CHEMISTRY AND ECOLOGY

Educational and Qualification Degree	Master
Professional Qualification	Environmental Chemist
Duration of Study	2 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 two semesters. Students complete 10 courses, including 9 compulsory and 2 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 Semester	ECTS credits	**Second 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 I	7 6 4 4 5 4	1. Renewable Energy Sources 2. Ecotoxicochemistry 3. Methods for water status analysis and assessment 4. Elective Course – Group II 5. Master's Thesis (Graduation)	4 4 3 4 15
	Total 30		**Total 30**
Elective Courses – Group I 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 II** 1. Geographic information systems 2. Conservation-Based Nature Protection 3. Biological Monitoring 4. Hazardous chemical substances and mixtures 5. Agroecology 6. Chemistry of the Atmosphere and Natural Waters	

COURSE ANNOTATIONS

CHEMISTRY AND ENVIRONMENT

ECTS credits: 7
Weekly workload: 3l + 1lab
Assessment method: exam
Exam type: written
Semester: I 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: I 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: I 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 *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: I 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: I 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: II semester **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** 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: II 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 + 1sem
Assessment method: Exam **Exam type:** Written

Semester: II semester **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences **Lecturer:** Prof. Emilia Varadinova emilia.varadinova@swu.bg
Course status: Compulsory

Course 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, ecological standards, and practical applications of assessments in the context of environmental protection and sustainable water resource management. The course includes theoretical lectures, laboratory exercises, and work with real-world data.

Course objectives:

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

Course tasks:

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

GREEN CHEMISTRY

ECTS credits: 4 **Weekly workload:** 2l+1sem
Assessment method: exam **Exam type:** written
Semester: I semester **Methodological Department:** Department of Chemistry
Faculty: Mathematics and Natural Sciences 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 ECOENERGY

ECTS credits: 4 **Weekly workload:** 2l + 1lab
Assessment method: exam **Exam type:** written
Semester: I 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: I semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assoc. Prof. Petko Mandjukov, 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: I 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: I 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 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—electrolyzes 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:** 2lectures+1sem
Assessment method: exam **Exam type:** written
Semester: I 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.

GEOGRAPHIC INFORMATION SYSTEMS

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: 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 NATURE PROTECTION

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: 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: II semester
Methodological Department: Department of Chemistry
Faculty: Mathematics and Natural Sciences
Lecturer: Assoc. prof. Lidia Sekelarieva, PhD
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: II 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 main characteristics, classification, properties, and risks associated with hazardous chemical substances and their mixtures. The course covers types of hazards – physico-chemical, 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 symbols, and safe handling of hazardous chemicals, including the European Union's REACH and CLP

regulations. The course combines theoretical knowledge with practical examples of risk assessment and response actions in incidents involving hazardous substances.

Course Objectives:

- To provide fundamental knowledge of the types and properties of hazardous chemical substances and mixtures.
- To introduce students to classification systems, labeling, and risk management related to hazardous chemicals.
- To develop skills for hazard identification and implementation of safety measures when working with hazardous substances.
- To build awareness of the legal and regulatory framework applicable in the EU and Bulgaria.

Course Tasks:

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

Final Grade (FG):

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

AGROECOLOGY

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: Assoc. Prof. Petranka Petrova, PhD
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: II 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 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. The course "Chemistry of the Atmosphere and Natural Waters" provides a comprehensive understanding of the chemical composition, processes, and transformations occurring in the Earth's atmosphere and natural aquatic systems.

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. Through lectures, laboratory work, and project-based learning, students will gain critical insight into atmospheric chemistry (including greenhouse gases, ozone chemistry, and aerosol formation), as well as the chemistry of surface water, groundwater, and marine systems. The course is suitable for students in environmental sciences, chemistry, geosciences, and related disciplines.

Objectives and Goals:

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

1. Explaining the major chemical and photochemical processes in the atmosphere (e.g., ozone formation, acid rain, smog).

2. 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.;
3. Evaluating the environmental impact of anthropogenic pollutants in air and water.
4. 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.