respect to stereochemical, selectivity, environmental, and safety outcomes analysis, and carry out advanced reactions, including multistep syntheses.			
Course contents <i>Theory</i> Organic reactions with mechanisms: oxidation; reduction; substitution, addition, and elimination reactions; alkylation of enolates and enamines; pericyclic reactions (cycloadditions, sigmatropic, and electrocyclic reactions); palladium-catalysed coupling reactions. Chemoselectivity, regioselectivity, and stereoselectivity (including diastereoselectivity and enantioselectivity). Protecting groups in organic synthesis (examples of protecting groups for functional groups such as alcohols, amines, carboxylic acids, aldehydes, and ketones). Flow chemistry in organic synthesis with industrial applications in modern chemical production. Solid-phase synthesis (SPS) in organic chemistry. Organic synthesis of target molecules on the basis of retrosynthetic methods, catalytic methods, and synthesis planning. <i>Practice</i> Retrosynthetic analysis of the molecular structure and design of a synthetic route for a given target molecule, <i>e.g.</i> a natural product or a pharmaceutical compound. Analysis of organic reaction protocol on stereochemical, selectivity, environmental and safety outcomes. Multistep synthesis of a target molecule by applying modern synthetic methods. Organic compound structure elucidation by combining different techniques, such as infrared (IR) and nuclear magnetic resonance (NMR) spectroscopy and mass spectrometry (MS).			
Literature <i>Primary Literature</i> 1. F.A. Carey, R.J. Sundberg, Advanced Organic Chemistry Part B: Reactions and Synthesis, Springer, 2007. 2. K.C. Nicolaou, S.A. Snyder, Classics in Total Synthesis II, VCH: New York, 2003. 3. S. Warren, P. Wyatt, Organic Synthesis: The Disconnection Approach, 2nd ed. Wiley, 2004. 4. K. Vollhardt, C. Peter Organic Chemistry, W. H. Freeman and Company, 1987. <i>Additional Literature</i> 1. Hand-outs distributed in class 2. Current scientific literature related to the subject			
No. of active teaching hours		Lectures: 2 (30)	Practice: 3 (45)
Teaching methods Lectures, theoretical exercises, experimental exercises, consultations			
Examination (maximum number of points 100)			
Exam prerequisites		points	Final exam points

Practical exercises	30	Written exam	30
Colloquium(s)	40		

Study program: Master academic studies – Applied Chemistry
Course title: Chemoinformatics
Teacher(s): Zoran Marković, Izudin Redžepović, Edina Avdović
Course status: Mandatory
Number of ECTS: 5
Prerequisites: Enrolled in the Master academic studies Applied Chemistry
Course objective The aim of this course is to provide students with the knowledge and practical skills needed to use computational methods and chemoinformatics tools for the analysis of chemical data. Students will learn about molecular representation, descriptors, similarity analysis, QSAR/QSPR modeling, and applications of machine learning, enabling them to apply these techniques in drug discovery, materials research, and other fields that rely on chemical data.
Course learning outcomes After successfully completing the course, the student will be able to: • Understand the basic principles of chemoinformatics and the relationship between molecular structure and properties. • Represent and manipulate chemical structures using SMILES, InChI, and molecular graphs. • Use software tools for the storage, retrieval, and analysis of chemical data. • Search for and interpret data from chemical databases such as PubChem, ChEMBL, and DrugBank. • Perform molecular similarity and diversity analysis using descriptors and fingerprints. • Evaluate data quality and the reproducibility of results. • Interpret analysis results and present findings through reports and presentations.
Course contents This course introduces students to the fundamentals of chemoinformatics, with a particular focus on the representation, storage, and analysis of chemical data. Students will learn how computational tools and data-driven methods are used to explore chemical space, predict molecular properties, and support applications such as drug discovery and the development of new materials. <i>Theory</i> • Introduction to chemoinformatics • Methods for molecular representation and chemical data • Chemical databases and search techniques • Molecular descriptors and similarity analysis • Fundamentals of QSAR and QSPR methods • Data curation, quality control, and result reproducibility • Practical tools and applications of chemoinformatics <i>Practice</i> • Working with chemical databases: searching, extracting, and filtering molecular data • Molecular visualization: displaying molecular structures and properties using software • Generation of molecular descriptors: calculation of molecular features • Molecular similarity analysis: comparison of molecules based on descriptors • Basics of QSAR/QSPR analysis: predicting molecular properties based on data • Application of cheminformatics tools in projects: simulations, modeling, property prediction • Data curation: cleaning and correcting chemical data for reliable analysis
Literature 1. A.R. Leach, V.J. Gillet, An Introduction to Chemoinformatics, Springer, 2007. 2. J.-L. Faulon, A. Bender, Eds., Handbook of Chemoinformatics Algorithms, Chapman & Hall/CRC, 2010.

3. K. Roy, Ed., Cheminformatics, QSAR and Machine Learning Applications for Novel Drug Development. Academic Press, 2023.			
4. J. Leszczynski, Ed., Springer Handbook of Chem and Bioinformatics, Springer Nature, 2026.			
No. of active teaching hours	Lectures: 2 (30)		Practice: 3 (45)
Teaching methods			
Lectures, practical exercises, mini projects.			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
Practical exercises	10	Written exam	55
Project	35		

Study program: Master academic studies – Applied Chemistry			
Course title: Working Internship			
Teacher(s): Goran Kaluderović, Vladimir Petrović, Dejan Milenković			
Course status: Mandatory			
Number of ECTS: 3			
Prerequisites: Enrolled in the Master academic studies Applied Chemistry.			
Course objective Acquiring practical experience of working in a professional environment. Preparing students for the transition from university to a real-world setting, enhancing their professional experience and developing soft skills.			
Course learning outcomes Students will be able to independently plan and conduct experimental work in a professional environment, as well as to work in a team. They will be able to apply the knowledge acquired during their studies in practice through solving tasks and problems in a real business environment.			
Course contents The specific content of this course will vary depending on the selected working environment. Familiarization with the daily responsibilities of employees in the chosen laboratory or company, to acquire the necessary practical skills in a professional setting. Introduction to the regulations specific to the selected position. Developing specific professional skills for handling work duties. Practical application of laboratory methods. Analytical evaluation and interpretation of experimental data. Systematic problem-solving while carrying out a work assignment. Writing reports and presenting results. Gaining on-site workplace experience. The student is required to write a Professional Internship Report.			
Literature Current scientific literature related to the specific research field.			
No. of active teaching hours		Lectures: /	Other: 6 (90)
Teaching methods Practical work.			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points

Study program: Master academic studies – Applied Chemistry				
Course title: Master Thesis				
Teacher(s): One supervisor from HoMe, and one from FSUKG or SUNP				
Course status: Mandatory				
Number of ECTS: 22				
Prerequisites: Enrolled in the Master academic studies Applied Chemistry. Acquired 20 ECTS.				
Course objective Participation in a guided Master's thesis project. Training students for planning and independently conducting experimental work in accordance with the research topic. Developing critical thinking and logical reasoning. Preparation for further independence and teamwork.				
Course learning outcomes The student will be able to independently design and conduct experimental work in the chosen field of chemistry. They will be able to independently analyze the obtained results and present them in the form of professional reports. The student will be qualified for further advanced scientific and applied research.				
Course contents Students will be engaged in a chosen research topic within a working group (inorganic, organic, analytical, or physical chemistry) and will be involved in problem-solving and execution of a specific task. This includes guided state-of-the-art research to define objectives, independent literature review to develop a structured research strategy, systematic problem-solving during experimental work, analytical evaluation and interpretation of experimental data, as well as scientific reporting and written presentation of the results. The Master's thesis introduces students to independent scientific research, problem-solving through critical thinking and logical reasoning, and reporting of the obtained results. Upon completion of the experimental work, the student is requested to write the Master's thesis. The thesis will then be independently evaluated and graded by both HoMe supervisor and FSUKG / SUNP supervisor. If the difference between the given grades is greater than or equal to 3, the third assessment will be carried out by a selected professor involved in the MAS Applied Chemistry study program.				
Literature The literature consists of peer-reviewed books and scientific articles selected depending on the chosen topic of the Master's thesis.				
No. of active teaching hours		Lectures: /	Study Research Work: 19 (285)	
Teaching methods Practical work (laboratory class).				
Examination (maximum number of points 100)				
Exam prerequisites		points	Final exam	points
Practical work		30	Written exam	70

Study program: Master academic studies – Applied Chemistry				
Course title: Master Seminar Defense of master thesis				
Teacher(s): One supervisor from HoMe, and one from FSUKG or SUNP				
Course status: Mandatory				
Number of ECTS: 5				
Prerequisites: Enrolled in the Master academic studies Applied Chemistry. Written Master thesis.				
Course objective Preparing student to concisely and systematically present the results obtained after conducting research work related to the Master's thesis. Visual literacy, narrative competence, and presentation skills.				
Course learning outcomes The student will have the ability to point out and present the most significant achievements reached during the research conducted. They will be able to lead a discussion on the results obtained, supported by scientific facts. They will possess the knowledge required to present research results using various visual and digital tools.				
Course contents Students will be engaged in presenting and defending the results obtained during their Master's thesis research. The research topic is linked to the selected working group (advanced inorganic, organic, analytical, or physical chemistry). Creating a visual presentation of the results obtained. Analyzing the results obtained and highlighting the most significant achievements. Clear and scientifically supported drawing of conclusions based on the obtained data. Scientific reporting and oral presentation of results. Working on the development of critical thinking, logical reasoning, as well as technical and narrative competencies. The student defends their thesis before a committee composed of three faculty members, presenting the results obtained during the preparation of the work.				
Literature The literature consists of peer-reviewed books and scientific articles selected depending on the chosen topic of the Master's thesis.				
No. of active teaching hours		Lectures: /	Other: 5 (75)	
Teaching methods Consultations and discussion of results with the instructor (mentorship-based teaching), preparation of the presentation for the defense, and oral defense of the Master's thesis.				
Examination (maximum number of points 100)				
Exam prerequisites		points	Final exam	points
Preparation of the presentation		30	Master's thesis defense	70

Study program: Master academic studies – Applied Chemistry			
Course title: Research Internship			
Teacher(s): Goran Kaluderović, Thomas Rödel, Valentin Cepus, Mathias Seitz			
Course status: Elective			
Number of ECTS: 5			
Prerequisites: Enrolled in the Master academic studies Applied Chemistry. Laboratory experience.			
Course objective Training students for independent work in a research laboratory through participation in a guided research project. Preparing students to tackle complex research tasks.			
Course learning outcomes Students will acquire the necessary expertise to independently plan and execute experimental protocols. Furthermore, they will be trained for advanced academic research and the successful completion of their master’s thesis.			
Course contents Research work on current topics within the selected area (inorganic, organic, analytical, or physical chemistry). Independent literature review to define experimental objectives. Development of a research strategy. Practical application of laboratory methods. Systematic problem-solving during experimental procedures. Application of spectroscopic techniques in chemical analysis. Analysis and interpretation of experimental data. Scientific reporting and oral presentation of results. Prior to the examination, students are required to submit a Research Internship Report.			
Literature <i>Primary literature</i> 1. A.T. Tyowua, <i>A Practical Guide to Scientific Writing in Chemistry: Scientific Papers, Research Grants and Book Proposals</i> , CRC Press, 2023. <i>Additional literature</i> 1. Current scientific literature related to the project.			
No. of active teaching hours		Lectures: 1 (15)	Practice: 4 (60)
Teaching methods Practical work (laboratory class).			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
Practical work	20	Oral exam	60
Internship Report	20		

Study program: Master academic studies – Applied Chemistry			
Course title: Instrumental Polymer Analysis			
Teacher(s): Valentin Cepus, Zhanna Evgrafova, Heike Kahl			
Course status: Elective			
Number of ECTS: 5			
Prerequisites: Enrolled in the Master academic studies Applied Chemistry.			
Course objective To teach foundations of the physical chemistry of polymers and their characterization methods. To give an overview of analytical techniques for polymers.			
Course learning outcomes Students will learn to perform basic polymer analyses using different techniques and write scientific reports. They will be able to apply and evaluate the basic principles of polymer characterization methods.			
Course contents <i>Theory</i> Statistical treatment of analytical data. Special chromatographic techniques for the investigation of polymers and polymer additives. Principles and instrumental parameters in molecule spectroscopy (IR and Raman spectroscopy). Thermal analytical methods for the characterization of chemical and physical properties of polymers. <i>Practice</i> The extraction of additives and analysis of extracts and residual monomers by GC/MS. Elastomer characterization by TMA. Qualitative analysis of polymers and copolymers by FTIR spectroscopy (MIR or NIR). Mn of polymers by vapour pressure osmometry or membrane osmometry.			
Literature <i>Primary literature</i> 1. B. Stuart, <i>Polymer Analysis</i> , ANTS, John Wiley&Sons Ltd., 2002. <i>Additional literature</i> 1. Current scientific literature related to Instrumental Polymer Analysis.			
No. of active teaching hours		Lectures: 1 (15)	Practice: 2 (30)
Teaching methods Lecture and laboratory exercises.			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
Practical exercises	30	Written exam	70

Study program: Master academic studies – Applied Chemistry				
Course title: Sustainable Transformation Chemistry				
Teacher(s): Bernhard Neumann, Valentin Cepus, Goran Kaluderović				
Course status: Elective				
Number of ECTS: 5				
Prerequisites: Enrolled in the Master academic studies Applied Chemistry.				
Course objective Enabling students to understand and apply the principles and strategies for the practical implementation of a sustainability-oriented chemical industry (sustainable chemistry, transformation chemistry). Acquiring ability to evaluate current and emerging technologies for the recycling of products and materials within an industrial and environmental context.				
Course learning outcomes After this course, students will have basic and advanced competencies in the field of sustainable chemistry and chemical process engineering (Green Chemistry). Students will gain the experience necessary to analyze and evaluate modern approaches in process engineering aimed at improving energy efficiency, resource utilization, replacing fossil raw materials with renewable biomass, as well as enhancing process and plant safety. Critical assessment of contemporary challenges and problems arising from industry, research, and development in the field of sustainable chemical processes. Application of sustainability principles within the analysis, evaluation, and further development of chemical and process-engineering systems.				
Course contents <i>Theory</i> Principles and concepts of sustainability-oriented chemistry and chemical process engineering. Analysis and evaluation of case studies illustrating sustainable process and production systems. Application of interdisciplinary approaches in the further development and optimization of workflows in chemical and process engineering. Assessment of process engineering measures regarding energy efficiency, resource efficiency, as well as plant and process safety. Evaluation of concepts for replacing fossil-fuel-based raw materials with renewable and bio-based resources. Examination of sustainability-oriented process technologies in chemical production, industrial recycling of products and materials, and environmental engineering. Classification and critical assessment of the contribution of these technologies to established sustainability concepts. Derivation of appropriate technical and organizational measures for the implementation of sustainable process solutions. Analysis of chemical processes against sustainability criteria and preparation for sustainability-based decision-making in an industrial, environmental, and process-engineering context.				
Literature 1. Sustainable Green Catalytic Processes, Eds. Mousumi Sen, Wiley, 2024.				
No. of active teaching hours		Lectures: 4 (60)	Practice: /	
Teaching methods Lecture, consultations, seminar.				
Examination (maximum number of points 100)				
Exam prerequisites		points	Final exam	points
Seminar		30	Written exam	70

Study program: Master academic studies – Applied Chemistry			
Course title: Advanced Inorganic Synthesis			
Teacher(s): Biljana Petrović, Marina Ćendić Serafinović			
Course status: Elective			
Number of ECTS: 5			
Prerequisites: Enrolled in the Master academic studies Applied Chemistry			
Course objective The main goal of this course is to acquire modern knowledge in the field of synthesis of various classes of inorganic compounds and methods of their purification and characterization. Students will develop an understanding of advanced synthetic strategies in inorganic chemistry, gain experience in multistep syntheses and inert-atmosphere techniques, learn to select appropriate characterization methods, and critically evaluate the scientific literature in inorganic synthesis.			
Course learning outcomes Upon successful completion of the course, students will be able to independently plan and execute advanced inorganic syntheses, safely handle air- and moisture-sensitive compounds, interpret spectroscopic and structural data, correlate synthetic methods with structure and reactivity and evaluate synthetic procedures reported in scientific literature.			
Course contents <i>Theory</i> Inorganic synthesis under specific conditions, including high-temperature, low-temperature and cryogenic conditions; hydrothermal and solvothermal methods; high-pressure and ultra-high-pressure synthesis; photochemical synthesis; synthesis under microwave irradiation and plasma conditions. Inert-atmosphere methods for the synthesis of air- and moisture-sensitive inorganic compounds. Laboratory safety, waste management, and green chemistry approaches in inorganic synthesis. Synthesis of coordination compounds, coordination polymers, clusters, and organometallic compounds. Ligand design and coordination strategies. Electronic and steric effects of ligands and their role in controlling the structure and reactivity of metal complexes. Electron-transfer reactions and fundamental mechanistic pathways in inorganic synthesis. Preparation and properties of metal complexes relevant to biological and medicinal applications. Characterization methods in inorganic chemistry: elemental analysis; melting and boiling point determination; spectroscopic methods for structural characterization. UV–Vis spectrophotometry (electronic d–d transitions and spectral terms). Infrared (IR) spectroscopy. Mass spectrometry. Nuclear magnetic resonance (NMR) spectroscopy. Electron paramagnetic resonance (EPR) spectroscopy. Circular dichroism. X-ray structural analysis, including the use of Scherrer’s formula and X-ray diffractometry. Chromatographic methods: classification of chromatographic techniques; planar (laminar) chromatography; column chromatography; adsorption chromatography; methods for separation and analysis of chromatograms; ion-exchange chromatography; affinity chromatography; paper chromatography; thin-layer chromatography (TLC); gas chromatography; and high-performance liquid chromatography (HPLC). <i>Practice</i> Practice (laboratory exercises) includes independent student work involving synthesis, purification and characterization of different compounds using modern methods (UV-Vis, IR, NMR, EPR, HPLC).			
Literature 1. W.L. Jolly, <i>Synthesis and characterization of inorganic compounds</i> , Prentice Hall International, Hearts, 1970. 2. R. Xu, W. Pang, Q. Huo, <i>Modern Inorganic Synthetic Chemistry</i> , Elsevier B.V., 2011. 3. A.K. Birdson, <i>Inorganic Spectroscopic Methods</i> , Oxford University Press, 1998.			
No. of active teaching hours		Lectures: 2 (30)	Practice: 3 (45)
Teaching methods Lectures, Laboratory practice, Seminars			
Examination (maximum number of points 100)			
Exam prerequisites		points	Final exam points

Practical exercises	30	Written exam	50
seminar(s)	20		

Study program: Master academic studies – Applied Chemistry			
Course title: Coordination Compounds in Pharmacy and Medicine			
Teacher(s): Jovana Bogojeski, Biljana Glišić			
Course status: Elective			
Number of ECTS: 5			
Prerequisites: Enrolled in the master academic studies in Applied Chemistry.			
Course objective The course seeks to transfer knowledge in the field of fundamentals of medical inorganic chemistry, with a particular focus on the application of coordination compounds in medical purposes – from diagnostics to therapy. Special emphasis will be dedicated on the use of transition metal complexes in the therapy of various diseases, as well as on the application of coordination compounds as radiopharmaceuticals and contrast agents.			
Course learning outcomes Upon completion of the course, the student possesses advanced knowledge of the application of metal complexes in medicine, can analyze structure-activity relationships of complexes, can interpret experimental data and critically evaluate literature, and is capable of participating in the design of new bioactive compounds.			
Course contents <i>Theory</i> Medicinal inorganic chemistry. Different aspects of medicinal inorganic chemistry. Essential macro- and microelements. Platinum complexes as antitumor agents. Ruthenium complexes as potential antitumor agents. Application of gold complexes in medicine. Application of silver and its complexes in medicine. Bismuth complexes in the treatment of gastrointestinal disorders. The use of mercury, arsenic, antimony, iron, cobalt, and gallium compounds in medicine. Metal complexes as therapeutic and diagnostic radiopharmaceuticals. Metal complexes as contrast agents in diagnostics. Disorders in metal ion metabolism. Chelation therapy. Metal complexes as synthetic metalloproteinases. <i>Practice</i> Synthesis and structural characterization of antitumor platinum(II) complexes. Investigation of the reactions of a platinum(II) complex with biologically important nitrogen- and sulfur-donor ligands (guanosine-5'-monophosphate and L-methionine) using NMR spectroscopy. Synthesis and structural characterization of antimicrobial gold(III) complexes. Preparation of media for biological evaluation. Sterilization. Laboratory rules in a microbiological laboratory. Evaluation of antibacterial activity of the synthesized gold(III) complexes by disc-diffusion and dilution methods.			
Literature <i>Primary literature</i> 1. E. Allesio, <i>Bioinorganic Medicinal Chemistry</i> , Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, 2011. <i>Additional literature</i> 1. Reviews in the field of medicinal inorganic chemistry 2. B. Glišić, Internal script			
No. of active teaching hours		Lectures: 2 (30)	Practice: 3 (45)
Teaching methods Lectures, consultations, practical classes			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
practical exercises	10	written exam	60
colloquiums	30		

Study program: Master academic studies – Applied Chemistry		
Course title: Antioxidants		
Teacher(s): Vladimir Petrović		
Course status: Elective		
ECTS: 5		
Prerequisites: Enrolled in the Master academic studies Applied Chemistry		
Course objective To introduce students with the latest scientific knowledge about reactive oxygen and nitrogen species that are formed in the body, their physiological role and toxicity, the mechanisms of antioxidant protection of the body, natural compounds and synthetic supplements that can improve health status. Students will expand the knowledge acquired in basic studies of chemistry, i.e. biochemistry, and become familiar with direct and indirect methods of qualitative and quantitative determination of antioxidant activity of natural and synthetic compounds.		
Course learning outcomes After mastering the material in this course, the student is expected to demonstrate and expand the knowledge acquired by attending this course, to show independence and creativity in the application of theoretical and practical knowledge in the field of antioxidant chemistry. He is expected to work competently in a modern laboratory dealing with this issue and to independently plan experiments and apply advanced methods, techniques and research procedures.		
Course contents <i>Theory</i> The phenomenon of oxygen toxicity in aerobic organisms. Formation and properties of toxic forms of oxygen and nitrogen in the cell and the concept of oxidative stress. Harmful effects of free radicals in the body and the development of diseases. Mechanisms of free radical toxicity: lipid peroxidation, oxidative damage to proteins, DNA and carbohydrates, mechanisms of action of pro-oxidative metals (iron, copper). Free radicals and aging. Enzymatic (superoxide dismutase, catalase, glutathione reductase and glutathione peroxidase) and non-enzymatic (L-ascorbic acid, α-tocopherol, carotenoids, ubiquinone, glutathione, uric acid, bilirubin and proteins that bind iron and copper ions) antioxidant protection of the body. Natural and synthetic antioxidants. Plants with antioxidant components. Polyphenolic compounds as antioxidants and their classification. Antioxidants as dietary supplements and additives. Food components with antioxidant and/or pro-oxidant role, bioactivation of antioxidants from food, mechanisms of action of antioxidants from food, carotenoids, vitamin E, vitamin C. Direct and indirect methods for determining the antioxidant activity of natural and synthetic compounds. Thermodynamic and kinetic approach to determining the potential antioxidant capacity and mechanism of action of some phenolic antioxidants (HAT, PCET and SPLET mechanisms). <i>Practice</i> Practical teaching follows lectures and is carried out in the form of experimental exercises that will include various methods for determining the total antioxidant capacity of compounds and mixtures, detection of compounds responsible for antioxidant activity, determination of lipid peroxidation inhibition capacity (AAPH test) and lipoxygenase inhibition, determination of vitamin C.		
Literature 1. B.V. Đorđević, D.D. Pavlović, M.G. Kostić, <i>Biochemistry of Free Radicals</i>, Faculty of Medicine, Niš, 2000. 2. Z.D. Petrović, D. Simijonović, V.P. Petrović, <i>Bioorganic Chemistry – Practical</i>, Faculty of Science, University of Kragujevac, 2015. 3. B. Halliwell, J.M.C. Gutteridge, <i>Free radicals in biology and medicine</i>, Oxford University Press Inc., New York, 2007. 4. F. Shahidi (ed), <i>Natural Antioxidants: Chemistry, Health Effects, and Applications</i>, AOCS Press, 1997. 5. E. Cadenas, L. Packer (eds.), <i>Handbook of Antioxidants</i>, Marcel Dekker, Inc., New York, USA, 2002.		
No. of active teaching hours	Lectures: 2 (30)	Practice: 3 (45)
Teaching methods		

Lectures, consultations, experimental exercises, seminars			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
Practical exercises	10	Written exam	55
Colloquium(s)	30		
Seminar(s)	5		

Study program: Master academic studies – Applied Chemistry
Course title: AI in Chemistry
Teacher(s): Izudin Redžepović, Dejan Milenković
Course status: Elective
Number of ECTS: 5
Prerequisites: Enrolled in the Master academic studies Applied Chemistry
Course objective The aim of the course is to introduce students to the application of artificial intelligence in chemistry, develop their practical skills in using machine learning and deep learning on chemical data, and empower them to critically interpret and validate the results of AI models.
Course learning outcomes After successfully completing the course, the student will be able to: • Understand the fundamental concepts of artificial intelligence in chemistry and explain the principles of machine learning, deep learning, and data-driven approaches. • Collect, clean, and prepare chemical datasets for AI applications while ensuring data quality and consistency. • Develop and apply AI/ML models to predict molecular properties and activities. • Interpret the results of AI models and assess their reliability and limitations in a chemical context. • Use relevant computational tools and software for AI in chemistry, including Python libraries, cheminformatics tools, and molecular modeling packages.
Course contents This course presents the application of artificial intelligence in chemistry, focusing on how machine learning and deep learning can be used to work with chemical data for predicting molecular properties and optimizing reactions. Students gain hands-on experience with cheminformatics tools, work with real-world datasets, and learn how to responsibly interpret and verify AI models. <i>Theory</i> • Concepts and applications of artificial intelligence in chemistry • Representation and preparation of chemical data • Machine learning and deep learning for property prediction • AI-assisted drug discovery, materials design, and reaction optimization • Practical projects using real chemical datasets • Interpretation and validation of AI models <i>Practice</i> • Collection and preparation of chemical datasets for analysis (cleaning, normalization, descriptor generation) • Conversion of molecular structures into different formats (SMILES, InChI, molecular graphs) • Development of simple machine learning models for predicting molecular properties (e.g., solubility, bond energy) • Classification of molecules based on biological activity or toxicity • Validation and interpretation of AI model results (accuracy assessment, visualization of predicted properties) • Mini-project development: analysis of a real dataset and presentation of results (written report, figures, discussion)
Literature 1. K.T. Butler, D.W. Davies, H. Cartwright, O. Isayev, A. Walsh, <i>Machine learning for molecular and materials science</i>, Nature, 2018, 559, 547–555. 2. H. Chen, O. Engkvist, Y. Wang, M. Olivecrona, T. Blaschke, <i>The rise of deep learning in drug discovery</i>, Drug Discovery Today, 2018, 23(6), 1241–1250.

3. Z.J. Baum, X. Yu, P.Y. Ayala, Y. Zhao, S.P. Watkins, Q. Zhou, *Artificial Intelligence in Chemistry: Current Trends and Future Directions*, Journal of chemical information and modeling, 2021, 61(7), 3197–3212.
4. K. Roy, (Ed.), *Cheminformatics, QSAR and Machine Learning Applications for Novel Drug Development*, Academic Press, 2023.

No. of active teaching hours	Lectures: 2 (30)		Practice: 3 (45)
Teaching methods			
Lectures, practical exercises, mini projects.			
Examination (maximum number of points 100)			
Exam prerequisites	points	Final exam	points
Practical exercises	10	Written exam	55
Project	35		

Study program: Master academic studies – Applied Chemistry			
Course title: Phytochemistry			
Teacher(s): Marko Z. Mladenović, Dušica Simijonović			
Course status: Elective			
Number of ECTS: 5			
Prerequisites: Enrolled in the Master academic studies Applied Chemistry			
Course objective: The objective of this course is to provide students with comprehensive knowledge of the most important biologically and pharmacologically active natural compounds. Emphasis is placed on their biological and ecological roles in living organisms, biogenetic origin and biosynthetic pathways of major classes of secondary metabolites, as well as their chemical characteristics, pharmacological activity and practical applications. In addition, the course aims to develop students’ critical thinking skills and their ability to analyze and interpret scientific problems in the field of phytochemistry.			
Course learning outcomes: Students will be able to: - explain the biosynthetic pathways of different classes of biologically active compounds, their structural features and pharmacological effects; - apply experimental techniques for the isolation and analysis of pharmacologically active secondary metabolites from natural sources; - critically evaluate and interpret the results of phytochemical analyses.			
Course contents: <i>Theory</i> Phytochemistry and plant metabolites. Primary and secondary plant metabolism. Definition, classification, biosynthesis and biological roles of secondary metabolites. Structure, physicochemical properties, pharmacological activity and applications of heterosides, saponins, tannins and terpenoids. Taxonomic significance of secondary metabolites. Methods for extraction, isolation and separation of secondary metabolites. Methods for metabolite identification. Modern instrumental techniques in the analysis of complex plant extracts. Applications and importance of phytochemistry. <i>Practice</i> Isolation and identification of secondary metabolites from plant material, determination of the composition of essential oils and extracts, and evaluation of their potential biological activity.			
Literature: 1. P.M. Dewick, <i>Medicinal Natural Products - A Biosynthetic Approach</i> , 3rd Edition, Wiley, Chichester, 2009. 2. R. Cannell, <i>Natural Products Isolation</i> , In: J. Walker (ed.), <i>Methods in Biotechnology</i> , Humana press, Totowa, New Jersey, 1998.			
No. of active teaching hours	Lectures: 2 (30)		Practice: 2 (30)
Teaching methods: Interactive lectures, frontal teaching, discussions, colloquia, laboratory exercises, use of electronic databases and consultations.			
Examination (maximum number of points 100)			
Exam prerequisites	Points	Final exam	Points
Practical exercises	20	Oral exam	55
Colloquium(s)	25		