CHEMISTRY AND ECOLOGY

Educational and Qualification Degree Master

Professional Qualification Environmental Chemist

Duration of Study 4 semesters

The Master's program *"Chemistry and Ecology"* and its associated academic disciplines are designed to provide students with in-depth knowledge of the fundamental laws and phenomena occurring in nature, as well as the impact of modern lifestyles and the activities involved in environmental management and protection. The program examines the interactions and interdependencies between organisms and their surrounding environment, with the goal of understanding how nature functions and developing appropriate measures to combat the consequences of pollution and climate change resulting from human activity.

The curriculum places special emphasis on chemical sources of pollution, their environmental partitioning, degradation, accumulation, and their effects on living organisms. The development and application of modern analytical methods for measuring chemical pollutants represent a vital component of environmental chemistry. Environmental toxicology, in itself, is a multidisciplinary field that encompasses various aspects of biology, ecology, and risk assessment.

Particular attention is given to modern alternative energy sources and their practical applications, as a key factor in reducing harmful atmospheric emissions. Additional knowledge is offered through elective courses focused on the principles of green chemistry, eco-toxicochemistry, emission control, the protection and conservation of biological systems, and the application of mathematical models for the statistical processing of experimental data.

Graduates of the Master's program will acquire solid theoretical preparation in the natural sciences, environmental regulations, and normative requirements necessary for conducting activities related to environmental protection.

Students will be trained to evaluate ecosystem quality, implement environmental control and management, understand methods for mitigating harmful environmental impacts, and predict adverse changes within ecosystems.

Graduates of the program will attain comprehensive knowledge and information concerning the chemistry of natural phenomena and processes in the environment, as well as the means of influencing them. This foundation will enable them to pursue successful careers as specialists in environmental laboratories of the Regional Inspectorates for Environment and Water (RIEW), Regional Health Inspections (RHI), chemical industry enterprises, and as educators. They may also be employed in municipal and corporate administration structures responsible for environmental monitoring, control, and protection.

The program also prepares professionals capable of addressing environmental challenges in the fields of chemical technology and biotechnological production, as well as in the development and utilization of new energy sources. Graduates will be able to carry out a variety of tasks related to environmental protection at the national, regional, and local levels, including the development of programs, projects, and strategic plans. They will be qualified to conduct analyses and assessments of the state of environmental components, monitor the operation of pollution sources and treatment facilities, and prepare environmental impact assessments and expert evaluations in the context of environmental management activities.

This Master's program is intended for individuals who have completed a Bachelor's or Master's degree in the professional fields of Chemical Sciences or Earth Sciences (specialization in Environmental Protection and Sustainable Development), as well as related disciplines in other academic fields where chemistry or ecology constitutes a significant part of the curriculum. Given the interdisciplinary nature of the program, it is also open to graduates of natural sciences, earth sciences, and engineering disciplines—particularly those in the field of chemical technologies—where at least 70% of the core coursework overlaps with that of the Chemistry and Environmental Protection specialization (e.g., graduates of the Agricultural

University, the University of Food Technologies, and the University of Chemical Technology and Metallurgy).

The duration of study is four semesters. Students complete 18 courses, including 14 compulsory and 4 elective subjects. The program concludes with the development of a Master's thesis or a state final examination.

CURRICULUM FOR THE MASTER'S DEGREE IN CHEMISTRY AND ECOLOGY

First Year			
First Semester	ECTS credits	**Second Semester**	ECTS credits
1. General and Inorganic Chemistry 2. Organic Chemistry 3. Analytical Chemistry and Metrology 4. Elective Course – Group I	8 10 8 4	1. Instrumental Analysis 2. Physicochemical Analysis 3. Chemical Technologies 4. Elective Course – Group II	10 8 8 4
	Total 30		Total
Second Year			
Third Semester	ECTS credits	**Fourth Semester**	ECTS credits
1. Chemistry and Environment 2. General Ecology 3. Instrumental Methods and Tools for Environmental Monitoring 4. Waste Management 5. Preservation of Biological Resources 6. Elective Course – Group III	7 6 4 4 5 4	1. Renewable Energy Sources 2. Ecotoxicochemistry 3. Methods for water status analysis and assessment 4. Elective Course – Group IV 5. Master's Thesis (Graduation)	4 4 3 4 15
	Total 30		**Total 30**
Elective Courses – Group I 1. Analysis of Organic Compounds 2. Electrochemistry 3. High-Molecular Natural Compounds 4. Solid State Chemistry 5. Mathematical Models in Chemistry and Biology		**Elective Courses – Group II** 1. Advanced Chromatographic Methods 2. General Microbiology 3. Molecular Spectroscopy 4. Methods for Analysis and Control 5. Methods for Processing Experimental Data 6. Metrology and quality control	
Elective Courses – Group III 1. Green Chemistry 2. Photovoltaic Systems as a Source of Eco-Energy 3. Ecometry 4. Fundamentals of Industrial Ecology and Emission Control 5. Advanced Electrochemical Systems for Eco-Energy Generation and Storage 6. Novel Food Additives		**Elective Courses – Group IV** 1. Application of geographic information systems in environmental chemistry 2. Conservation-Based Nature Protection 3. Biological Monitoring 4. Hazardous chemical substances and mixtures 5. Agroecology 6. Chemistry of the Atmosphere and Natural Waters	
	Total 30		

COURSE ANNOTATIONS
GENERAL AND INORGANIC CHEMISTRY

ECTS Credits: 8
Weekly Workload: 2l+2lab
Assessment method: Exam
Exam type: Written
Semester: First Semester
Methodology Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturers: Assoc. Prof. Elitsa Chorbadzhiyska, PhD
elli_e1@swu.bg

Course status: Compulsory

Course Description:

The training in this academic discipline covers the study of fundamental topics in general chemistry, including: electronic structure, atomic nucleus, periodic law and the periodic table of elements, molecular structure, structure of coordination compounds, intermolecular interactions, chemical bonding in solids, valency of chemical elements, basic concepts in thermodynamics, chemical kinetics, chemical equilibrium, adsorption, catalysis, phase rule, physicochemical analysis, solubility of substances, theory of dilute solutions, electrolyte solutions, colloidal systems, electrochemical processes, and metal corrosion.

The laboratory exercises complement the lecture content through practical chemical experimentation.

Course Objectives:

The objectives of the General and Inorganic Chemistry I course are as follows:

1. To acquire chemical knowledge in general chemistry, based on an understanding of the structure of matter and the laws and regularities of nature.
2. To develop skills and proficiency in performing chemical experiments in a specialized inorganic chemistry laboratory.
3. To cultivate chemical thinking and the ability to work independently with scientific chemical literature.

Teaching Methods: Lectures and laboratory exercises.

Assessment: Written examination.

Enrollment in the course: Not required.

Exam registration: In coordination with the lecturer and the academic office.

Students who complete the Master's Degree Program and acquire the knowledge and skills provided by this course will be qualified to work as chemists in research and/or applied laboratories, as well as in organizations involved in environmental monitoring and protection.

The final grade (FG) is awarded only if the student has received a minimum pass grade (3.00) from continuous assessment.

ORGANIC CHEMISTRY

ECTS credits: 10
Weekly workload: 3l+2lab
Assessment method: Exam
Exam type: Written
Semester: 1st semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assoc. Prof. Maya Chochkova, PhD
mayabg2002@yahoo.com

Course status: Compulsory

Course description (Annotation):

The course covers general theoretical topics such as modern concepts of the nature of chemical bonds in organic molecules, methods for determining the composition, structure, and reactivity of organic molecules, clarification of the main types of organic reactions and their mechanisms, issues of stereochemistry of organic compounds; study of major groups of organic compounds: alkanes, alkenes, alkynes, alkadienes, alicyclic compounds, aromatic hydrocarbons, halogen derivatives of hydrocarbons, hydroxyl derivatives of hydrocarbons. The course also addresses the properties of carbonyl and carboxylic compounds, nitrogen-containing compounds, heterocyclic compounds, and important biologically active compounds such as carbohydrates, amino carboxylic acids, peptides, and lipids.

Course objective:

The aim of the course is to provide students with fundamental knowledge about the composition, structure, properties, and methods of synthesis of the most important classes of organic compounds. Practical and seminar sessions aim to support students in understanding and assimilating the lecture material, to develop habits for creative application of knowledge, and to build skills for experimental work in the field of organic chemistry.

Teaching methods: Lectures, laboratory exercises, seminars; problem solving; tests; out-of-class assignments.

Prerequisites: Basic knowledge in inorganic chemistry and physics is required.

Assessment method: Written exam

Enrollment in the course: Not required

Exam registration: In coordination with the lecturer and academic office

Students who have acquired the "Master" educational qualification degree will be able to apply the knowledge and skills gained in this course as chemists in research and/or applied laboratories and organizations involved in environmental monitoring and protection.

Final grade (FG) is calculated **only if** the student has received at least a "Satisfactory" (3.00) in **ongoing assessment**.

ANALYTICAL CHEMISTRY AND METROLOGY

Semester: I	Weekly workload: 2 l + 2 lab
Form of assessment: Examination	Type of exam: Written
ECTS credits: 8	
Methodological guidance:	Department: "Chemistry"
Faculty:	Faculty of Mathematics and Natural Sciences
Lecturer:	Assoc. Prof. Petko Mandzhukov, PhD pmanjukov@abv.bg
Course status:	Compulsory

Course Description:

Fundamental principles of classical quantitative analysis. Gravimetric analysis. Volumetric analysis: acid-base titrations (protonometry), complexometry, redox titrations (redoximetry), and precipitation titrations. Titration curves. Selection of an appropriate method to solve a specific analytical problem, selection of indicators and conditions for conducting the analysis. Evaluation of systematic and random errors caused by various factors,

and the accuracy of the overall analytical procedure. Basic instrumental methods of analysis – potentiometry and spectrophotometry. Detection of the equivalence point using instrumental methods.

Course Objective:

The course aims to familiarize students with the wide range of tools and methods in analytical chemistry, applicable depending on the goals of the analysis, the characteristics of the object being analyzed, and the capabilities of the analytical laboratory. It also addresses the role of classical analytical methods in modern analytical chemistry. Topics include the selection of representative samples from different material types, sample preparation, the rationale for choosing a specific analytical method, and the methods for processing and evaluating the results with regard to their main metrological characteristics.

Teaching Methods: Lectures, laboratory exercises, and independent work.

Prerequisites: General requirements of the Master's program "Metrology in Chemistry for Non-Specialists."

Exam Registration: Coordinated with the lecturer and the academic office.

Career Prospects: Students who obtain a Master's degree and apply the knowledge and skills acquired in this course will be able to work as chemists in research and/or applied laboratories and organizations involved in environmental monitoring and protection.

Final Grade (FG): The final grade is awarded only if the student has achieved at least a "Satisfactory" (3.00) in the ongoing assessment.

INSTRUMENTAL ANALYSIS

ECTS credits: 10
Weekly workload: 2l+ 2lab
Assessment method: Exam
Exam type: Written
Semester: 2nd semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assoc. Prof. Petko Mandjukov, PhD
pmanjukov@abv.bg

Course status: Compulsory

Course description:

The course focuses on the fundamental stages of analysis using instrumental methods. It covers absolute and relative methods, calibration, and basic metrological characteristics of instrumental techniques. Principles of atomic spectroscopic, electrochemical, and radiochemical methods of analysis are also included.

Course Objectives:

The goal of the course is to acquaint students with the basic principles of the most commonly used instrumental methods for analyzing the elemental composition of various substances. The course discusses the physical basis, advantages, and limitations of the analytical techniques. The aim is for students to gain the necessary knowledge to choose an appropriate analytical method for a given task. Special emphasis is placed on trace element analysis.

Teaching methods: Lectures, lab exercises, and extracurricular assignments

Prerequisites: Basic knowledge in general chemistry, physical chemistry, physics, and mathematics. Completion of the course "Analytical Chemistry – Part I" is required.

Exam registration: Coordinated with the lecturer and the academic office

Graduates holding a Master's degree will be able to apply the knowledge and skills acquired from this course in scientific research and/or applied laboratories and organizations involved in environmental monitoring and protection.

Final grade (FG) is calculated **only if** the student has received at least a "Satisfactory" (3.00) in **ongoing assessment**.

PHYSICOCHEMICAL ANALYSIS

ECTS credits: 8
Weekly workload: 2l+1lab
Assessment method: Exam
Exam type: Written
Semester: 2nd semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assoc. Prof. Petranka Petrova , PhD
ppd@swu.bg

Course status: Compulsory

Course Description:

The course "Physicochemical Analysis" includes both lectures and laboratory exercises. The lectures cover the fundamentals of thermodynamic equilibria in one-component, two-component, and three-component systems. Topics include thermodynamic and chemical potentials in equilibrium systems, applications of the phase rule, triple points, polymorphism and allotropy, concentration representations, and phase diagrams of binary and ternary systems. Special attention is given to ternary systems involving aqueous-organic solvent mixtures.

Laboratory work complements the lectures through chemical experiments, including:

- Construction of evaporation and distillation curves
- Study of solubility methods
- Experimental construction of the $CaCl_2$ –H_2 O solubility diagram
- Solubility diagrams for ternary systems (inorganic salt–water–organic solvent)

Goals, Tasks, and Expected Results:

Course goals:

1. Acquire knowledge for constructing and analyzing phase diagrams of one-, two-, and three-component systems.
2. Understand the principles of dissolution, evaporation, and distillation in systems and their practical application.
3. Develop chemical thinking and independent work with phase diagrams for the production of chemical substances.

The course aims to provide broad-based chemical training for bachelor students in Chemistry, and specialized knowledge within the master's curriculum.

Expected results:

Students will develop specialized skills in the field of metrology in chemistry, particularly in reading and constructing phase diagrams of one-, two-, and three-component systems.

Teaching methods: Lectures, lab work, and extracurricular assignments
Prerequisites: Basic knowledge in general chemistry, physical chemistry, physics, and mathematics. Completion of "Analytical Chemistry – Part I" is required.
Exam registration: Coordinated with the lecturer and the academic office
Students who obtain a Master's degree and apply the knowledge gained from this course will be qualified to work as chemists in research and/or applied laboratories and institutions related to environmental monitoring and protection.
Final grade (FG) is awarded **only if** the student has received a minimum average grade of **Satisfactory (3.00)** from the ongoing assessment.

CHEMICAL TECHNOLOGIES

ECTS credits: 8
Weekly workload: 2l+1lab
Assessment method: exam
Exam type: written
Semester: II semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Prof. Boris Shivachev, PhD
blshivachev@swu.bg

Course status: Compulsory

Course Description:

The course covers the processes and equipment that underpin chemical technologies. Students become familiar with the fundamental principles of hydrodynamic, heat transfer, and diffusion processes, as well as the design of the equipment in which these processes occur. The course also explores the principles of constructing chemical plants in accordance with modern industrial requirements. The application of these principles is illustrated with examples of both inorganic and organic technologies that are well developed in the country and form the foundation of the chemical industry.

Course Objectives:

To familiarize students with the theoretical foundations of the most widely used processes in chemical technologies and their application in selecting and determining the characteristics of the equipment needed for these processes. The course also aims to demonstrate the integration of knowledge from various scientific fields (chemistry, ecology, materials science, etc.) in the development of chemical technologies and to introduce students to the most important chemical productions.
Teaching Methods: lectures, practical exercises, and extracurricular work
Prerequisites: Basic knowledge in general chemistry, physical chemistry, physics, and mathematics
Exam registration: arranged with the lecturer and the academic office

Students who obtain a Master's degree and apply the knowledge and skills gained in this course will be able to work as chemists in research and/or applied laboratories and organizations related to environmental monitoring and protection.
The final grade (FG) is awarded only if the student has achieved at least a "Satisfactory" (3.00) from the ongoing assessment.

CHEMISTRY AND ENVIRONMENT

ECTS credits: 7
Weekly workload: 3l+1lab
Assessment method: exam
Exam type: written
Semester: III semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assist. Prof. Kiril Chuchkov, PhD
kchuchkov@swu.bg

Course status: Compulsory

Course Description:

The main objective of the course *Chemistry and Environment* is to introduce students to the fundamental concepts and patterns related to the chemistry of phenomena and processes occurring in nature and the surrounding technological world, which have direct implications for environmental protection and conservation. The course emphasizes the chemical composition and structure of major pollutants in the biosphere, hydrosphere, and soil. Important chemical processes and their impact on the environment are discussed. Selected technological aspects and methods for environmental protection and prevention are briefly addressed. Trends in the development of modern energy sources are also outlined.

Laboratory exercises familiarize students with selected chemical processes occurring in nature that have a direct or indirect impact on environmental preservation.

Lectures are supported by illustrative examples focused on the analysis of real-world samples, presented using multimedia and PC systems.

Course Objectives and Tasks:

1. To familiarize students with the specifics of key environmental processes and phenomena related to pollution.
2. To provide knowledge about the main pollution factors and their environmental consequences.
3. To develop creative thinking and the ability to independently analyze phenomena and processes, as well as to select appropriate approaches and methods for their resolution.

Teaching methods: lectures, project work, and extracurricular activities

Prerequisites: Basic knowledge in general chemistry, organic chemistry, and analytical chemistry

Exam registration: arranged with the lecturer and the academic office

Students who obtain a Master's degree and apply the knowledge and skills acquired in this course will be able to work as chemists in research and/or applied laboratories and organizations engaged in environmental monitoring and protection.

The final grade (FG) is awarded only if the student has achieved at least a "Satisfactory" (3.00) in the ongoing assessment.

GENERAL ECOLOGY

ECTS credits: 6
Weekly workload: 2l+1sem
Assessment method: exam
Exam type: written
Semester: III semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assoc. Prof Lidia Sekelarieva, PhD
sakelarieva.lidia@abv.bg

Course status: Compulsory

Course Description:

The course *General Ecology* focuses on the core concepts of ecology as an interdisciplinary science that integrates biology, physical sciences, and social sciences, closely related to environmental protection. The course aims to familiarize students with the subject, objectives, and research methods in ecology; with the main ecological factors – abiotic, biotic, and anthropogenic; with the concept of the limiting effect of environmental factors and organismal adaptations to them; with the composition, structure, development, and productivity of biological macro-systems such as populations, biocenoses, and ecosystems; with the cycles of matter and energy flow in these systems; and with the nature and organization of the biosphere.

Course Objectives and Tasks:

1. Acquisition of theoretical knowledge about the structure and functioning of living macro-systems;
2. Development of skills for research, analysis, and evaluation of populations, communities, and ecosystems;
3. Enhancement of creative thinking and the ability to independently select approaches and methods for problem-solving.

Teaching methods: lectures, seminars, and self-directed study

Prerequisites: Basic knowledge in botany, zoology, microbiology, soil science, general chemistry, organic chemistry, biochemistry, and general physics

The knowledge and skills acquired through *General Ecology* provide a solid foundation for understanding and successfully studying all core and applied ecological disciplines.

The final grade (FG) is awarded only if the student has achieved at least a "Satisfactory" (3.00) in the ongoing assessment.

INSTRUMENTAL METHODS AND TOOLS FOR ENVIRONMENTAL MONITORING

ECTS credits: 4
Weekly workload: 2l+1lab
Assessment method: exam
Exam type: written
Semester: III semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assoc. Prof. Petko Mandzhukov, PhD
pmanjukov@abv.bg

Course status: Compulsory

Course Description:

The course *Instrumental Methods and Tools for Environmental Monitoring* includes lectures and laboratory exercises. The curriculum covers the main stages of analysis using instrumental methods. Topics include absolute and relative methods, calibration, and key metrological characteristics of instrumental analysis. It outlines the principles of the most commonly used atomic, spectroscopic, electrochemical, and chromatographic techniques. The course discusses the physical principles, practical applications, advantages, and limitations of these instrumental analytical methods. Special emphasis is placed on sampling procedures for environmental objects.

Laboratory exercises introduce students to some of the most commonly used methods and tools for field measurements and laboratory monitoring, as well as methods for calibration, data processing, and presentation of analytical results.

Course Objectives and Tasks:

1. Familiarize students with the capabilities of modern instrumental methods in analytical chemistry, frequently applied in environmental analysis.
2. Develop practical knowledge and skills for conducting field research and operating specialized analytical equipment.
3. Foster creative thinking and the ability to independently select suitable methods for solving specific analytical problems and evaluating the results.

The final grade (FG) is awarded only if the student has achieved at least a "Satisfactory" (3.00) in the ongoing assessment.

WASTE MANAGEMENT

ECTS Credits: 4
Weekly workload: 2l+1sem
Assessment method: Exam
Exam type: Written
Semester: III (Third semester)
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assist. Prof. Veselina Dalgatcheva, PhD
dalgacheva@swu.bg

Course status: Compulsory

Course Description:

The course "Waste Management" is part of the Master's program "Chemistry and Ecology" and aims to train professionals to conduct pedagogical and regulatory activities, participate in the development of plans, programs, expert evaluations, and reports related to Environmental Impact Assessments (EIA) in the field of waste management within the Department of Chemistry at Southwest University "Neofit Rilski."

The curriculum emphasizes sustainable development, incorporating environmentally friendly technologies focused on waste minimization, valorization, reuse, and final disposal. The course covers the European Union Directives, Regulations, and Decisions, as well as the harmonized Bulgarian legislation related to waste management.

Objectives and tasks:

The main objectives of the "Waste Management" course are:

1. To familiarize students with EU legislation and Bulgarian regulatory framework concerning the management of municipal, hazardous, construction, and certain industrial wastes.
2. To teach methods for waste characterization.
3. To present technological solutions for the valorization and disposal of municipal, construction, and hazardous medical wastes.
4. To address commonly generated waste types and their treatment methods.
5. To develop creative thinking and the ability to independently select approaches and methods to solve problems related to environmentally sound waste management.

Graduates holding a Master's degree who have acquired knowledge and skills in this course will be qualified to work as chemist-ecologists in research and/or applied laboratories, chemical industries, scientific units, and creative teams involved in developing plans, programs, and strategies for waste management.

The final grade (FG) is awarded only if the student achieves at least a satisfactory grade of 3.00 in the ongoing assessments.

PRESERVATION OF BIOLOGICAL RESOURCES

ECTS Credits: 5 **Weekly workload:** 2l+1sem
Assessment method: Exam **Exam type:** Written
Semester: III (Third Semester) **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Assist. prof. Al. Pulev, PhD
spu@abv.bg

Course status: Compulsory

Course Description:

The academic course *Conservation of Biological Resources* provides essential knowledge regarding the nature of biological resources, their potential for biomass production, their role in meeting the population's demand for biological products, and the means and methods for their conservation. The course introduces the ecological foundations of bioproductivity, terrestrial biological resources (forests, meadows and pastures, medicinal plants, aromatic, vitamin-rich, ornamental and melliferous plants, fungi, and terrestrial animals), and aquatic biological resources (mountain lakes, reservoirs, the Danube and its wetlands, inland rivers, the Black Sea, and coastal lakes and marshes).

The course examines modern approaches and methods for the conservation of various biological resources, both individually and as integrated systems. It applies relevant principles and knowledge from fundamental biological disciplines such as biology and ecology, as well as from resource management fields such as forestry, hunting, and fisheries.

The course is part of the curriculum in the Master's program **"Chemistry and Ecology"** and is taught over one semester. It is structured in three parts:

- The first part covers the ecological basis of bioproductivity, along with the goals and objectives of biological resource conservation.
- The second part focuses on terrestrial biological resources and issues related to their preservation.
- The third part addresses aquatic biological resources and methods for their conservation.

This knowledge will enable students to adopt an integrated approach in protecting biological resources and to develop the necessary competencies to make sound and contemporary management decisions.

The course is closely related to subjects such as *General Ecology*, *Renewable Energy Sources*, *Instrumental Methods and Tools for Environmental Monitoring*, *Environmental Norms and Standards*, *Conservation Biology*, *Biological Monitoring*, and others included in the curriculum.

Objectives and tasks

The primary objectives of the course are to:

1. Acquire theoretical knowledge about the structure and functioning of biological resources to meet the population's needs for biological products, and methods for their protection.
2. Develop skills in the investigation, analysis, and evaluation of biomass production potential.
3. Foster creative thinking and the ability to independently choose approaches and methods for addressing specific problems.

To successfully master the course material, students are expected to have foundational knowledge in botany, zoology, microbiology, soil science, general chemistry, organic chemistry, biochemistry, and general physics. The **Final Grade (FG)** is awarded only if the student achieves a minimum **Current Assessment (CA)** grade of at least **Satisfactory (3.00)**.

RENEWABLE ENERGY SOURCES

ECTS Credits: 4 **Weekly workload:** 2l+1lab
Assessment method: Exam **Exam type:** Written
Semester: IV (Fourth Semester) **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturers:** Assoc. Prof. Elitsa Chorbadzhiyska, PhD
elli_e1@swu.bg

Course status: Compulsory

Course Description:

The course *"Renewable Energy Sources"* aims to familiarize students with the chemical and environmental challenges related to energy production from renewable sources.The lecture content covers the following topics:

(i) Energy generation from renewable energy sources (RES): fundamentals of energy sources and principles of producing clean energy from solar, wind, hydro, biomass, geothermal, marine waves and currents, and hydrogen.

(ii) Chemical processes for the production and storage of green energy from RES.

(iii) Life cycle analysis of materials used in renewable energy systems.

(iv) Environmental aspects of "green energy" from RES—CO_2 emissions and green certificates.

(v) Sustainable development through the utilization of energy and materials from renewable sources.

The practical sessions reinforce the lecture material by engaging students in hands-on activities, such as generating eco-electricity from photovoltaic systems and producing liquid renewable fuel (bioethanol) from biomass. Students will gain practical insight into:

- Chemical processes involved in producing materials for solar cells,
- The chemistry of fermentation processes in biomass to obtain bioethanol,
- Real-world application of biofuels (bioethanol, biogasoline, biodiesel, and biogas),
- Usage of specialized software tools for calculating RES potential at specific locations, estimating CO_2 emissions, and developing models for achieving sustainable development using RES.

Lectures incorporate both chemical and environmental perspectives on RES, using contemporary textbooks, scientific literature, and reputable online sources. Instruction is supported by multimedia tools (PowerPoint, videos), and an electronic platform with a virtual library, as well as materials for students' independent study and online interaction with the lecturer.

To successfully engage with the course content, students are expected to have fundamental knowledge in general and inorganic chemistry, organic chemistry, analytical chemistry, instrumental methods of analysis, physics, and informatics.

Objectives and tasks

The main objectives of the course *"Renewable Energy Sources"* are:

1. To acquire theoretical and practical knowledge of the chemical processes involved in energy generation from RES and their environmental assessment.
2. To familiarize students with the fundamentals of renewable energy systems for green energy production.
3. To develop an analytical approach for applying acquired knowledge to promote sustainable development through increasing the share of eco-energy in the energy mix.

Graduates with a Master's degree will be able to apply the knowledge and skills acquired in this course to pursue careers as environmental chemists in various contemporary fields dealing with chemical and environmental issues.

The **Final Grade (FG)** is determined only if the student has received a minimum **Current Assessment (CA)** grade of **Satisfactory (3.00)**.

ECOTOXICOCHEMISTRY

ECTS Credits: 4 **Weekly workload:** 2l+1lab
Assessment method: Exam **Type of exam:** Written
Semester: IV (Fourth Semester) **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Assoc. Prof. Petranka Petrova, PhD
ppd@swu.bg

Course status: Compulsory

Course Description:

With the advancement of human technological capabilities, the impact on the natural environment has acquired a global scale. The alarming level of pollution with various chemical substances leads to climate change and alters the living conditions of many biological species, including humans. A significant proportion of environmental pollutants are organic compounds. Many of them are foreign to the human body and are referred to as xenobiotics. These include natural and synthetic pharmaceuticals, pesticides, herbicides, industrial and household toxins, food additives, cosmetics, and others.

Course Objectives and Tasks:

The aim of this course is to introduce students to the fundamental principles of the toxicology of xenobiotics, the mechanisms of their toxic and carcinogenic action, and the free-radical processes they induce. Students will study cellular antioxidant defense mechanisms, hepatotoxic metabolites, and liver damage caused by xenobiotics. The course also covers the most common cases of acute poisoning from medications, industrial and household chemicals, and agricultural substances, along with the application of appropriate antidotes. Students will gain an understanding of the regulation, control, and integration of biotransformation and detoxification processes in the body. This course builds upon prior knowledge acquired in disciplines such as inorganic and organic chemistry, biochemistry, physical chemistry, and others. It prepares students for modern methods in the pharmaceutical and chemical industries, as well as for technologies aimed at environmental protection.

The Final Grade (FG) is determined only if the student has received a minimum passing grade (Satisfactory 3.00) from the current assessment.

METHODS FOR WATER STATUS ANALYSIS AND ASSESSMENT

ECTS Credits: 3 **Weekly workload:** 2l+1lab
Assessment method: Exam **Exam type:** Written
Semester: IV **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Prof. Emilia Varadinova, PhD
emilia.varadinova@swu.bg

Course status: Compulsory

Annotation:

The course **"Methods for Analysis and Assessment of Water Status"** introduces students to the fundamental principles, approaches, and modern methods for studying and evaluating the quantitative and qualitative characteristics of water. The curriculum covers physico-chemical, biological, and hydrological methods for analyzing water bodies—both surface and groundwater. Special attention is given to the regulatory framework, environmental standards, and practical applications of assessments in the context of environmental protection and the sustainable management of water resources. The course includes theoretical lectures, laboratory exercises, and working with real data.

Course Objectives:

- To provide students with theoretical knowledge about the different types of water pollution and the parameters used in water assessment.
- To introduce students to modern methods and technologies for water analysis and monitoring.
- To develop practical skills in applying methods for assessing the ecological status of water bodies.
- To cultivate critical thinking and the ability to interpret results within the framework of environmental norms and requirements.

Course Tasks:

- Study of key water quality indicators – physical, chemical, and biological.
- Mastery of analytical methods – spectrophotometry, titrimetry, chromatography, etc.
- Application of methods for biological assessment (bioindicators, macrozoobenthos, etc.).
- Working with regulatory documents and requirements (such as the EU Water Framework Directive).
- Conducting laboratory exercises and interpreting the results.
- Assessing the condition of real water bodies and preparing reports.

Final Grade (FG):

The final grade is awarded only if the student has received at least a “Satisfactory” (3.00) in the ongoing assessment (OA).

ANALYSIS OF ORGANIC COMPOUNDS

ECTS Credits: 4 **Weekly workload:** 2l+1lab
Assessment method: Exam **Exam type:** Written
Semester: I (First Semester) **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Prof. Ivanka Stoyneva, PhD
istoineva@yahoo.com
Course status: Elective

Course Description:

The syllabus of the course includes lectures and laboratory exercises that cover the main methods for characterizing and identifying organic compounds. It includes methods that describe the physical and chemical properties of the studied compounds, as well as those used to determine their structure using modern instrumental techniques and approaches.

Course Objectives:

The objective of the course is to provide students with knowledge and skills related to the methods and approaches for separation and identification of various organic compounds, along with correct interpretation of the obtained results.

Teaching Methods:

Lectures are illustrated with various examples related to the analysis of both simple and complex compounds. Multimedia systems and computers (PCs) are also used.

Prerequisites:

Basic knowledge of organic chemistry and instrumental methods is required.

ELECTROCHEMISTRY

ECTS Credits: 4 **Weekly workload:** 2l+ 1lab
Assessment method: Exam **Exam type:** Written
Semester: I (First Semester) **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Assoc. Prof. Elitsa Chorbadzhiyska, PhD
ellie_e1@swu.bg
Course status: Elective

Course Description:

The syllabus of the course "Electrochemistry" includes lectures and laboratory exercises on theoretical electrochemistry, extended with examples of practical relevance. The course expands and deepens the fundamental knowledge of electrochemistry introduced in the mandatory courses "General and Inorganic Chemistry – Part I" and "Physicochemistry". The lecture material is divided into the following sections: "Introduction to Electrochemistry", "Basic Concepts and Functions in Electrochemical Thermodynamics",

"Key Patterns in Electrochemical Kinetics", and "Practically Significant Electrode Processes". Unlike other electrochemistry courses, this one does not cover electrolyte dissociation and transport processes in electrolyte solutions, as these are thoroughly addressed in the aforementioned courses.

The laboratory exercises illustrate and complement the lectures by giving students the opportunity to become familiar with basic electrochemical methods and the equipment used for their application.

Course Objectives:

The aim of the elective course "Electrochemistry" is to provide students with fundamental theoretical knowledge and practical skills in the field of electrochemistry through the use of modern teaching methods and their active participation in the learning process. The expected results of the course are the acquisition of knowledge and competencies that allow students a broader professional realization.

Teaching Methods:

Lectures, lab exercises, preparation of coursework.

Prerequisites:

General admission requirements for the Master's program in Chemistry and Ecology for non-specialists.

Graduates of the Master's program will be able to apply the knowledge and skills gained from this course as chemist-ecologists in research and/or applied laboratories, in chemical enterprises, in research units and creative teams developing plans, programs, and strategies for environmental management, as well as in teaching practice.

The final grade (FG) is awarded only if the student has received a minimum passing grade (at least 3.00) from the continuous assessment.

HIGH-MOLECULAR NATURAL COMPOUNDS

ECTS credits: 4 **Weekly workload:** 2l+1lab
Assessment method: Exam **Exam type:** Written
Semester: I **Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Assoc. Prof. Maya Chochkova, PhD
mayabg202@yahoo.com
Course status: Elective

Course Description:

The course on high-molecular natural compounds covers the structure and configuration of high-molecular compounds, including aspects of stereoisomerism and macromolecular flexibility, their chemical and physical properties, supramolecular structures, methods for determining molecular weight, and the physicochemical characteristics of polymers, as well as their wide applications in practice.

Course Objectives:

The objective of the course is to provide students with fundamental knowledge of the composition, structure, properties, synthesis, analysis, and application of the most important classes of high-molecular compounds.

Teaching Methods:

Lectures illustrated with diagrams and figures using an overhead projector, supported by periodic tests.

Students who complete this course as part of a Master's program will be able to work as chemists-ecologists in research and/or applied laboratories, chemical enterprises, academic institutions, and creative teams developing plans, programs, and strategies for environmental management, as well as in educational practice.
Final Grade (FG) is formed only if the student has achieved at least a "Satisfactory" (3.00) grade from the continuous assessment.

SOLID STATE CHEMISTRY

ECTS credits: 4 **Weekly workload:** 2l+1sem
Assessment method: Exam **Exam type:** Written
Semester: I **Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Assoc. Prof. Elitsa Chorbadzhiyska, PhD
elli_e1@swu.bg **Course status:** Elective

Course Description:

The curriculum of the elective course Solid State Chemistry includes lectures and laboratory exercises covering modern issues in inorganic materials science. The program directs bachelor students' attention to modern inorganic materials and clarifies the relationship between synthesis, structure, and properties. The lectures and lab exercises are intended for bachelor chemistry students with broad knowledge of general inorganic chemistry (parts I–III) and other compulsory chemistry disciplines.
The lecture material is divided into topics such as: materials cycle, preparative methods for obtaining solids, direct reactions with solids, crystallization, synthesis of solid-phase materials through gas-phase transport reactions, intercalation syntheses, ion-exchange syntheses, physical and chemical methods for producing thin films, new forms of carbon, molecular metals, metal-phthalocyanine polymers, organic and inorganic conductive polymers, polythiazyl and polyacetylene batteries.
Laboratory exercises focus on obtaining inorganic salts from aqueous and non-aqueous solutions, chemical methods for producing thin films such as chemical deposition in solutions, pyrolysis with hot air, and others.

Course Objectives:

1. Provide broad preparation of chemistry students in inorganic materials science through the elective Solid State Chemistry course at the bachelor level.
2. Master basic methods for obtaining solids and understand the synthesis–structure–property relationship to create modern materials.
3. Guide bachelor chemists towards specialized master's programs in materials science.

Teaching Methods: Lectures and exercises.

Assessment:

Written exam

Students completing the course as part of a Master's degree program, using the acquired knowledge and skills, will be able to work as chemists-ecologists in research and/or applied laboratories, chemical enterprises, scientific teams, developing environmental management plans, programs, and strategies, as well as in educational practice.
Final grade (FG) is granted only if the student has achieved at least a "Satisfactory" (3.00) in continuous assessment.

MATHEMATICAL MODELS IN CHEMISTRY AND BIOLOGY

ECTS credits: 4 **Weekly workload:** 2l+1sem
Assessment method: exam **Exam type:** written
Semester: 1st semester **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Assist. Prof. Boryana Garkova, PhD
big@swu.bg
Course status: Elective

Course Description:

The curriculum covers topics related to the theory of mathematical models in biology and chemistry. The course will introduce the main concepts and principles in this field. Basic concepts and techniques of mathematical modeling and their application in the relevant areas will be explained. Practical applications of mathematical models in areas such as molecular biology, crystallography, pharmacology, and drug design will be illustrated with examples.

Objectives, tasks, and expected outcomes:
The aim of the course is for students to acquire fundamental concepts and some basic theoretical results in the theory of mathematical modeling, and its application in biology and chemistry. Each student should gain practical skills in creating mathematical models.

Organization of training:

1. Lectures – audiovisual technologies will be used for more accessible teaching:
   a. overhead projector
   b. computer projector
   c. lectures will be uploaded on the university website
2. Exercises – during lectures, homework assignments will be given, which students must complete and submit to the assistant for evaluation

Form of assessment for the written exam:

Control tests and course projects are graded on a six-point scale.
Each homework assignment is graded up to 100 points. Depending on the points scored, a grade for the homework assignment is given.
Students with continuous assessment >= 1.00 are allowed to take the exam.
The final grade (FG) is calculated only if both the continuous assessment and the exam grade are >= 1.00.
Grading scale on the six-point system for homework, control tests, and quizzes:

- Students with continuous assessment >= 5.50 are exempt from the exam.
- Students with continuous assessment between 4.00 and 5.50 are exempt from the written exam tasks and only take the written theory exam.
- Students with continuous assessment between 1.00 and 4.00 take the written exam tasks and theory.

The final grade (FG) is formed only if the student has received at least a "Satisfactory" (3.00) grade in continuous assessment.

MODERN CHROMATOGRAPHIC METHODS

ECTS credits: 4 **Weekly workload**: 2l+1lab
Assessment method: exam **Exam type**: written
Semester: II semester **Methodological Department**: Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer**: Assoc. Prof. Radoslav Chairov, PhD
rchayrov@swu.bg
Course status: Elective

Course Description:

The applications of chromatographic methods have been continuously evolving over the past four decades due to new technologies and the growing demand for more efficient methods of separating complex mixtures. The course "Modern Chromatographic Methods" is based on various contemporary chromatographic techniques widely used in analytical laboratories. The diversity of these techniques allows for the separation of gases and volatile compounds via gas chromatography (GC), non-volatile compounds with extremely high molecular weight (including biopolymers) via liquid chromatography (LC), and much more economically via preparative thin-layer chromatography (TLC). The course will also cover an advanced method for the separation of organic compounds using microwave-assisted high-performance liquid chromatography (MW-HPLC).

Course Objectives:

The objective is for students to acquire in-depth theoretical knowledge in chromatography and to explore the principles and applications of modern techniques used in industrial and scientific domains.

Assessment: written exam

Graduates with a Master's degree, using the knowledge and skills acquired in this course, will be able to pursue careers as chemist-ecologists in research and/or applied laboratories, in chemical enterprises, in scientific institutions, and in creative teams developing plans, programs, and strategies for environmental management, as well as in educational practice.

Final Grade (FG) is calculated only if the student has received a **minimum continuous assessment grade of Satisfactory (3.00)**.

GENERAL MICROBIOLOGY

ECTS credits: 4 **Weekly workload**: 2l+1sem
Assessment method: Exam **Exam type**: Written
Semester: II semester **Methodological Department**: Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer**: Prof. Emilia Varadinova, PhD
emilia.varadinova@swu.bg
Course status: Elective

Course Description:

The course aims to familiarize students with the current state of biology and microbiology as a leading scientific discipline. It covers the characteristics of microorganisms as biological entities, the structural and functional organization of the prokaryotic cell, and the features of eukaryotic microorganisms. The course also examines, from a comparative perspective, the differences in energy and constructive metabolism of microorganisms and the practical applications of their metabolic capabilities.

It includes the organization of bacterial genomes, forms of genetic exchange, and genetic variability. The main characteristics of viruses are also discussed—chemical composition, structure, replication, and the primary types of viruses.

The seminars focus on both classical and modern methods of studying microorganisms and viruses, current classification approaches, and some practical applications. They provide opportunities for independent work and student preparation.

Teaching Methods:

Lectures illustrated with diagrams and figures using overhead projection; periodic tests.

Graduates who complete this course as part of a Master's degree program will be qualified to work as chemist-ecologists in research and/or applied laboratories, in chemical enterprises, in scientific institutions and creative teams involved in developing plans, programs, and strategies for environmental management, as well as in educational practice.

Final grade (FG) is calculated only if the student has received a **minimum continuous assessment grade of Satisfactory (3.00)**.

MOLECULAR SPECTROSCOPY

ECTS credits: 4 **Weekly workload**: 2l+1lab
Assessment method: Exam **Exam type**: Written
Semester: II semester **Methodological Department**: Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer**: Prof. Ivanka Stoyneva, PhD istoineva@yahoo.com
Course status: Elective

Course Description:

The syllabus for the course *Molecular Spectroscopy* includes lectures and laboratory exercises related to some of the fundamental instrumental methods used to characterize organic compounds. The course covers the main characteristic spectral bands for various classes of organic compounds, allowing students to use the studied methods to identify and solve specific chemical problems.

Course Objectives:

The goal of the course is to provide students with systematic knowledge and skills for identifying and characterizing chemical compounds using molecular spectroscopy methods (UV, IR, Raman) and to correctly interpret the results obtained.

Teaching Methods:

Lectures and laboratory exercises. Lectures are illustrated with various examples related to the analysis of simple and complex compounds. Multimedia PC systems and computers are also used.

Prerequisites:

Basic knowledge of organic chemistry and instrumental analysis methods is required.

Pedagogical Approach:

Lectures are supported by diagrams and figures, presented via overhead projector, along with periodic tests.

Graduates who complete this course as part of a Master's degree program will be qualified to work as chemist-ecologists in research and/or applied laboratories, in chemical enterprises, in scientific institutions and creative teams engaged in developing plans, programs, and strategies for environmental management, as well as in educational practice.

Final grade (FG) is awarded only if the student has achieved at least a **Satisfactory (3.00)** in continuous assessment.

METHODS FOR ANALYSIS AND CONTROL

ECTS Credits: 4 **Weekly Workload:** 2l+1sem
Assessment method: Exam **Exam type:** Written
Semester: 2nd Semester **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Assoc. Prof. Petko Mandjukov, PhD
pmandjukov@abv.bg

Course status: Elective

Course Description:

The goal of this course is to acquaint students with the capabilities of instrumental methods used in scientific research and in solving problems related to substance identification, determination of their structure and quantitative composition, chemical equilibrium studies, and more.

The course includes a review and comparison of the analytical characteristics of most methods applied in qualitative and quantitative component analysis. Special attention is given to the selection of an appropriate analytical method when addressing a specific analytical problem.

The course provides a general overview of chemical analysis methods with instrumental detection of the analytical signal. It is a natural continuation of the course in Analytical Chemistry.

Course Objectives:

To provide students with knowledge on spectrometric, electrochemical, and combined methods (for separation and determination) used in chemical and biotechnological industries.

Practical Training:

Laboratory exercises are individual and take place in specialized departmental laboratories. Prerequisite knowledge includes completed courses in Analytical Chemistry, Physics, Physical Chemistry, and Mathematics.

Teaching Methods:

Lectures are supported with visual aids such as diagrams and figures, demonstrated using an overhead projector. Periodic tests are conducted.

Career Opportunities:

Graduates with a Master's degree, applying the knowledge and skills acquired in this course, will be qualified to work as environmental chemists in research and/or applied laboratories, in chemical enterprises, scientific units, and creative teams developing environmental management plans, programs, and strategies, as well as in teaching.

The **Final Grade (FG)** is calculated only if the student has achieved at least **Satisfactory (3.00)** in current assessment.

METHODS FOR PROCESSING EXPERIMENTAL DATA

ECTS credits: 4
Weekly workload: 2l+1sem
Assessment method: exam
Exam type: written
Semester: II
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Prof. Stefan Stefanov, PhD

Course status: Elective

Course Description:

Students acquire basic knowledge and skills for applying some important methods for processing experimental data and numerical methods for solving optimization problems.
• Prerequisites: Basic knowledge in mathematical analysis, linear algebra, analytical geometry.
Teaching method:
Lectures illustrated with diagrams and figures, demonstrated with the help of an overhead projector, periodic tests.
Students who have obtained a Master's degree, using the knowledge and skills acquired in this course, will be able to work as environmental chemists in research and/or applied laboratories, in chemical enterprises, in scientific units and creative teams developing plans, programs, and strategies for environmental management, as well as in pedagogical practice.
The final grade (FG) is formed only if the student has received at least a Satisfactory 3.00 grade from the ongoing assessment.

METROLOGY AND QUALITY CONTROL

ECTS credits: 4
Weekly workload: 2l+1sem
Assessment method: exam
Exam type: written
Semester: II
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assoc. Prof. Petko Mandjukov, PhD
Course status: Elective

Annotation:

The course **"Metrology and Quality Control"** aims to introduce students to the fundamental principles and methods of metrology, as well as the role of measurements in the process of quality management and assurance in various production and laboratory activities. It covers types of measurements, measurement units, standards, measuring instruments, calibration, and traceability. Special emphasis is placed on quality management systems, national and international standards (e.g., ISO 9001), and methods for statistical control and conformity assessment. The course combines theoretical knowledge with practical applications, developing skills for analyzing, interpreting, and controlling measurement results.

Course Objectives:

- To provide essential knowledge of metrology and its significance in ensuring accurate and reliable measurements.
- To acquaint students with modern approaches and standards in quality management.

- To develop skills for applying measuring instruments, calibration methods, and quality control techniques in practice.
- To prepare students for working in environments that require compliance with quality standards and measurement traceability.

Course Tasks:

- Studying key metrological concepts – types of measurements, errors, calibration, traceability.
- Familiarization with metrological standards and reference instruments.
- Learning methods for evaluating measurement uncertainty.
- Studying the principles and structure of quality management systems (including ISO standards).
- Applying methods of statistical quality control (control charts, process analysis, etc.).
- Developing skills for assessing the conformity of products and processes with specified requirements.
- Conducting practical exercises and solving case studies related to metrological control and quality management.

GREEN CHEMISTRY

ECTS credits: 4
Weekly workload: 2l+1sem
Assessment method: exam
Exam type: written
Semester: III semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assoc. Prof. Maya Chochkova, PhD
mayabg202@yahoo.com

Course status: Elective

Course Description:

The primary objective of the course is to introduce students to the fundamental concepts and provide them with both theoretical and practical knowledge on the core principles and physical laws of green chemistry, with a focus on its application in the field of renewable energy sources and the environmental impact of green energy. The course content encompasses essential topics and physical principles based on the twelve guiding principles of green chemistry. Special emphasis is placed on the effective application of green chemistry in key areas such as solar energy, biomass, biofuels, and carbon dioxide conversion, in alignment with environmental protection standards as defined by national and European regulations.

The lecture material is illustrated with tables, schemes, and graphs used in the analysis of real-world problems in the field of green chemistry. Presentations will be delivered using multimedia and PC-based systems.

To successfully follow the course, students are expected to have foundational knowledge in general chemistry, physics, biology, mechanics, thermodynamics, and heat transfer.

Objectives and Goals:

The main goals of the "Green Chemistry" course are:

1. To familiarize students with the basic principles and foundations of applying green chemistry across different fields.
2. To acquire systematic knowledge and skills related to the environmental impact of green energy.

3. To develop creative thinking and the ability to independently select approaches and methods when solving a given problem.

Students who have obtained a Master's degree and apply the knowledge and skills acquired in this course will be able to pursue careers as chemists in research and/or applied laboratories, industrial and governmental institutions, and non-governmental organizations engaged in environmental protection.

The final grade (FG) is calculated only if the student has received at least a Satisfactory 3.00 from ongoing assessment.

PHOTOVOLTAIC SYSTEMS AS A SOURCE OF ECO-ENERGY

ECTS credits: 4
Weekly workload: 2l+1lab
Assessment method: exam
Exam type: written
Semester: III semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assoc. Prof. Elitsa Chorbadzhiyska, PhD
ellie_e1@swu.bg

Course status: Elective

Course Description:

The curriculum of the course *Photovoltaic Systems as a Source of Eco-Energy* aims to introduce students to the chemical and environmental challenges associated with energy generated from photovoltaic systems.

The lecture material sequentially covers: (i) the role of eco-energy from photovoltaic systems in the overall energy mix, materials used in the production of solar cells, and the basic principles of solar cell operation; (ii) the structure of a photovoltaic module, types of photovoltaic modules, and their characteristics; (iii) inverters, electronic controllers, solar chargers, and batteries for storing eco-energy; (iv) types of photovoltaic generators – grid-connected, off-grid, hybrid systems, and the specifics of eco-energy generation; (v) applications of photovoltaic systems – best practices, EU regulatory framework for the use of eco-energy from photovoltaic systems, and environmental assessment of electricity generated from photovoltaic systems.

Laboratory exercises reinforce the lecture content by providing hands-on experience in generating eco-electricity from photovoltaic systems through: (i) designing and constructing a photovoltaic module; (ii) building an autonomous photovoltaic system; (iii) developing a project for a solar-powered office; and (iv) constructing a 210 Wp photovoltaic generator connected to the grid and performing an environmental assessment of the generated electricity.

The lectures explore photovoltaic systems as a source of eco-energy from chemical, instrumental, and environmental perspectives, utilizing contemporary textbooks, scientific articles, and online resources. The lecture material is presented using multimedia tools (PowerPoint, video), as well as an electronic platform offering a virtual library and the necessary materials for students' independent work, with access to the Internet and online communication with the lecturer.

To successfully master the course material, students need basic knowledge in general and inorganic chemistry, organic chemistry, analytical chemistry, instrumental methods of analysis, physics, and informatics.

Objectives and Goals:

The objectives of the course *Photovoltaic Systems as a Source of Eco-Energy* are:

1. To acquire theoretical and practical knowledge of the chemical processes involved in photovoltaic energy production and its environmental assessment.
2. To familiarize students with the fundamentals of photovoltaics and the various types of photovoltaic systems for eco-energy generation.
3. To develop an analytical approach to applying the acquired knowledge in generating eco-energy from photovoltaic systems and evaluating their contribution to the national energy mix.

The final grade (FG) is determined only if the student has obtained at least a Satisfactory 3.00 in the ongoing assessment.

ECOMETRICS

ECTS credits: 4
Weekly workload: 2l+1sem
Assessment method: exam
Exam type: written
Semester: III semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assoc. Prof. Petko Mandzhukov, PhD
pmanjukov@abv.bg

Course status: Elective

Course Description:

The course explores fundamental methods for statistical processing of results from environmental studies: statistical criteria used for hypothesis testing; regression analysis, time series analysis; ANOVA; classification and pattern recognition — cluster analysis (similarity criteria, agglomerative procedures); an introduction to mathematical neural networks. The course discusses potential applications of these methods in solving environmental problems and processing experimental data.

Objectives and Goals:

The main objectives of the *Ecometrics* course are:

1. Introducing students, both qualitatively and quantitatively, to core methods for processing environmental data and, more broadly, data in experimental sciences.
2. Establishing a closer interdisciplinary connection with mathematics.
3. Fostering creative thinking and independent problem-solving skills for practical challenges.

The aim of the course is to acquaint students with some of the fundamental methods of applied mathematics used in processing experimental data, allowing for the extraction of additional information about the studied object or system.

Students are expected to acquire the knowledge and skills necessary for processing and interpreting analytical results, as well as for further analysis of the obtained data to extract more comprehensive insights into the studied object or system.

The final grade (FG) is awarded only if the student has achieved a minimum grade of Satisfactory 3.00 in the ongoing assessment.

FUNDAMENTALS OF INDUSTRIAL ECOLOGY AND EMISSION CONTROL

ECTS credits: 4 **Weekly workload:** 2l+1sem
Assessment method: exam **Exam type:** written
Semester: III semester **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer**: Assoc. Prof. Petranka Petrova , PhD ppd@swu.bg

Course status: Elective

Course Description:

The main objective of the course *Fundamentals of Industrial Ecology and Emission Control* is to familiarize students with the primary industrial sources of soil, water, and air pollution. The course presents the fundamental methods and instruments for measuring and monitoring various technological parameters and potential pollutants. Using specific examples from the chemical industry, the course outlines core processes and equipment used for purifying process water and gases from various pollutants. Special attention is given to the measures that must be implemented to reduce or prevent emissions of harmful substances. The course discusses potential modifications to traditional processes and technologies to limit emissions by integrating additional purification units. It also introduces the basic principles of designing zero-waste technological systems.

Lectures are illustrated with diagrams, schematics, photographs, and video footage of technological processes, apparatuses, and specific components. Multimedia PC systems are used for their presentation.

Successful completion of the course requires foundational knowledge in analytical, inorganic, and organic chemistry, chemical processes and apparatuses, and chemical engineering technologies.

Objectives and Goals:

The main goal of the course is to provide students with the necessary theoretical and, to a lesser extent, practical foundation in industrial ecology and the control of harmful emissions from industrial production.

The primary tasks of the *Fundamentals of Industrial Ecology and Emission Control* course are:

1. To introduce students to the main industrial pollutants affecting air, soil, and water.
2. To equip students with knowledge of specific processes (absorption, adsorption, extraction, etc.) and equipment (pumps, settlers, absorbers, etc.) used in reducing harmful emissions.
3. To foster creative thinking and the ability to independently analyze phenomena and processes, and to select appropriate approaches and methods for resolving environmental challenges.

The final grade (FG) is awarded only if the student has achieved a minimum grade of Satisfactory 3.00 in the ongoing assessment.

MODERN ELECTROCHEMICAL SYSTEMS FOR ECO-ENERGY GENERATION AND STORAGE

ECTS credits: 4
Weekly workload: 2l+1sem
Assessment method: exam
Exam type: written
Semester: III semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assoc. Prof. Elitsa Chorbadzhiyska, PhD – elitsa@swu.bg

Course status: Elective

Course Description:

The main objective of the course is to acquaint students with the fundamental principles of electrochemical systems and their most important applications as technologies for energy generation and storage. The course covers both conventionally used systems and innovative technologies that are currently the focus of intensive research. In view of the anticipated transformations in the energy sector, as outlined in the concept of the hydrogen economy, the main focus of the course is on technologies for hydrogen production and utilization as an environmentally clean fuel—electrolyzers and fuel cells, including microbial ones. The lectures are illustrated with numerous visuals and comparative data. A multimedia system is used for their presentation.

The laboratory exercises complement the lecture material and provide students with the opportunity to closely examine some of the technologies presented in the course, as well as to measure and compare key operational characteristics of various types of electrochemical systems.

To successfully master the material, students are expected to have foundational knowledge in general chemistry, electrochemistry, analytical chemistry, general biology, and ecology.

Objectives and Goals:

The main tasks of the course "Modern Electrochemical Systems for Eco-Energy Generation and Storage" are:

1. Introducing students to modern electrochemical systems that have found practical application in energy conversion and storage.
2. Developing students' practical skills related to the construction of prototypes and the measurement of operational characteristics of key electrochemical systems.
3. Fostering creative and heuristic thinking in students through the resolution of case studies, the preparation of course projects, and other active learning methods.

By applying the knowledge and skills acquired in this course, students holding a Master's degree will be able to pursue careers in research and/or applied laboratories, production facilities, and companies engaged in the development, operation, and maintenance of systems and equipment for energy conversion and storage (electrolyzers, fuel cells, including microbial, batteries, accumulators, etc.). Given the expected restructuring of the energy system, particular emphasis is placed on the knowledge and skills related to hydrogen technologies.

The final grade is formed only if the student has received at least a "Satisfactory" (3.00) in the continuous assessment.

NEW FOOD ADDITIVES

ECTS credits: 4
Weekly workload: 2l+1sem
Assessment method: exam
Exam type: written
Semester: III semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Prof. Ivanka Stankova, PhD – ivastankova@swu.bg

Course status: Elective

Course Description:
The course "New Food Additives" aims to familiarize students with the use of substances essential for balanced and healthy nutrition. Over the past decade, there has been a global shift in dietary habits, increasingly diverging from the principles of balanced nutrition. This has led to deficiencies in biologically active compounds, vitamins, and minerals.
The course curriculum covers:

- food additives authorized for use in the food industry;
- food as energy sources;
- vitamins and minerals;
- amino acids and antioxidants.

Objectives and Goals:
The objective of the course is to introduce students to the use of substances necessary for a balanced and healthy diet. Students will acquire a contemporary and objective understanding of certain functions of biologically active compounds, including: the body's need for vitamins and minerals; enhancement of physical and mental performance; support for adaptation to environmental conditions; and ensuring proper growth and development in children.
Graduates who have obtained a Master's degree and have completed this course will be able to pursue careers as chemists in research and/or applied laboratories, economic and governmental institutions, as well as non-governmental organizations involved in environmental protection.
The final grade is awarded only if the student has received a minimum grade of "Satisfactory" (3.00) from continuous assessment.

APPLICATION OF GEOGRAPHIC INFORMATION SYSTEMS IN ENVIRONMENTAL CHEMISTRY

ECTS credits: 4
Weekly workload: 2l+1sem
Assessment method: exam
Exam type: written
Semester: IV semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assist. Prof. Galina Bezinska, PhD – galinabezinska@swu.bg

Course status: Elective

Course Description:

The course "Geographic Information Systems" within the Master's program "Chemistry and Ecology" presents general concepts for the development and implementation of GIS. The topics are grouped into modules covering fundamental theoretical areas. During the course, the main subjects may be adapted to reflect ongoing developments and innovations in the technology, while still adhering to the requirements of the core topics.

Objectives and Goals:

Course objective: The aim of the course is to provide specific knowledge about the emergence and application of selected information technologies. All knowledge is directly focused on systems for mapping, management, analysis, and decision-making support in the governance of geographic entities and territories with local, regional, and global relevance.

Tasks: The curriculum includes the following fundamental themes: technological support for GIS; user software – interface and functionality; data types and structures; databases and modern methods for data storage and management; spatial and network analysis; application of GIS in various professional fields.

Expected outcomes: By the end of the semester, students should be able to:

- Structure their graphic database as map layers and select appropriate symbols and methods for their cartographic representation;
- Use various methods for inputting graphic data;
- Structure the attribute database, define data types and corresponding field types;
- Apply appropriate classification methods for their attribute data;
- Identify and utilize relevant transformation and interpolation procedures and understand their use cases;
- Perform spatial and tabular operations in geographic analyses.

Students who acquire solid knowledge in this field will be well-positioned to engage in the development and management of GIS projects.

The final grade is awarded only if the student has received a minimum grade of "Satisfactory" (3.00) from continuous assessment.

CONSERVATION BASED NATURE PROTECTION

ECTS credits: 4
Weekly workload: 2l+1sem
Assessment method: exam
Exam type: written
Semester: IV semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assist. prof. Al. Pulev, PhD
spu@abv.bg

Course status: Elective

Course Description:

Biological diversity is a significant resource for the development of tourism. Its preservation is fundamental to the implementation of the concept of sustainable tourism. Of particular importance in this regard is the system of protected areas. These areas are regarded as both national and global heritage, and as a specific form of nature conservation that contributes to the advancement of culture and science, as well as to societal well-being. In parallel, the conservation of biodiversity—both at the species level and in terms of habitats—is of critical importance to achieving sustainable tourism.

Objectives and Goals:
The aim of the course is to provide fundamental knowledge about the nature and importance of biodiversity as a resource for tourism development.
Expected outcomes: The course aims to develop skills for working with different categories of protected areas and the individual components of biodiversity.
The final grade is awarded only if the student has received a minimum grade of "Satisfactory" (3.00) from continuous assessment.

BIOLOGICAL MONITORING

ECTS Credits: 4 **Weekly workload:** 2l+1sem
Assessment method: exam **Exam type:** Written
Semester: IV semester **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Assoc. prof. Dr. Lidia Sakelarieva: sakelarieva.lidia@abv.bg

Course status: Elective

Course Description:
The course "Biological Monitoring" clarifies the essence and characteristics of biological monitoring of the environment as a part of ecological monitoring. It covers the nature, principles, ecological basis, different levels, and areas of application of biological indication. The course studies organisms, species, and groups of species (communities) of plants, animals, and microorganisms used as indicators for assessing the condition (quality) of air, soils, water, and ecosystems. It also addresses the applicability of various groups of methods, criteria, and indicators for biological assessment and monitoring of air, soils, and water (saprobic indices, diversity indices, biotic indices, etc.) adopted in Bulgaria and European countries.
Objectives and Goals:
The goal of the course is for students to acquire solid theoretical and practical preparation during their training for the direct application of knowledge in determining the condition and quality of air, water, soil, and ecosystems based on biological control and biological monitoring.
The main tasks of the course are aimed at:

1. Mastering theoretical knowledge of different groups of methods, criteria, and indicators for biological assessment and monitoring of environmental components;
2. Acquiring skills for investigating, analyzing, and assessing the environment based on biological control and biological monitoring;
3. Developing creative thinking and the ability to independently select approaches and methods for solving a given problem.

To successfully master the course material, basic knowledge of botany, zoology, microbiology, soil science, general ecology, and general chemistry is required. The knowledge and skills acquired during training in "General Ecology" will provide students with a solid foundation for understanding and successfully mastering all core and applied ecological disciplines.

The final grade (FG) is assigned only if the student has achieved at least a satisfactory grade (3.00) in the ongoing assessments.

HAZARDOUS CHEMICAL SUBSTANCES AND MIXTURES

ECTS Credits: 4 **Weekly workload:** 2l+1sem
Assessment method: exam **Exam type:** Written
Semester: IV semester **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Assoc. prof. Petranka Petrova, PhD ppd@swu.bg
Course status: Elective

Annotation:

The course **"Hazardous Chemical Substances and Mixtures"** aims to familiarize students with the fundamental characteristics, classification, properties, and risks associated with hazardous chemical substances and their mixtures. The course explores the different types of hazards—physicochemical, health-related, and environmental—as well as national and international regulatory frameworks governing the production, storage, transportation, and disposal of such substances. Special emphasis is placed on labeling systems, hazard markings, and safe handling practices for hazardous chemicals, including the European Union's REACH and CLP Regulations. The course combines theoretical knowledge with practical examples in risk assessment and emergency response actions related to hazardous substances.

Course Objectives:

- To provide essential knowledge about the types of hazardous chemical substances and mixtures and their properties.
- To introduce students to classification systems, labeling, and risk management related to hazardous chemicals.
- To develop skills in identifying hazards and applying safety measures when working with hazardous substances.
- To build understanding of the legal and regulatory framework applicable within the EU and Bulgaria.

Course Tasks:

- Study of main categories of hazardous substances: explosive, flammable, toxic, corrosive, carcinogenic, and others.
- Mastery of classification systems such as the Globally Harmonized System (GHS) and the CLP Regulation.
- Analysis of requirements for the safe storage, transportation, and disposal of hazardous chemicals.
- Working with Safety Data Sheets (SDS) and understanding their content.
- Review of real-life case studies and incidents involving hazardous substances and conducting risk assessments.
- Learning emergency response methods for incidents involving hazardous chemicals.

Final Grade (FG):

The final grade is awarded only if the student has received at least a "Satisfactory" (3.00) from the ongoing assessment (OA).

AGROECOLOGY

ECTS Credits: 4 **Weekly workload:** 2l+1sem
Assessment method: Exam **Exam type:** Written
Semester: IV semester **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Assoc. Prof. Dr. Petranka Petrova, ppd@swu.bg
Course status: Elective

Course Description:

The course in Agroecology provides students with the opportunity to understand the essence and specifics of this type of environmentally sustainable agricultural production. It prepares them theoretically and practically, giving them the necessary knowledge for the application of national programs in the field of agriculture and natural resource conservation (e.g., the National Rural Development Program 2007-2013, the National Agroecological Program of the Ministry of Agriculture and Food).

Seminar exercises familiarize students with various methods and instruments for determining, researching, evaluating, and diagnosing components of different ecological, edaphic, and biological factors.

The lectures are illustrated and supplemented with examples drawn from the results of active ecological farms from various regions in the country (e.g., farms integrated with rural and ecological tourism and marketing of organic products).

Basic knowledge of general chemistry, organic and analytical chemistry, general biology, and ecology is necessary for successful mastery of the course material.

Objectives and Goals:

The main tasks of the course 'AGROECOLOGY' are:

1. Introducing students to basic concepts in agroecology and the relationships between plants, plants and microorganisms, plants and animal organisms, among others;
2. Acquiring systematic knowledge and skills to determine different components of the agroclimate, characterize the ecological basis of crop rotation, and mineral nutrition of plants, as well as diagnose biological and ecological characteristics of weeds, pests, and diseases in agroecosystems;
3. Developing creative thinking and the ability to independently select approaches and methods for solving specific problems in organic agriculture, which is primarily based on certified organic plant and animal production that does not pose health risks to consumers due to the absence of chemical contaminants (e.g., nitrates or pesticide residues) and applies practices that protect the natural environment.

The final grade (FG) is awarded only if the student has achieved at least a satisfactory grade (3.00) in ongoing assessments.

CHEMISTRY OF THE ATMOSPHERE AND NATURAL WATERS

ECTS Credits: 4 **Weekly workload:** 2l+1sem
Assessment method: Exam **Exam type:** Written

Semester: IV semester **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Assoc. Prof. Dr. Petranka Petrova: ppd@swu.bg

Course status: Elective

Course Description:

The course "Chemistry of the Atmosphere and Natural Waters" is studied as part of the training for obtaining the educational and qualification degree "Master of Ecology," aiming to broaden and deepen the knowledge of processes occurring in natural waters.

Particular attention is given to the main characteristics and factors influencing the formation of the chemical composition of natural waters, assessments of their pollutant load, the self-purification capacity of water bodies, processing and interpretation of analysis results for the pollution of water flows and basins, among others.

The curriculum also provides the necessary knowledge for organizing monitoring systems for natural waters; preparing forecasts on changes in their quality; managing various activities related to the use and protection of natural waters, including the development of programs to safeguard them from negative impacts, and more.

Objectives and Goals:

The main tasks of the course "Chemistry of the Atmosphere and Natural Waters" are:

1. Introducing students to the main characteristics and factors influencing the formation of the chemical composition of natural waters, as well as assessment of pollutants, self-purification capacity, etc.;
2. Acquiring systematic knowledge and skills related to monitoring natural waters and managing activities for their use and protection;
3. Developing creative thinking and the ability to independently select approaches and methods for solving specific problems.

The final grade (FG) is assigned only if the student has achieved at least a satisfactory grade (3.00) in ongoing assessments.