UNIVERSITY OF PRISHTINA

FACULTY OF MATHEMATICAL & NATURAL SCIENCES

DEPARTMENT OF CHEMISTRY

DOCTORAL PROGRAMME IN CHEMISTRY

COURSE DESCRIPTION

A. COMPULSORY COURSES

Code	SUBJECT TITLE	SEMESTER	Hours	ECTS
K1	ELECTROANALYTICAL METHODS	I	30	12
K2	SPECTROSCOPIC METHODS FOR DETERMINATION OF COMPOUND STRUCTURES	I	30	8
K3	METHODS FOR SEPARATION IN CHEMISTRY	I	30	10

B. OPTIONAL COURSES

Code	SUBJECT TITLE	SEMESTER	Hours	ECTS
IK1	INORGANIC ELECTROCHEMISTRY	II	20	10
IK2	THE CHEMISTRY OF COMPLEX COMPOUNDS	II	20	12
IK3	SELECTED CHAPTERS FROM BIOINORGANIC CHEMISRTY	II	20	8
IK4	NANOTECHNOLOGIES	II	20	8
PhK1	PHYSICAL CHEMISTRY OF POLYMERS	II	20	8
PhK2	SELECTED CHAPTERS FROM THE CHEMISTRY OF MATERIALS	II	20	12
PhK3	ORGANIC ELECTROCHEMISTRY	II	20	8
PhK4	THERMODYNAMICS OF MEMBRANE PROCESSES	II	20	10
OK1	METHODS OF ORGANIC SYNTHESIS	II	20	10
OK2	THE STUDY OF REACTION MECHANISMS IN ORGANIC CHEMISTRY	II	20	8
OK3	ORGANIC STEREOCHEMISTRY AND STEREOSELECTIVE SYNTHESIS	II	20	12
OK4	CHEMISTRY OF NATURAL PRODUCTS	II	20	8
EK1	ENERGY AND ENVIRONMENT	II	20	12
EK2	ANALYTICS OF ORGANIC EFFLUENTS OF FOSSIL FUELS IN THE ENVIRONMENT	II	20	10
EK3	ANALYTICS OF INORGANIC EMISSIONS AND EFFLUENTS	II	20	8
EK4	ENVIRONMENTAL ELECTROCHEMISTRY	II	20	8
AK1	REAL SAMPLE ANALYSIS	II	20	8
AK2	SENSORS IN ANALYTICAL CHEMISTRY	II	20	12
AK3	ATOMIC SPECTROCHEMISTRY IN ANALYTICAL CHEMISTRY	II	20	10
AK4	CHEMOMETRICS	II	20	8

Subjects' syllabuses

a. COMPULSORY COURSES

SUBJECT TITLE: ELECTROANALYTIC METHODS
PROFESSOR: dr.sc. Mujë Rugova, professor; dr.sc.Fetah Podvorica, professor; dr.sc.Ramë Vataj, associate professor.
ECTS: 12
Number of lectures: 30 (First semester)
COURSE GOALS: Knowledge expansion on theoretical basis of electrochemistry, usage of various electrochemical techniques, competency development needed for research work.
EXPECTED RESULTS: Capability of candidates to individually resolve problems from the research field.
EVALUATION: test and oral exam
COURSE SUMMARY: *Basics, definitions and concepts.* Ions, electrolytes, charged particles. Galvan's element and electrolysis. Electrochemical cells, thermodynamic properties and potential of electrodes. Kinetics basics and mechanisms of electrochemical reactions. Faraday's and non-Faraday's processes in electrodes. Processes controlled with diffusion and kinetics. *Electroanalytic methods. Potentiometry:* Referent and indicating electrodes. Potentiometric titration. Determination of equivalent point of titration. *Voltametry.* Classic polarography; drop electrode of mercury, diffusive current, polarographic wave equation. Kinetic and catalytic polarographic wave. ECE mechanism of electrode reaction. Polarography with direct and alternating current. Voltametry with linear potential change and cyclic voltametry. Pulsive voltametry and differential pulsive voltametry; polarography. Anodic and catodic stripping voltametry. *Electrogravimetry.* Precipitation potential and electrolysis time. Reactions in anodes. *Coulometry* with potential and current control. *Conductometry.* Determination of electric conductivity of solutions. Direct conductometry and conductometric titration. *Spectroelectrochemistry.* Electrochemical aspects of modern microscopic methods.
LITERATURE: 1. J. Kroyta, J. Dvorak: Principles of Electrochemistry, Wiley, New York 1987. 2. D.R. Crow: Principles and Application of Electrochemistry, Routledge, Champan and Hall, New York 1988. 3. I. Piljac: Elektroanalitičke metode, Teorijske osnove, mjerne naprave i primjena, Udžbenici Sveućilišta u Zagrebu, RMC d.o.o., Zagreb 1995. 4. J. Wang: Analytical Electrochemistry, VCH, New York 1994. 5. A.J. Bard, I. Rubinstein: Electroanalytical Chemistry, A Series of Advanced, Vol. 20, Marcel Delkker, Inc., New York 1998. 6. C.M.A. Brett, A.M. Oliviera Brett: Electroanalysis, Oxford University Press, Oxford 1998. 7. D.A. Skoog, D.M. West i F.J. Holler: Osnove analitičke kemije, Školska knjiga, Zagreb 1999. 8. A. Kaifer and M. Gomez-Kaifer: Supramolecular Electrochemistry, Wiley-VCH, Weinheim 1999.

SUBJECT TITLE: SPECTROSCOPIC METHODS FOR DETERMINATION OF COMPOUND STRUCTURE

PROFESSOR: dr. sc. Hysen Reçi, professor; dr. sc. Ramiz Hoti, associate professor; dr. sc. Avni Berisha, assistant professor

ECTS: **8**

Number of lectures: 30; (first semester)

COURSE GOALS: The student should be familiarized with specific experimental methods, gets the capability to use the data for the analysis of the compounds' chemical structure and consistency.

EXPECTED RESULTS: Capability of individual research.

EVALUATION: Continuous evaluation of all activities of the student such as seminars and oral interviews.

COURSE SUMMARY: Analytical and spectrometric analysis methods; elementary analysis. UV-VIS spectroscopy. IR spectroscopy. Fourie transformation in spectroscopy. Interferometry and Fourie transformation (FT) in infrared (IR) spectroscopy. Dispersive spectroscopy and FT spectroscopy of Raman. Nuclear Magnetic Resonance (NMR) (^{1}H and ^{13}C). Classic experimental techniques. Modern methods of nuclear magnetic resonance . Mass spectrometry (MS). Mass analyzers. Spectrometry of X-rays etc. Usage of spectroscopic and crystallographic data for analyzing compounds and confirmation of crystal and monocrystal structure with X-ray diffraction.

LITERATURE:

1. R. M. Silverstein, F. X. Webster, D. J. Kiemle, *Spektrometric Identification of Organic Compounds*, (seventh ed.), John Willey & Sons Inc. New York, (2005).
2. H. O. Kalinowski, S. Berger, S. Braun, *Carbon-13 NMR Spectroscopy*, Willey, Chichester, (1991).
3. L. D. Field, Organic Structures from Spectra, Wiely- Blackwell, 2008.
4. Yong-cheng Ning, Structural Identification of organic Compouds with Spectroscopic Techniques, Wiley, 2008.
5. K. Tsui, X-ray spectrometry: Recent technological Advances, Viley, 2004
6. J. Schraml, J. M. Bellama, *Two-dimensional NMR Spectroscopy*, Willey, New York, (1988).

SUBJECT TITLE: METHODS FOR SEPARATION IN ANALYTICAL CHEMISTRY
PROFESSOR: dr.sc.Tahir Arbneshi, professor; dr.sc.Fatmir Faiku, assistant professor & dr.sc. Mustafë Bacaj, professor
ECTS: 10
Number of lectures 30; (first semester)
COURSE GOALS : Knowledge expansion in the field of separation methods in analytical chemistry
EXPECTED RESULTS: Capability of candidates to individually resolve problems from the research field.
EVALUATION: Test and oral exam.
COURSE SUMMARY: Definition and classification of methods for separation. Sample preparation; extraction, liquid-liquid extraction, liquid-solid extraction, solid-liquid extraction. Extraction for solid state. Supercritical extraction technique; "Head-space", ionic exchange, Chromatography. Kinetic processes in chromatography. Physical forces and molecular interactions. Intermolecular and inter-ionic forces. Gas chromatography, ionic chromatography, HPLC, electrophoresis, capillary electrophoresis, isoelectric focus, dialysis, mass spectrometric. Detectors and selection of detectors. The role and importance of modern chromatographic methods in analytical chemistry. Definition and classification of chromatographic methods. Theoretical principles of chromatographic methods. Modern theories. Optimization of chromatographic separation. Adsorptive chromatography. Ionic chromatography with high efficiency. Other methods of modern chromatography (capillary electrophoresis, chromatography with ionic pairs, affinitive chromatography). Selection of chromatographic methods for analytical purposes. Quantitative chromatographic analysis. Chromatographic combined techniques. Selected chapters from chromatographic estimation in analytical chemistry.
LITERATURE : 1. C. E. Meloan, *Chemical Separation, principles, techniques, and experiments*, John Wiley & Sons inc, New York, (1999). 2. D. Harvey, *Modern Analytical Chemistry*, McGraw-Hill, Boston, (2000). 3. D. C. Harris, *Quantitative Chemical Analysis*, Fifth Edition, W. H. Freeman and Company, New York, (1999). 4. S. Ahuja, *Handbook of bioseparations*, Academic press, California, (2000). 5. Veronika R. Meyer *Practical High-Performance Liquid Chromatography*, , John Wiley, (2000). 6. James M. Miller *Chromatography – Concepts and Contrast*, , John Wiley, (2005).

b. OPTIONAL COURSES

SUBJECT TITLE: CHEMISTRY OF COMPLEX COMPOUNDS
PROFESSOR: Dr.sc. Ismet Hashani, professor
ECTS: 12
Number of lectures 20; (second semester)
COURSE GOALS: Advancement and knowledge expansion in the field of inorganic complex compounds.
EXPECTED RESULTS: Capability of candidates to individually solve problems from the field of inorganic complexes through electrochemical methods.
EVALUATION: Test and oral exam.
COURSE SUMMARY: Complex compounds, central atoms and monodentate, bidentate and polidentate ligands. Isomer types; hydratic, ionic, coordinative and polymerizing. Stereoisomery of complex compounds. Types $Ma_2b_2c_2$, Ma_4b_2, $M(aa)_2b_2$, $M(ab)_2c_2$ and $M(aa)_3$. Stability of complexes in solutions. Theory of Sixhvik – Luis – Langmiur.: $[Ni(CN)_4]^{2-}$, $[Ni(Cl)_4]^{2-}$, $[Ni(CO)_4]$, $[Fe(CO)_5]$, $[Cr(CO)_6]$,$[Cr(NH_3)_4)]^{3+}$. Complex compounds that have a ligand such as unsaturated hydrocarbons.
LITERATURE: 1. R.G Wilkins: *Kinetics and Mechanism of Reactions of transition Metal Complexes* VCH (Winheim), (1991). 2. Bedri A. Kamberi : *Bazat Teorike së Kimisë së Përgjithshme dhe Inorganike*, Pishtinë (1995). 3. M.M. Jones: *Elementary Cordination Chmistry*, Prentice-Hall, Inc. London-Sidney-Toronto-New Delhy-Tokio (1964). 4. H. Tobe, *Electron Transfer Reactions of Complex Ions in Solution*, Academic Press, New York (1970).

SUBJECT TITLE:	INORGANIC ELECTROCHEMISTRY
PROFESSOR :	dr.sc. Mujë Rugova, professor, dr.sc.Musaj Paçarizi, assistant professor; dr.sc. Merita Shehdula, professor
ECTS: 10	
Number of lectures 20; (second semester)	
COURSE GOALS : Expansion of knowledge from the field of electrochemistry, usage of various electrochemical techniques, study of electrochemical properties of different metallic complexes	
EXPECTED RESULTS: Capability of candidates to individually solve problems from the field of research.	
EVALUATION: Test and oral exam.	
COURSE SUMMARY: Basic aspects of electrochemistry: fundamental electrodic reactions (reactions of electron transfer, Potential and electrochemical cells, kinetic aspects of reactions). Voltametric techniques (cyclic voltametry – reversible and irreversible processes; pulsive differential voltametry, chronoamperometry). Practical aspects: essential instruments for electrochemical measurements (electrodes, electrochemical cells, solutions for electrochemical studies). Applicative aspects: electrochemical behavior of metallic complexes – metallocenes (ferrocenes, vanadocenes etc.), complexes of chrome, manganese, cobalt etc.; Metallic complexes with active redox ligands; Transit metals' clusters; superconductors in electrochemistry; electrochemistry of proteins; linear correlation between redox potential and physical-chemical parameters.	
LITERATURE : 1. I.Piljac: *Elektroanaliticke metode* RMC, Zagreb, (1995). 2. A.J.Bard, L.R.Faulkner:*Electrochemical Methods;Fundamental and Applications*, JW&S, (2001). 3. P.Zanello: *Inorganic Electrochemistry (Theory, practice and aplication),* RSC, (2003) **ADDITIONAL LITERATURE**: 4. Scientific articles published in international magazines	

SUBJECT TITLE: SELECTED CHAPTERS OF BIOINORGANIC CHEMISTRY
PROFESSOR : dr. sc. Selim Jusufi, professor; dr.sc.Merita Shehdula, professor
ECTS: 8
Number of lectures 20; (second semester)
COURSE GOALS: Knowledge expansion from the field of bioinorganic chemistry, application of bioorganic compounds in medicine, pharmacy and environment protection.
EXPECTED RESULTS: Capability of candidates to individually solve problems from the field of bioinorganic chemistry.
EVALUATION: Test and oral exam.
COURSE SUMMARY : Introduction to bioinorganic chemistry; Methods for studying biocomplexes; Bioligands and interaction with biometals; Biometals in nature, living beings and their importance; Biometals, metal enzymes which catalyze hydrolytic and oxidation and reduction processes, oxygen carriers; Model systems and experiments, blood alternatives; Fixation and circulation of nitrogen; Toxic elements, inhibitative effect and elimination from the living environment; Usage of metals, metalloids and non-metals and their compounds in medicine, pharmacy, diet and environmental protection.
LITERATURE : 1. H.B.Bertini, S.j.Lippard:*Principles in Bioinorganic Chemistry*; University Science Book, (1994). 2. K.B.Jacimiriskij: *Uvod u Bioneorgansku hemiju*, Privredni Pregled, Beograd, (1980). 3. J.A.Cowan: *Inorganic Biochemistry, An Introduction*; 2nd ed; Wiley VCH, New York, (1997). 4. M.N.Hughes: *The Inorganic Chemistry of Biological Procesesses*; J.Wiley and Sons, London, (1974).

SUBJECT TITLE: NANOTECHNOLOGIES
PROFESSOR : Dr.sc. Lule Beqa,
ECTS: **8**
Number of lectures 20; (second semester)
COURSE GOALS: Expansion of knowledge from the field of nanotechnology, application in technology.
EXPECTED RESULTS: Capability for individual scientific research
EVALUATION: Test and oral exam.
COURSE SUMMARY: Development of nanotechnologies. Science of surfaces and thin layers: experimental methods, electronic and photo-electronic spectroscopy, diffraction of electrons with low energy, thermal desorption. Molecular and atomic nanostructures, nanostructures of solid materials, electronic and magnetic properties of nanostructures and their application. "Zoo" of carbon (fullerene). Application in technology.
LITERATURE : 1. P.W. Atkins: Physical Chemistry, 6rd Edition. Oxford University Press, Oxford 1998. 2. C.J. Chen: Introduction to Scanning Tunneling Microscopy, Oxfor5d University Press, Oxford 1993. 3. D. Sarid: Scanning Force Microscopy with Aplications to Electric, Magnetic, and Atomic Forces, Oxford University Press, Oxford 1993. 4. N. Taniguchi: Nanotechnology, Oxford University Press, Oxford 1966. 5. D. Koruga: Fullerene C_{60}: History, Physics, Nanobiology, Nanotechnology, Elsevier Science, Amsterdam 1993.

SUBJECT TITLE:	PHYSICAL CHEMISTRY OF POLYMERS
PROFESSOR:	Dr.sc.Teuta Selimi, associated professor
ECTS:	**8**
Number of lectures 20; (second semester)	
COURSE GOALS : Knowledge expansion from the field of polymers	
EXPECTED RESULTS: Capability of candidates to individually solve problems from the research field.	
EVALUATION: Test and oral exam.	
COURSE SUMMARY: Structure of chains, size and shape of polymers. Importance of molecular mass and structure for the physical and chemical properties of the polymer. Statistics of the polymer chains: conformations of the polymeric chains, rotation radius, distance between the two edges of the chain, density. Physical properties of polymers: vitreous state. Methods for determining molecular masses. Methods for determining the size of particles. Solutions of polymers: theory of solutions, thermodynamics of solutions, dissolubility, conformation, the formation of polelectrolytes' complexes. Polymers in the surface: the adsorption of polymers, kinetics of absorption.	
LITERATURE: 1. A,Tager: *Physical chemistry of polymers*,Mir Publishers,Moscow, (1978). 2. A.Y.Grosberg,A.R.Khokhlov:*Giant Molecules*,Academic Press,San Diego, (1997). 3. S.F.Sun:*Physical Chemistry of Macromolecules*:Basic Principles and Issues,bot.2, Wiley,New York,(2004). 4. P.W.Atkins,J. de Paula:Atkins'*Physical chemistry,*bot.7, Oxford Univ. Press,Oxford,(2002). 5. T.Radeva(red.):*Physical Chemistry of Polyelectrolytes*,M.Dekke,New York,(2001). 6. G.Decher,J.B.Schelnoff, *Multilayer Thin Films* ,Wiley-VCH,Weinheim,(2003).	

SUBJECT TITLE: SELECTED CHAPTERS FROM THE CHEMISTRY OF MATERIALS
PROFESSOR: dr.sc. Fetah Podvorica, professor; dr.sc. Rame Vataj, professor
ECTS: 12
Number of lectures 20; (second semester)
COURSE GOALS : Expansion of knowledge from the chemistry of materials.
EXPECTED RESULTS: Capability of candidates to individually solve problems from the research field.
EVALUATION: Test and oral exam.
COURSE SUMMARY: Introduction, basics of the chemistry of materials, the chemistry of solid state, metals, semi-conductive materials, silicon, ceramics, superconductors, "soft" organic materials, classification of polymers and their mechanism of production, application of "soft materials", optic and magnetic materials, nanomaterials, definition of nanotechnology; nanomaterials and their fabrication; carbon nanotubes, chemical and electrochemical modification of surfaces and the formation of nanostructures, molecular conductors, biosensors; material characteristics; structural characteristics with electronic microscopes (SEM), electrochemical microscopy (SECM), spectroscopy of photoelectrons with X-rays (XPS); microscopy with tunnel effect (STM), microscopy with atomic force (AFM); chemical and optical characteristics.
LITERATURE : 1. Fahlman, B.; *Materials Chemistry*, 1st edition, Springer Science, Netherlands (2008). 2. Gersten, J.; Smith, F.; *The physics and Chemistry of Materials*, 1st edition, John Wiley & Sons, USA (2001). 3. Bard, A.; *Integrated Chemical Systems: A Chemical Approach to Nanotechnology*, John Wiley&Sons, New York, (1994). **ADDITIONAL LITERATURE** 1. Scientific articles and REVIAL in the field of chemistry of materials in magazines such as *Chemistry of Materials* published by American Chemical Society and *Journal of Materials Chemistry* published by Royal Society of Chemistry.

SUBJECT TITLE: ORGANIC ELECTROCHEMISTRY
PROFESSOR: dr.sc. Mujë Rugova, professor; dr.sc. Fetah Podvorica, professor; dr.sc. Rame Vataj, professor
ECTS: 8
Number of lectures 20; (second semester)
COURSE GOALS: Expansion of knowledge from the field of organic electrochemistry.
EXPECTED RESULTS: Capability of candidates to individually resolve problems from the research field.
EVALUATION: Test and oral exam.
COURSE SUMMARY: The structure of inter-phase boundaries; thermodynamics of the electric boundary phase; electro-kinetic phenomenon. Electrodic kinetics: speed-potential ratio, multilevel stationary electrodic kinetics, kinetics of linear potential change, reversible and irreversible reactions, reaction sequence, impact of the structure of the inter-phase boundary in electrodic kinetics, determination of the mechanism of electrochemical reaction. Electrochemical kinetics, Electrocatalysis: the role of materials in electrodic kinetics, examples of electro-organic and electro-inorganic synthesis. Electrochemical conversion of energy and electrochemistry of clean environment. Experimental techniques. Oxidation and reduction of functional groups of organic molecules in water and in organic solvents; Electrochemical polymerization, polymerization of aniline; Anodic oxidation of organic compounds which contain oxygen.
LITERATURE : 1. A. Bard, L.R. Faulkner: *Electrochemical Methods; Fundamentals and Applications*, 2nd edition, John Wiley & Sons, New York, (2001). 2. J.O'M Bockris, S.U.M. Khan; *Surface Electrochemistry*, Plenum Press, New York, (1993) 3. C. H. Hamann, A. Hamnett, W. Vielstich: *Electrochemistry*, Verlag Chemie, Weinheim, (1998). 4. H. Lund, O. Hammerich, *Organic Electrochemistry*, 4th edition, Marcel Dekker Inc. New York, (2001). **ADDITIONAL LITERATURE**: 1. Scientific magazines and scientific monographies.

SUBJECT TITLE: THERMODYNAMICS OF MEMBRANE PROCESSES
PROFESSOR : dr.sc. Bashkim Thaçi, assistant professor dr.sc. Salih Gashi, professor
ECTS: 10
Number of lectures 20; (second semester)
COURSE GOALS: Expansion of knowledge from the field of thermodynamics of membrane processes.
EXPECTED RESULTS: Capability of candidates to individually solve problems from the field of the membrane research.
EVALUATION: Test and oral exam.
COURSE SUMMARY: Mathematical formulations of thermodynamics, Thermodynamic functions. Statistic thermodynamics. Thermodynamics of ions in solutions. Phase equilibrium which involves solutions. Cogitative properties of solutions. Synthetic membranes and their preparation, Microfiltration. Ultra filtration. Reverse osmosis. Membrane materials. Preparation and properties of membranes of reverse osmosis. Physical and chemical nature of separation with reverse osmosis. The mechanism for transporting through membranes of reverse osmosis. Effects of polarization of concentration, Separation, Treatment of non-liquid solutions in liquid state with reverse osmosis, Separation of gases with reverse osmosis.
LITERATURE : 1. Jane Kucera, "*Reverse Osmosis, Design, Processes, and Applications for Engineers*", John Wiley & Sons (2010). 2. S. Sourirajan and T.Matsuura, "*Reverse osmosis/Ultra filtration process principles*", N.R.C.Canada, Ottawa,1985. 3. P.M.Bungay, H. K.Lonsdale and M.N.de Pinho, *Synthetic Membranes, Science Engineering and Applications,* D.Reidel pub.comp. Dordrecht,1986. **ADDITIONAL LITERATURE**: • P.Meares, *Membrane separation processes*, Elsevier Pub.Co.Amsterdam,(1976) • S.Sourirajan and t.Matsuura, *Reverse osmosis/Ultra filtration process principles*, N.R.C.Canada, Ottawa,(1985).

SUBJECT TITLE: METHODS OF ORGANIC SYNTHESIS
PROFESSOR: dr.sc.Sevdije Govori, associated professor, dr.sc. Majlinda Daci, assistant professor dr.sc.Vuksan Kalaj, professor
ECTS: 10
Number of lectures 20; (second semester)
COURSE GOALS : Expansion of knowledge from the field of synthesis of organic compounds.
EXPECTED RESULTS: Capability of candidates to individually resolve problems from the research field.
EVALUATION: Test and oral exam.
COURSE SUMMARY: Synthetic ways for producing organic molecules using commercially appropriate raw materials. Synthesis planning of organic molecules: research of adequate first substrates and reactions for producing chosen molecule and if possible retro-synthetic transformation of the chosen molecule into synthetic precursor. About this subject will be studied various types of "synthones" which in chemical reactions tend to form carbonic skeleton of the chosen molecules. Here are also involved the transformations as well as constructive reactions of carbon-carbon bond in organic synthesis.
LITERATURE : 1. B. M. Smith: *Organic Synthesis: Theory, Reactions and Methods*, McGraw-Hill, (1994)**.** 2. D. Lednicer,: *Strategies for Organic Drug Synthesis and Design*, Willey, New York, (1998). 3. B. M. Smith, J. March: *Advanced Organic Chemistry*, 5th Ed., Willey, New York , (2001). 4. W. Carruthers, Iain Coldham: *Modern methods of organic synthesis,* 4th Ed., New York, (2004). **ADDITIONAL LITERATURE**: Reviews from the field of organic synthesis.

SUBJECT TITLE:	THE STUDY OF REACTION MECHANISMS IN ORGANIC CHEMISTRY
PROFESSOR: dr. sc. Sevdije Govori, associated professor; dr. sc. Osman Leci, professor; dr. sc. Arben Haziri, assistant professor	
ECTS: 8	
Number of lectures 20; (second semester)	
COURSE GOALS: Expansion of knowledge from the field of reaction mechanisms in organic chemistry.	
EXPECTED RESULTS: Capability of candidates to individually resolve problems from the research field.	
EVALUATION: Test and oral exam.	
COURSE SUMMARY: The structure and stability of organic compounds. Polar reactions in acidic and basic environment. Peri-cyclic reactions. Free-radical reactions. Catalytic reactions. Substitution, elimination and rearrangement reactions. Researching the mechanism of reaction based on product study. Detection and character of intermediates in chemical reactions. Organic photochemistry.	
LITERATURE : 1. T. H. Lowry, K. S. Richardson, *Mechanism and Theory in Organic Chemistry*, 3rd ed., Plenum, New York, (1987). 2 R. A. Moss, M. S. Platz, M. Jones, Jr. *Reactive Intermediate Chemistry*, Wiley-Interscience, New York (2004). 3 M. B. Smith, J. A. March, *Advanced Organic Chemistry: Reactions, Mechanism, and Structure*, 6th ed., Wiley, New York (2007). **ADDITIONAL LITERATURE**: Reviews from the field of organic chemistry.	

SUBJECT TITLE: ORGANIC STEREO-CHEMISTRY AND STEREO-SELECTIVE SYNTHESIS
PROFESSOR: dr. sc. Ramiz Hoti, associated professor; dr. sc. Vuksan Kalaj, professor
ECTS: 12
Number of lectures 20; (second semester)
COURSE GOALS: Students will expand their theoretical and practical knowledge from the field of organic stereochemistry and teach the methods of stereo-selective synthesis of organic compounds.
EXPECTED RESULTS: Capability of candidates to individually resolve problems from the research field.
EVALUATION: Continuous evaluation of all of student's activities, seminars and oral interview.
COURSE SUMMAR: Isomers of organic compounds. Stereo-isomers and their structure. Constitution, configuration and conformation of organic compounds. Types of molecular models and their usage. The symmetry of molecules, elements of symmetry, operations and groups of symmetry. Chiro-optical methods (dispersion of optical rotation and circular dichroism). Intra-molecular symmetry (homotopic and heterotopic groups, enantiotopic and diastereotopic groups). Non-symmetrical synthesis. Application of NMR spectroscopy to determine configuration of stereo-isomers (anisotropic effect, lanthanides impact in chemical displacement, NOE effect. Cycloenantiotopy and cyclodiastereotopy. Stereo-isomer systems with biological importance, chirality of supramolecular systems.
LITERATURE: 1. E. L. Eliel, S. H. Wilen, *Stereochemistry of Organic Compounds*, Willey Interscience, New York, (1994). 2. F. A. Carey and R. J. Sundberg, *Advanced Organic Chemistry (part A and part B)* New York, … 2000 (A), (2001) (B). 3. Clayden, Greeves, Warren and Wothers, *Organic Chemistry*, Oxford Univ. press, (2001).

SUBJECT TITLE: THE CHEMISTRY OF NATURAL PRODUCTS
PROFESSOR: dr.sc. Nevzat Aliaga, professor; dr.sc. Muhamet Bicaj, professor
ECTS: 8
Number of lectures 20; (second semester)
COURSE GOALS: Expansion of knowledge from the field of chemistry of natural products, their isolation, characteristics, and application on the research level.
EXPECTED RESULTS: Capability of candidates to individually resolve problems from the research field.
EVALUATION: Test and oral exam.
COURSE SUMMARY: Isolation of natural products, their chemical determination, (carbohydrates, lipids, alkaloids, vitamines, aromatic natural compounds, antibiotics). Finding the most appropriate synthetic way of producing them comparing to the methods of isolation. Their identification, characteristics, structure, biological properties and their usage.
LITERATURE : 1. Paul.M. Dewick., *Medicinal Natural Products: A Biosynthetic Approach ,* 2nd ed. John Wiley&Sons, New York, (2001). Stephen P. Stanforth., *Natural product chemistry at a glance*, 1st ed. Blackwell Publishing Ltd, Oxford, (2006). 2. Raphael Ikan.,*Selected Topics in the Chemistry of Natural Products*, World Scientific Publishing Co Pte Ltd, Singapore, (2007). 3. Stephen P. Stanforth., *Natural product chemistry at a glance*, 1st ed. Blackwell Publishing Ltd, Oxford, (2006). 4. Raphael Ikan.,*Selected Topics in the Chemistry of Natural Products*, World Scientific Publishing Co Pte Ltd, Singapore, (2007).

SUBJECT TITLE: ENERGY AND ENVIRONMENT
PROFESSOR: dr.sc.Majlinda Daci, assistant professor; Academic prof.dr. Nexhat Daci, professor
ECTS: 12
Number of lectures 20; (second semester)
QËLLIMI I KURSIT: Introducing the young professionals with Kosovo's main natural resource, that is coal. Since the future of energy in Kosovo is based on the usage of coal as a fuel, they will use their knowledge to manage the exploiting and the usage of this fossil fuel.
EXPECTED RESULTS: Capability of candidates to individually resolve problems from the research field.
EVALUATION: Test and oral exam.
COURSE SUMMARY: Resources of energy**,** needs of energy, explorative trends, supply strategies, primary production of energy, secondary energy, synthetic fuels and electricity, the science of inorganic matter in coal: the origin, characteristics, our researches in Kosovo's coal; the science of organic matter in coal: coal as an organic chemical substance, the structure of coal, the analysis of functional groups, the extraction of coal, balance between energy and environment, energy impact in environmental pollution, water pollution with organic and inorganic polluters, energy and earth's pollution, energy and air's pollution.
LITERATURE : 1. W. P. Cunningham, M. A. Cunningham, *Principles of Environmental Science*, McGraw Hill, New York, (2006). 2. E. Enger, B. Smith, *Environmental Science*, McGraw Hill, 8th edition, New York (2002). 1. H. Mandel: *World Energy: looking ahead to2020*, IPC Science and Technology Press, London. 3. M. L. Gorbaty, *Coal Science*, Academic Press, New York, (1983). 4. H. V. Gelboin, *Polycyclic Hydrocarbons and Cancer*, Academic Press, New York, (1998). 5. D.W. Van Krevelen, *Coal typology, chemistry, physics and constitution*, 3rd ed, Elsevier Publishing Company, Amsterdam, (1993). 6. C. Karr, Jr., *Analytical Methods for Coal and Coal Products,* Academic Press, New York, (1988).

SUBJECT TITLE: ANALYTICS OF ORGANIC EFFLUENTS OF FOSSIL FUELS IN THE ENVIRONMENT
PROFESSOR: dr.sc.Majlinda Daci, assistant professor; Academic prof.dr. Nexhat Daci, professor
ECTS: 8
Number of lectures 20; (second semester)
COURSE GOALS: Introducing the students to environmental pollution as a result of coal combustion.
EXPECTED RESULTS: Capability of candidates to individually think of problem solving from the field of research.
EVALUATION: Test and oral exam.
COURSE SUMMARY: The quantity of organic substances (capable of energy production) in the coal of Kosovo, organic effluents during the process of coal combustion, phenols, amines and aromatic hydrocarbons (all carcinogenic) as effluents in the environment, competitive reactions in the structure of fossil fuels amongst essential metals and those with carcinogenic impact, functional groups in the organic macromolecule of fossil fuels.
LITERATURE : 1. E. Enger, B. Smith, *Environmental Science*, McGraw Hill, 8th edition, New York (2002). 2. R.P.Schwarzenbach, P.M.Gschwend, D.M.Imboden, *Environmental Organic Chemistry,* Wiley-Interscience; 2nd ed (2002). 3. L. H. Keith, *Energy and Environmental Chemistry: Fossil fuels,* Ann Arbor Science, Virginia, (2009). 4. H. V. Gelboin, *Polycyclic Hydrocarbons and Cancer*, Academic Press, New York, (1998). 5. S.E.Manahan, *Environmental Chemistry*, Taylor and Francis, UK, (2009).

SUBJECT TITLE: ANALYTICS OF INORGANIC EMISSIONS AND EFFLUENTS
PROFESSOR: dr. sc. Selim Jusufi, professor, dr. sc. Bardha Korça, associated professor
ECTS: 8
Number of lectures 20; (second semester)
COURSE GOALS: Expansion of knowledge from the field of inorganic emissions and effluents.
EXPECTED RESULTS: Capability of candidates to individually resolve problems from the research field.
EVALUATION: Test and oral exam.
COURSE SUMMARY: Consistency of the inorganic substance in the coal of Kosovo, analysis of inorganic substances (metals) in the floating ash as emission and in precipitating ash, analysis of heavy metals with carcinogenic properties in the organic substance – macromolecule of matrix.
LITERATURE : 1. D.W. Van Krevelen, *Coal typology, chemistry, physics and constitution*, Elsevier Publishing Company, Amsterdam, (1981). 2. Clarence Karr, Jr., *Analytical Methods for Coal and Coal Products*, Academic Press, New York, (1988). 3. Colin Baird, Michael Cann, *Environmental Chemistry*, W.H.Freeman, 4th edition, (2008). 4. Gary W. vanLoon, Stephen J. Duffy, *Environmental Chemistry, A Global Perspective*, Oxford University Press, USA, (2005).

SUBJECT TITLE: ENVIRONMENTAL ELECTROCHEMISTRY
PROFESSOR: dr. sc. Tahir Arbneshi, professor; dr. sc. Naser Troni, assistant professor
ECTS: 10
Number of lectures 20; (second semester)
COURSE GOALS: Gaining knowledge about the opportunity of applying electrochemistry in the research and protection of the environment.
EXPECTED RESULTS: Capability for individual scientific and research work.
EVALUATION: Test and oral exam.
COURSE SUMMARY: Basics of electrochemical measurements: current, charged particles, potential, transport of charged particles and mass, electrochemical cell, electrode/electrolyte boundary, oxidation, reduction and adsorptive processes. Electrochemical methods and techniques (potentiometer, amperometer, conductometer, polarograph etc.). Electrochemical instruments and tools. (Electroanalytics of inorganic and organic compounds with natural and anthropogenic origin in water, air, sediment and soil – "environment monitoring"). "In-situ" measurements with electrochemical sensors (ion-selective electrode, pH, dissolved oxygen, redox potential etc.). Electrochemical technologies for treating pollutants in wastewaters. Electrochemistry for a clean environment (fixation of CO_2, photo-electrochemistry etc.).
LITERATURE : 1. I. Piljac, Elektroanalitičke, metode, Teorijske osnove, mjerenje naprave i primjena, Udžbenici Sveućilišta u Zagrebu, RMC, 1995. 2. J. Wang: Analytical Electrochemistry, 3rd Edition, John Wiley and Sons, 2006. 3. K. Rajeshwar and J.G. Ibanez: Environmental Electrochemistry, Academic Press, 1997.

SUBJECT TITLE: REAL SAMPLES ANALYSIS
PROFESSOR: dr.sc. Fatbardh Gashi, assistant professor; dr.sc. Naser Troni, assistant professor
ECTS: 8
Number of lectures 20; (second semester)
COURSE GOALS: Expansion of knowledge from the field of analyzing real samples.
EXPECTED RESULTS: Capability of candidates to individually resolve problems from the research field.
EVALUATION: Test and oral exam.
COURSE SUMMARY: The importance of analyzing real samples, raw material and industrial products. Sampling, getting samples in solid, liquid and gaseous state. Analytic procedures for separation. Preparation of samples for analysis (dissolution, extraction, mineralization, supercritical extraction, extraction in solid state etc. Methods for analyzing cement, minerals, alloys. Analysis of water, biomaterials, soil and food. Selection and development of certain methodology for analysis. Referential materials. Interpretation of final results. Determination of fluorides in pharmaceutical preparations (EJS). Determination of iodine and bromine in medicaments and foods (FIA), Determination of metals and metalloids in artificial mineral fertilizers, biomaterials, soil and food (FAAS and ETAAS). Complete analysis of drinkable water (gravimetric and volumetric, UV/VIS spectrophotomery, GC, JC and HPLC). Determination of alkalies in silicate materials and biological samples (FEAS). Determination of sulfides in wastewaters (FIA).
LITERATURE :

1. D. A. Skoog, J. J. Leary: *Principles of Instrumental Analysis*, fourth edition, Saunders College Publishing, New York, (1992).
2. J. Wang: *Analytical Electrochemistry*, VCH, New York, (1994).
3. M. Csuros: *Environmental sampling and analysis for technicians*, Lewis Publishers, USA, (1994).
4. D. Harvey: *Modern Analytical Chemistry*, McGraw-Hill, Boston, (2000).

SUBJECT TITLE:	SENSORS IN ANALYTICAL CHEMISTRY
PROFESSOR:	dr.sc. Tahir Arbneshi, professor; dr.sc. Kurt Kalcher, professor, University of Graz, Austria
ECTS:	**12**
Number of lectures 20; (second semester)	
COURSE GOALS:	Expansion of knowledge about sensors.
EXPECTED RESULTS:	Capability of candidates to individually resolve problems from the research field.
EVALUATION:	Test and oral exam.
COURSE SUMMARY:	Chemical sensors and biosensors – definition, theoretical basics, parts of sensor's system. Elements that transform, electric elements, optical elements, thermic elements, mass elements. Elements of sensitivity: mechanism of chemical and biological study, biokinetic systems, active chemical and biological matters in the systems of sensors, techniques of immobilization of chemical and biological reagents, Role of materials in system of sensors – polymers. Analyzing success rate of sensor: selectivity, sensitivity, precision, reproduction, and reversibility. Chemical and electrochemical sensors: potentiometric, amperometric, ion-selective electrodes, modificated electrodes, microelectrodes, standard electrodes in systems of sensors, conductometric and FET (field effect transitor) sensors. Optical sensors and bisensors. Techniques of optical detection, visible spectroscopy of absorption, fluorescent spectroscopy, methods of reflection, techniques for light dispersion, direct methods, indicating methods, optic sensors based on optic basis. Mass and thermic sensors: Piezoelectric effect, superficial acoustic waves. Usage of chemical sensors: industrial processes, environmental protection, medicine. Production and construction of sensors, materials and modern technology: sensors with high level of integration, microfluidics, micro-electromechanical systems (MEMS and BioMEMS, Micro-Total-Analytical-Systems (μTAS), Lab-on-a-chip systems, Nanosensors and Biochips).
LITERATURE :	1. B. R. Eggins, *Chemical Sensors and Biosensors*, John Wiley & Sons Ltd., New York, (2002). 2. P. A. Oeberg, T. Togawa, J. Hesse, J. W. Gardner, W. Goepel (Eds), *Sensors Applications*, John Wiley and Sons Ltd., New York, (2002). 3. O. S. Wolfbeis (Editor), *Fiber Optic Chemical Sensors and Biosensors,* CRC Press, Boca Raton, (1991), vols. 1 & 2. 4. N. Hall (Editor), The New Chemistry, Cambridge University Press, Cambridge, (2000).

SUBJECT TITLE: ATOMIC SPECTROMETRY IN ANALYTICAL CHEMISTRY
PROFESSOR: dr.sc.Hysen Reçi, associated professor; dr.sc.Fatmir Faiku, assistant professor
ECTS: **10**
Number of lectures 20; (second semester)
COURSE GOALS: Expansion of knowledge for theoretical spectrometric methods and modern experimental access of basic analysis; expansion of knowledge of basics of analytical methodology in specific samples from the environment.
EXPECTED RESULTS: Develop the competency and required knowledge for research and professional work.
EVALUATION: Test and oral exam.
COURSE SUMMARY: Analysis of elements with spectrometric atomic methods, historical development, current state, application for some elements. *Preparing the sample*: collecting and preparing the sample, mineralization, separation and concentration of elements prior to analysis, sources of contamination. Theory of atomic spectrometry; atomic absorption, emission and fluorescence. Atomic absorption spectrometry (AAS); basic properties of instruments (types, automatism, sources of radiation), calibration, atomism in flames, electro-thermic atomism, specific techniques (technique of generating cold vapors, hydride technique). Atomic spectrometry of emission (ASE); flame, plasma, sources of excitation; construction of spectrometer, detection of emission signal. Advanced instrumental techniques of liquid and gaseous chromatography, capillary electrophoresis. Comparison of methods and their efficiency in determination of the quality of products, essential and toxic substances, additives etc.
LITERATURE : 1. L.H.J. Lajunen, Spectrochemical Analysis by Atomic Absorption and Emission, Royal Society of Chemistry, Cambridge 1992. 2. D.A. Skoog, F.J. Holler, T.A. Neiman: principles of Instrumental Analysis, 5rd Edition, Harcourt Brace College Publishers, Philadelphia 1998. 3. J. Noelte: ICP Emission Spectrometry – A Practical Guide, Wiley-VCH, Weinheim, 2003. 4. M. Kastelan-Macan: Kemijska analiza u sustavu kvalitete, Skolska knjiga Zagreb, 2003.

SUBJECT TITLE: CHEMOMETRICS
PROFESSOR: dr.sc. Fatbardh Gashi, assistant professor
ECTS: 8
Number of lectures 20; (second semester)
COURSE GOALS: Advancement of knowledge from the field of chemometrics.
EXPECTED RESULTS: Capability of candidates to individually resolve problems from the research field.
EVALUATION: Test and oral exam.
COURSE SUMMARY: Introduction to chemometrics. Descriptive statistics, statistical testing, optimization and experimental design. Two and three-dimensional design. Analysis of main components, modeling. Validity and quality control. Linear programming.
LITERATURE : 1. D. L. Massart, B. G. M. Vandeginste, L. M. C. Buydens, S. de Jong, P. J. Lewi, J. Smeyers-Verbeke: *Handbook of Chemometrics and Qualimetrics, Part A*, Elsevier, Amsterdam (1997). 2. James N. Miller, Jane C. Miller, *Statistics and Chemometrics for Analytical Chemistry*, Pearson Education, Harlow, (2000). 3. Richard G. Brereton, *Chemometrics: Data Analysis for the Laboratory and Chemical* Plant, Wiley, (2003). 4. Dr. Alqi Çullaj. *Sigurimi Dhe Kontrolli i Cilësisë Në Analizat Kimike*. Universiteti i Tiranës, Tiranë, (2002). **ADDITIONAL LITERATURE**: Reviews from the field of chemometrics.