UNIVERSITY OF NIŠ
FACULTY OF OCCUPATIONAL SAFETY
IN NIŠ

STUDY PROGRAMMES OF
DOCTORAL ACADEMIC STUDIES

OCCUPATIONAL SAFETY ENGINEERING & ENVIRONMENTAL ENGINEERING

Niš, 2014.

U N I V E R S I T Y O F N I Š
FACULTY OF OCCUPATIONAL SAFETY

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Study programmes have been accredited since 2013.

TABLE OF CONTENTS:

ABOUT STUDY PROGRAMMES OF DOCTORAL ACADEMIC STUDIES

Faculty of Occupational Safety in Niš accredited doctoral studies in the field of technical and technological sciences, which represent the advanced acquired fundamental knowledge and skills of general and vocational courses at bachelor and master studies.

The curriculum of doctoral studies includes two study programs:

- Occupational Safety Engineering
- Environmental Engineering

Study programmes of doctoral studies in **Occupational Safety Engineering** and **Environmental Engineering** are designed taking into account: the modern programme of doctoral studies at higher education institutions in Europe and the world; current scientific research in the framework of international and national projects and curricula of institutions with which the Faculty has established various forms of cooperation and signed agreements on scientific and educational cooperation and scientific research; developmental and research projects implemented in large enterprises in the country; as well as the opinions and recommendations of PhDs who acquired this academic title at the Faculty of Occupational Safety in Niš.

The content of the study programmes is the result of the synthesis of educational and scientific-research processes at the Faculty, on the one hand, and the result of the accepting European and worldwide development trends in this area, on the other hand. The programs are integral, comprehensive and provide the students with modern scientific knowledge in the fields of **Occupational Safety Engineering** and **Environmental engineering.**

Study programmes are in compliance with the European standards in terms of admission requirements, duration of study, mode of study and acquiring diploma, particularly with regard to the outcome of the study programme, or the students' competence.

Upon completion of doctoral studies at these programmes, the students acquire the scientific name doctor of science - **Occupational Safety Engineering,** or **Environmental engineering.**

Doctoral studies last three years (six semesters) and have a volume of 180 ECTS credits. Out of total number of ECTS credits, the students gain 30 credits by taking compulsory courses, 30 credits by taking optional courses, and 120 ECTS credits by study research work in the field of doctoral dissertation, by writing and defending a doctoral dissertation.

The studies are organized through lectures, study research work, development and defense of the doctoral dissertation.

The application process, preparation and defense of a dissertation, as well as the fulfillment of the requirements for doctoral dissertation are defined by the Regulation on doctoral studies at the Faculty of Occupational Safety in Niš.

Admission to doctoral studies is performed on the basis of application requirements proposed by the Faculty and announced by the University of Niš. A person is eligible to enroll in the first year of doctoral studies if he/she:

- completed master academic studies, gained a minimum of 300 ECTS credits and has overall GPA of at least 8.00 at bachelor and master academic studies, or
- completed master academic studies, gained a minimum of 300 ECTS and published scientific papers in the scientific field of doctoral studies, or
- has the academic title of Magister of Sciences, and if he/she delivered doctoral dissertation in accordance with the Article 128 of the Law on Higher Education, or
- completed basic studies (Level VII/1) with a GPA of at least 8.00, or
- completed basic studies (Level VII/1) and published scientific papers in the scientific field of doctoral studies.

For admission to doctoral studies, a candidate is obliged to know at least one foreign language.

The list of admitted candidates for the first year of doctoral studies shall be based on the overall average mark in the previous levels of study, the length of study and the research results. Eligible candidates for enrolling the study program of doctoral studies are those from the ranking list based on the number of points, as it has been defined by the Regulations on doctoral studies at the Faculty of Occupational Safety in Niš, provided that they are in the ranking list within the limited number of places defined by admission requirements.

STUDY PROGRAMME

OCCUPATIONAL SAFETY ENGINEERING

THE PURPOSE OF THE STUDY PROGRAMME

- Developing and connecting fundamental and applied scientific disciplines in occupational safety within interdisciplinary and multidisciplinary context and modern scientific research trends worldwide. The ultimate intention is to improve the theory and practice of occupational safety, the development of a modern system of occupational health and safety, and improving the quality of work and life in general.
- Development of competence for independent, scientifically and socially relevant research and their application in practice of occupational health and safety.
- Qualifying experts with high scientific culture that requires the abilities of critical thinking and analyses, creativity, originality, inventiveness and innovation in various fields of professional activity.

STUDY PROGRAMME OBJECTIVES

- Training for critical analysis and research of the domains and responsibilities of science and occupational safety practice, for the development of a modern and efficient system of occupational health and safety, humanizing the quality of work and life in general, and creating safe and reliable solutions in the future.
- Developing scientific knowledge, competence and academic skills for interdisciplinary and multidisciplinary approach, critical examination and studying fundamental problems of safety based on modern paradigms as well as the dealing with key issues of engineering and managerial practices of risk management, prevention and occupational health.
- Developing critical thinking and active reflection necessary for the development, conceptualization and implementation of occupational health and safety policies, strategies and educational interventions in social , industrial, economic and educational context in Serbia, and a critical approach to the possibilities of implementing modern achievements worldwide in occupational health and safety theory and practice in the national context.
- Training for self- organizing, managing and implementation of scientific research, the involvement in both national and international projects and competent communication of research results.
- Developing the ability for associating, improvement and advancement of knowledge gained at basic and master studies and raising awareness about the need for lifelong learning and continuous professional development.

STUDY PROGRAMME OUTCOMES

Enabling students to, after completing the studies, acquire knowledge, skills and developed abilities to:

- exchange and use of modern knowledge in the field of occupational safety engineering,
- organize and implement innovative, developmental and scientific research,
- verify the results through patents and new technical solutions,
- individually solve theoretical and practical problems in the field of occupational safety engineering,
- develop new technologies and procedures for protecting persons, property and business,
- critical thinking, creative and independent actions,
- respect the ethical principles and good scientific practice,
- connect on a professional level in communicating scientific research results at scientific conferences and in scientific journals,
- develop scientific disciplines – occupational health and safety and science in general through critical analysis, evaluation and synthesis of new and complex ideas, and
- promote technical - technological progress and culture of safety, health and occupational safety in academic and professional environment.

After completing the study programme, the student shall acquire the following competencies for:

- thorough knowledge and understanding of occupational safety engineering,
- connecting basic knowledge in various fields and their application in occupational safety engineering,
- following contemporary professional achievements,
- developing skills and competence in using knowledge for protecting persons, property and business,
- the use of information and communication technologies, and
- work in multidisciplinary teams .

The students' competence shall be verified during the study through publication of scientific research within the selected scientific areas in reference scientific journals.

СТРУКТУРА СТУДИЈСКОГ ПРОГРАМА

ID		COURSE	S	Status	Active classes		ECTS
					L	SRW	
FIRST YEAR							
1		Scientific Research Methods	1	C	4	2	10
2		Selected Areas of Mathematics	1	C	4	2	10
3		Systems Risk Analysis	1	C	4	2	10
4		*Elective course*	2	B	3	3	10
		Physical and Chemical Processes in Working Environment		E	3	3	10
		Safety in Technological Systems		E	3	3	10
5		Study Research Work 1	2	C	0	16	20
Total active classes per year = 40							
Total ECTS credits = 60							
SECOND YEAR							
6	Within the same group of elective courses	*Elective course*	3	B	3	3	10
7		*Elective course*	3	B	3	3	10
		Elective Courses, Block 1					
		Diagnostics and Maintenance of Technical Systems					
		Ergonomics of Products	3	E	3	3	10
		Ergonomics in Automated Systems	3	E	3	3	10
		Fire and Explosion Risk Assessment	3	E	3	3	10
		Integrated Safety Systems	3	E	3	3	10
		Electromagnetic Radiation	3	E	3	3	10
		Human Reliability	3	E	3	3	10
		Design of the Systems for Noise and Vibration Protection	3	E	3	3	10
		Design of Integrated Fire and Explosion Protection	3	E	3	3	10
		Electrotechnical Safety Systems	3	E	3	3	10

	Elective Courses, Block 2					
	Managing Thermal Comfort of the Working Environment	3	E	3	3	10
	Professional Risk Management	3	E	3	3	10
	Toxicology	3	E	3	3	10
	Hazardous Substance Management	3	E	3	3	10
	Working Environment and Health	3	E	3	3	10
	Collaborative Information Systems	3	E	3	3	10
	Economic Valorization of Projects in the Working Environment	3	E	3	3	10
	Engineering Ethics	3	E	3	3	10
	Knowledge Management and Decision-making in Working Environment	3	*E*	3	3	10
8	Study Research Work 2	3	C	0	8	10
	Study Research Work 3-1	4	C	0	20	30
Total active classes per year = 40						
Total ECTS credits = 60						
THIRD YEAR						
	Study Research Work 3-2	5	E	0	20	30
	Study Research Work 3-3	6	E	0	20	20
	Doctoral Thesis Defence	6	E	0	0	10
Total active classes per year = 40						
Total ECTS credits= 60						

S – semester, L – lectures, SRW – Study Research Work, C - compulsory course; E - elective course; B – block courses

CURRICULUM

SCIENTIFIC RESEARCH METHODS

Course objectives: Understanding the concept of scientific truth, the goals of scientific research, basic methodological tools and methodological novelties of the ruling scientific paradigms with the aim to find the answers how to grasp the nature of current phenomena and processes in technical and technological sciences.

Learning outcomes: Theoretical and practical knowledge about the methods, tools and techniques for conducting scientific research. Students' ability to think scientifically and creatively, to determine and methodologically study diverse phenomena and issues; and be methodologically competent to individually make scientific discoveries and to place them at the disposal of others.

Course content: The concept and the subject of research methodology. The significance of scientific research. The basic epistemological issues and problems. Division of sciences. The objectives and characteristics of research. Types of scientific research. The facts, hypotheses, laws and theories in scientific research. Theoretical and methodological basis of scientific research. The term, important features and classification of scientific research. The basic structure of the research. Research design: conceptualization and reconceptualization. The choice of research topic. Research project as scientific and operational-organizational document. The structure of the draft of scientific idea. Methods, techniques, procedures and instruments of scientific research. Research design: problem formulation, the subject and the goals of scientific research. Ethical issues in scientific research. The interdependence of teaching and research in the field of safety. Writing and publishing scientific paper. Doctoral thesis writing. Evaluation of scientific results.

SELECTED AREAS OF MATHEMATICS

Course objectives: Acquiring knowledge in mathematics needed for analysis, making models and simulation of structures and processes in living and working environment.

Learning outcomes: Students' ability to independently and/or in a team analyze mathematical problems in modeling and simulation of structures and processes in living and working environment. Adopting methods for choosing the software programmes for the analysis of risks and safety system in living and working environment.

Course content: Combinatorics and graph theory. Logic in computer science. Discrete matehematics. Theory of financial mathematics. Data processing and analysis. Statistics and random processes. Differential and difference equations. Numerical methods. Operational research. Optimization methods. Mathematical modeling. Risk simulation. The selected chapters from the theory of engineering experiments.

SYSTEMS RISK ANALYSIS

Course objectives: Gaining knowledge about continuous and discrete processes in living and working environment, their analysis, modeling and simulation, as well as the risk management of these processes using the method of systems analysis.

Learning outcomes: Individual and/or team problem solving in assessing partial and aggregate risks in living and working environment.

Course content: Basic systems concepts. Systems analysis. Continuous and discrete processes. Stochastic processes. Modelling and simulation of processes. Functional and network modelling. Ambiguity and risk. Risk, vulnerability, resilience and robustness of the system. Risk and vulnerability management. Business risks. Environmental risks. Risks in emergency situations. Risk aggregation. Extension of methods of risk analysis by organizational, individual and social factors. Hybrid models for risk analysis in complex systems. Application of the methods of multicriteria analysis, optimization and decision making in the selection of risk reducing options. Risk assessment software. Decision support systems in managing risks in complex systems.

PHYSICAL AND CHEMICAL PROCESSES IN WORKING ENVIRONMENT

Course objectives: Acquiring scientific competence, academic skills and creative abilities to improve the processes that would minimize the generation of chemical and physical hazards. The deepening of theoretical knowledge and principles for the protection from mechanical, electromagnetic, thermogenic and chemical processes.

Learning outcomes: Students should acquire skills to learn and understand the origin of physical and chemical hazards in work processes, characteristics of complex sources of hazards and their mutual negative effects, to understand and apply the methods for analysis, description and prediction, and to be able to design passive and active safety systems.

Course content: Principles of protection from physical hazards in the working environment. Hazards in mechanical processes - vibration, noise. Hazards in electromagnetic processes - ionizing and non-ionizing radiation. Hazards in thermogenic processes - thermal comfort. Chemical contamination of the working environment. Physical and chemical properties of gases, vapours and aerosols. Chemical processes in open-air working environment. Chemical processes in indoor working environment (production and non-production activities). Chemical processes in the ordinary course of production. Chemical processes in emergency production

SAFETY IN TECHNOLOGICAL SYSTEMS

Course objectives: Acquiring knowledge necessary for the analysis and selection of optimal solutions in terms of safety in technological systems.

Learning outcomes: Students should gain knowledge and skills for the analysis and application of methods and methodologies in terms of safety in technological systems.

Course content: Fundamentals of risk management in technological systems. The criteria for risk assessment of threats to workers' health in technological systems. Identification of hazards. Estimation of exposure, risk characterization and classification. Assessment of the risk consequences in technological systems on working environment. Implementation of protective measures and technical solutions with the aim to increase the level of safety in technological systems

DIAGNOSTICS AND MAINTENANCE OF TECHNICAL SYSTEMS

Course objectives: Scientific and technical procedures of the development, methods and means for recognizing the conditions of technical systems under the conditions of limited information. The acquisition of scientific competence, academic skills and creative abilities to improve the process of technical systems diagnostics, and system maintenance with the purpose of increasing safety and risk reduction.

Deepening of theoretical knowledge and principles of diagnostic methods and doctrines about technical systems maintenance. Development of proactive procedures for safety process management in terms of occupational safety.

Learning outcomes: Students will develop skills to understand the demands necessary to meet technical requirements during their use (effectiveness, availability, efficiency), without jeopardizing employees' safety and working environment. The application of methods for analysis, description and prediction of various processes, and the design of passive and active protection systems.

Course content: Technical systems diagnostics: A system of technical diagnostics. Procedures for the control of process parameters. Diagnostic tools (vibroacoustic, thermovision, corrosion, non-destructive testing).

Maintaining conditions of technical system: Models of technical system maintenance. Condition-based maintenance - Models for condition diagnostics. Proactive maintenance - forecasting and planning, minimizing risk. Quantifying the influential parameters related to the quality of the workplace and the environment.

ERGONOMICS OF PRODUCTS

Course objectives: Acquiring knowledge about the application of ergonomic findings and principles in the design of the product/environment (specially intended for different types of designers).

Learning outcomes: After successful completion of the planned programme content, students will be able to understand and apply basic ergonomic principles in the design of various products/systems in human environment, providing the basis for equal participation in the team during the design of products/systems and to evaluate ergonomic quality of a particular product/system/environment.

Course content: Ergonomics and design. Physical, cognitive and organizational ergonomics. Anthropometric data. Biomechanical data. Information receiving and processing. Ergonomic design principles. Safety, the efficiency of use and maintenance. Ergonomic recommendations for design in the electrical industry. Ergonomic recommendations for graphic design. Ergonomic recommendations for the design of transportation means. Ergonomic recommendations for furniture design. Ergonomic recommendations for the design of consumer products. Ergonomic recommendations for persons with special needs and the elderly. Ergonomic recommendations for the design of public spaces/environments.

ERGONOMICS IN AUTOMATED SYSTEMS

Course objectives: Acquiring knowledge about ergonomic design of centers for control and management of a variety of automated systems.

Learning outcomes: Upon successful completion of this course, students should be able to: describe the automation, specify human factors and define the man-machine system; choose the appropriate standards of ergonomic design in control and management centers; apply adequate ergonomic and information methods for the design of display boards, graphic displays, keyboards, command desks and working environment in the control centers of various automated systems (electric companies, air and rail traffic, large technological systems, etc.); analyze and assess emergency and stressful situations, operator errors and errors in control and management centers; design new control and management centers within complex systems, and provide suggestions for redesigning of the existing ones.

Course content: Automation and human factor. Development of the man - machine system for control and management of automated systems. Problem areas of research. Control and management center. Standardization of ergonomic design of control and management centers. Information research methods - information channels; throughput capacity of operators. Ergonomic research methods - work activities of operators; operator fatigue; mental models of operators activities; operators' training. Ergotechnical research of display panels, graphical displays, keyboards, command desks and working environment. The analysis of accidents and stressful situations. The analysis of operator errors and machine errors in control and management centers. Proposals for redesign and new design of control and management centers.

FIRE AND EXPLOSION RISK ASSESSMENT

Course objectives: Acquiring the knowledge required for the analysis and evaluation of fire and explosion risk and preparing students to apply scientific and professional achievements in solving the problems of fire and explosion safety problems, and to participate in development and management of fire and explosion safety systems.

Learning outcomes: Students will be able for risk assessment of fire and explosion with the aim to apply an integrated system of fire and explosion protection.

Course content: *Theoretical lessons* – Fire danger (primary and secondary). Fire risk as a result of the probability of fire and estimated losses and damages. Fire risk assessment (probability of occurrence and development). Determining the level of fire risk (potential and acceptable). Factors of fire risk assessment (fire load, fire location, ventilation, fire spread, the level of preventive safety, etc.). Methods for risk assessment (analytical, algebraic, numeric, etc.). Risk assessment of explosion and fire in buildings. Risk assessment of fire and explosion in the open air. Modeling fire and explosion in the indoor and outdoor space (physical and empirical models, models of mathematical analogies and simulation models).

Fire and explosion risk management.

Practical classes: Exercises, Other forms of teaching, Study Research Work

Computational exercises :Calculating parameters of fire and explosion risk

Practical classes: Modeling fire and explosions, field work

Study research work: Project tasks

INTEGRATED SAFETY SYSTEMS

Course objectives: Acquiring scientific competence, academic skills and creative abilities for integrated problem-solving.

Learning outcomes: Students will acquire skills, knowledge and understanding of the characteristics of processes within complex technological units.

Acquisition professional competence for:

- developing an integrated management strategy,
- developing the methods and methodology for integrated management,
- integrated management of subjects in safety systems.

Course content: The concept of integrated safety system. Risk-based system analysis of safety. Process-based approach to integration. Basic elements of integration of planning process, quality management, risk assessment, maintenance, monitoring and verification (monitoring and audits), training, organizational learning, change management, emergency response, reporting and documentation, as well as the process of managing resources (human, intellectual, material, financial). Standards of system and software engineering and systems for risk reduction. Performance and criteria for interoperability and integration of safety systems. Modelling and simulation of systems risk in an organization. Life cycle models of an integrated safety system. Models for interactive team management of an integrated safety system. Tools for support to interactive teamwork and decision-making

ELECTROMAGNETIC RADIATION

Course objectives: Gaining theoretical and practical knowledge necessary to explore the issues of electromagnetic radiation in the working environment.

Learning outcomes: Gaining knowledge to find optimal ways of protection from the effects of electromagnetic fields and radiation from non-ionizing radiation (UV, IR, LF and HF electrical radiation) and ionizing radiation (X-rays and nuclear) in the working environment.

Course content: Corpuscular quantum electromagnetic radiation: Wave–particle duality. Quantum models of the atoms. Potential well. The tunnel effect. Secondary quanting. General characteristics of the wave functions and energy eigenvalues. The principle of superposition. Orthonormality. The Schrödinger equation. The evolution of the wave function in time. A continuity equation. Linear operators. One- dimensional, two- dimensional and three-dimensional Schrödinger equation. The linear harmonic oscillator. Quantum theory of angular momentum. Approximation methods. Perturbation theory. Variational methods. Numerical methods. **Thermal radiation:** measurement, standardization, sources of radiation; impact on humans; application and methods of protection. Methods of technical investigation using thermal radiation, thermography. **Ultraviolet radiation:** radiation sources; impact on humans and the application; harmful effects; standardization and methods of protection; ultraviolet germicidal irradiation. Application of UV radiation in disinfection in industry and medicine. **Ionizing radiation:** the absorption law; doses and dosimetry of ionizing radiation. X - radiation (roentgen) in industry and medicine; Optimization of radiation protection, optimization. Optimization and global optimization. The control and quality assurance programmes. Measurement and protection from ionizing radiation. **Macroscopic electromagnetic field of electrical devices:** the antenna and the radiation of electromagnetic energy. Sources of low frequency and high frequency electromagnetic radiation. Process modeling of electromagnetic fields. Penetration of electromagnetic waves into buildings and biological organisms. The biological effects of electromagnetic fields on living systems, biological harmful effects on biological systems, animals and humans. Standardizing the size of the electromagnetic fields. Continuous monitoring of electromagnetic radiation, electromagnetic compatibility, the impact of electromagnetic radiation on technological and municipal systems, methods to eliminate electromagnetic interference in municipal systems.

HUMAN RELIABILITY

Course objectives: Acquiring knowledge for practical implementation of human reliability assessment methods.

Learning outcomes: Upon successful completion of this course, students should be able to: identify the nature of human behavior and describe the causes of human error; determine the factors that influence human reliability, as well as the main indicators of operator reliability; choose and apply the appropriate method for assessing human reliability; assess human reliability individually or as a team, depending on the nature of the job and the organization being analyzed; create database of human errors, formulate error mechanisms and performance shaping factors; design procedures and strategies for reducing human errors and explore new areas in which they can be applied; critically analyze and interpret significant facts about investigated accidents and human errors.

Course content: Development of methods human reliability assessment. Theories about accidents and disaster overview. Development of "human–machine system". Reliability of "man – machine" system. Probability of safety assessment. Identification and presentation of human error. Methods of human reliability: Cognitive Reliability and Error Analysis Method; Assessment method for the performance of safety operations; Technique for Human Error Analysis; Human Reliability Management System; Human Cognitive Reliability; Simplified Plant Analysis Risk Human Reliability Assessment; Nuclear Action Reliability Assessment; Controller Action Reliability Assessment- Socio-Technical Assessment of Human Reliability, etc. Trends in the development of methods for human reliability assessment. Case studies - practical application of commonly used methods.

DESIGN OF THE SYSTEMS FOR NOISE AND VIBRATION PROTECTION

Course objectives: Acquiring scientific competence, academic skills and creative skills to solve specific problems in the workplace environment generated by noise and vibration, through source identification and characterization, and passive and active control of noise and vibration.

Learning outcomes: Skills: knowledge and understanding the origin of noise and vibration; knowledge and understanding of the characteristics of complex sources of noise and vibration; knowledge, understanding and application of methods for analyzing, describing and predicting noise and vibration; modelling of noise and vibration propagation from the source to the environment using the appropriate methods and software; measurement and analysis of noise and vibration; the design of passive and active systems for noise and vibration protection.

Course content: Sources of noise and vibration: basic properties, interaction between solid structures and sound waves, generating sound and vibration, indoor and outdoor transmission of sound. Noise modelling: monopole, dipole, quadrupole, cylindrical source of noise. Modeling the propagation of noise and vibration: analytical techniques, models, software. Numerical methods: finite element method. Sound fields: one-dimensional and three-dimensional sound field, the propagation of waves in the mobile media. Advanced measurement techniques: time domain analysis, frequency domain analysis, analog and digital signal analysis. Methods for identifying sources of noise and vibration: the conventional methods in time domain and frequency domain, cepstrum analysis, envelope analysis, method of sound intensity, acoustic holography, vibration condition monitoring.

Passive methods for noise and vibration control: barriers, cabins, vibroinsulation materials, vibroabsorption materials, acoustic treatment of rooms, sound-absorbing materials. Active methods for noise and vibration control: active control of sound propagation in ducts, active control of sound radiation from a vibrating structure, active control of sound propagation in enclosed spaces, active vibration isolation. Active systems with and without feedback. Design of passive and active systems for protection from noise and vibration.

DESIGN OF INTEGRATED FIRE AND EXPLOSION PROTECTION

Course objectives: Acquiring knowledge necessary for solving problems of fire protection and fire protection system management with the aim to implement an integrated fire and explosion system of protection.

Learning outcomes: Students will be qualified to develop methodologies, methods and procedures for the management of integrated fire and explosion safety system.

Course content*:Theoretical Lessons:* Systems for automatic detection and fire alarm systems (conventional, addressable and analogue addressable). Fire detectors - types and criteria for selection and placement inside the building. Control panels. Fixed fire extinguishing systems (types and applications). Fire hydrant network. Fixed water fire extinguishers (sprinklers and drenchers), foam fire extinguishers, CO_2 fire extinguishers, powder CO_2 fire extinguishers, etc. Selection and calculation of elements of fixed fire-extinguishing systems.

Systems for detection of flammable gases or vapours. Explosion protection systems. Smoke and dust extraction systems.

Integrated systems of fire and explosion protection.

Practical classes: Practice, Other forms of teaching, study research work

Study research work: Project tasks

ELECTROTECHNICAL SAFETY SYSTEMS

Course objectives: Acquiring the knowledge required for the use, design and research of electro-technical systems of occupational safety and fire protection in the working and living environment.

Learning outcomes: Students will develop competence to analyze, control, monitor and design the systems together with the engineers with diverse expertise, and to develop knowledge for generating methods and procedures for management of integrated safety systems that include electro-technical systems.

Course content: Lighting protection electrical systems. Electrical systems for protection from the harmful effects of electricity. Electromagnetic compatibility. Grounding and bonding electrical systems. Static electricity and elimination systems. Electrical systems for fire protection, protection from burglary and protection in emergency situations. Integration and collaboration of electrical systems in occupational and environmental safety. Electrical systems and pollution of workplace environment. Electrical systems and their impact on human health.

MANAGING THERMAL COMFORT IN THE WORKING ENVIRONMENT

Course objectives: Acquiring knowledge about comfort parameters of the workplace environment. Understanding the elements of thermal comfort and other factors in relation to the specific characteristics of workplace and work operations, with the aim to improve working conditions and workers' health. Qualification for managing thermal comfort parameters in the working environment.

Learning outcomes: Ability to apply the knowledge in practice with the aim to improve working conditions, preserve health and increase productivity. The use of modern software tools in managing comfort parameters of the working environment and the implementation of occupational health and safety measures.

Course content: Elements of comfort of the working environment, thermal comfort, lighting, noise and vibration. Workplace and the environment – comfort parameters - thermal comfort. Objective and subjective feeling of comfort, human metabolic processes, energy balance in man - the balance of thermal energy. Heat losses and heat gains in the interaction with technological processes and operations in the workplace. Latent heat, convection and radiation in the interaction between of human bodies and the workplace environment, work environment and indicators of thermal comfort. The influence of other factors on thermal comfort - gender, age, habits, etc. Metrology of thermal comfort with specific workplace conditions. Measures and conditions for providing optimal conditions in the workplace. The ability to manage comfort parameters in the worker – workplace interaction. Application of software in describing thermal comfort

PROFESSIONAL RISK MANAGEMENT

Course objectives: Acquiring knowledge and skills to analyze the status of occupational safety and health system and the choice of optimal solutions in terms of professional risk management.

Learning outcomes: Gaining knowledge that allows the development and implementation of optimal solutions in the process of professional risk management.

Course content: Methods and methodologies for professional risk assessment. Quantitative and qualitative methods of assessment. Qualitative and quantitative indicators of the quality of the working environment in terms of professional risk management. Identification of professional risk on the basis of the parameters of the working environment, which characterize undesired events: injuries, occupational diseases, work-related illnesses and other indicators of the quality change of workplace environment. Standardization and professional risk. The culture of safety in terms of professional risk management.

TOXICOLOGY

Course objectives: Acquiring knowledge about toxicity of chemical agents in workplace environment, their movement from the source to entry into human organism, moving through the body and their effects on target organs and systems. The choice of methods for the assessment of health risks, not only for the occurrence of poisoning and injuries, but also for excessive mortality in certain professional groups.

Learning outcomes: Students will be able to understand the phenomena, the principles and the rules in toxicology; to determe dominant routes of entry of occupational chemical agents, their absorption, transport and deposition in the target organs and systems, as well as the mechanisms of their action; to apply the methods for assessing health risks from toxic substances; to determine the level of safety in the workplace and establish measures for prevention or reduction the occurrence of professional poisoning.

Course content: Toxic substances. Properties of toxic substances. Classification of toxic substances. Special groups of toxic substances. Exposure to toxic substances. Toxic effect. Toxic parameters. Research of substance toxicity. Toxicokinetics. Toxicodynamics. Occupational safety measures when working with toxic substances. Inorganic toxic substances. Organic toxic substances. Introduction to the chemical analysis of working atmosphere.

HAZARDOUS SUBSTANCE MANAGEMENT

Course objectives: Acquiring scientific knowledge and principles necessary for the evaluation, analysis and management of risks caused by hazardous substances throughout all stages of the operating cycle within technological systems that contain hazardous materials, from the design, the construction, the use to their degradation.

Learning outcomes: Knowledge and understanding of the issues related to hazardous substance management in terms of safety, and the importance of a comprehensive response to the question "How safe is safe enough?".

Course content: Actualization and importance of hazardous substance management. Hazardous substances in manufacturing, logistics and transport processes. The classification of hazardous substances and harmonization of regulations. Characteristics of hazardous substances and requirements related to this type of material: packaging, storage, transportation. Determining risks when working with hazardous substances in manufacturing, logistics and transport processes: identification, analysis, risk assessment, risk monitoring. Risk management in working with hazardous materials. Risk management of hazardous substances in manufacturing facilities – determining the criteria, procedures and algorithms with the aim to minimize risk. Vehicle routes in transportation of dangerous goods – determining criteria, procedures and algorithms with the aim to minimize risks in transport. Defining the location for the storage of hazardous materials – postulating a problem, algorithm solution. Preventive protection from undesirable effects of hazardous substances: detection, alarm and safety systems. Safety procedures and training as a form of preventive action in case of undesirable event caused by hazardous materials.

WORKING ENVIRONMENT AND HEALTH

Course objectives: Acquiring knowledge about the influence of occupational hazards and workload on employees' health and quality of life, and the selection of risk assessment method for the occurrence of disease and injuries, loss of work ability and excessive mortality in certain professional groups.

Learning outcomes: Qualifications for professional health risk assessment and studying the mechanisms of the impact of occupational hazards and workloads on the organs and systems in the human body; organizing the research that will improve the quality of life and reduce the burden of disease and excessive mortality; forecasting and organizing other measures that will prevent or reduce the occurrence of occupational diseases and occupational trauma.

Course content: Healh risk assessment of potential risks and hazards in the workplace. Determining specific demands and workload, and health risks. Ambient monitoring of physical hazards (noise, vibration, thermal loads, ionizing radiation, electromagnetic fields, radiation) and their impact on the health of the exposed. Ambient monitoring of biological hazards and health risk. Ambient monitoring of chemical hazards and combined toxic effects (additive, synergistic and antagonistic). Interaction between occupational hazards and dangers and assessment of health outcomes. Determining bio-indicators (indicators of exposure, impact indicators and indicators of sensitivity) in chronic occupational exposure and health risk assessment. Methods for evaluating the interaction between the risks from the living and working environment to health and work ability. Descriptive epidemiological methods in the study of health disorders resulting from the hazards in the working and living environment, descriptive epidemiological studies (cohort studies, clinical history studies, environmental studies). Assessment of burden of disease and excessive mortality.

COLLABORATIVE INFORMATION SYSTEMS

Course objectives: To familiarize students with contemporary theoretical and practical aspects of Collaborative Information Systems, information technologies for support to management and decision-making processes, basic methods, techniques and tools for the development of information and collaborative systems management in working and living environment protection.

Learning outcomes: Knowledge and understanding of the role, fundamentals, concepts and structure of collaborative information systems. Practical knowledge and skills about the methods, techniques and software tools for design management of collaborative information systems. Practical knowledge and skills in implementing modern software solutions of artificial intelligence, expert systems. DSS decision support systems in living and working environment. Knowledge about information systems as a basis for monitoring networks in the living and working environment. Application of collaborative information systems in living and working environmental protection. The use of collaborative information systems in change management of living and working environmental protection.

Course content: ***Information and data for risk analysis and risk assessment in the workplace.*** The acquisition, storage, and processing of information from the living and working environment. Models for data processing and data analysis. The organizational aspects of information systems. Structures and processes in local and distributed information systems. Information and communication technologies as technical foundation of information systems. Network architecture, network hardware and software. Information systems as a basis for monitoring networks in the workplace. ***Safety techniques in computer networks and distributed systems***. Protecting data about human resources. ***Systemic approach to collaboration.*** Interoperability of systems. The structure and elements of collaborative systems. Processes and flows in collaborative systems. Standards and standardization of collaborative systems. Technological aspects of collaboration. Modeling of collaborative systems. Managing collaborative processes and process integration. Multimedia collaboration systems. Collaborative systems intended for heterogeneous systems. Organizational and procedural aspects of collaboration. Organizational structure in relation to collaboration. Collaborative chains and multi-collaboration organization. The human factor as the limiting factor of collaboration. The use of collaborative systems in working environment protection.

ECONOMIC VALORIZATION OF PROJECTS IN THE WORKING ENVIRONMENT

Course objectives: To educate PhD students to master economic categories related to the achievement of the objectives connected to the improvement of the working environment.

Learning outcomes: Acquiring knowledge and skills required in this area.

Course content: The position of economics in the study of environmental problems. Economic crisis and the possibility of its solutions. Economic, social and cultural aspect. Economic and cultural aspects of the working environment safety. Economic indicators of occupational safety performance. Sources of data and information for economic analysis of occupational safety. The methodology and methods for making the policy plans of feasibility studies and other projects in the field of working environment safety. Methods for economic valorization of the projects in the workplace environment. Impact analysis of project implementation on the condition of occupational safety and health. Condition and directions of occupational safety and health development in Serbia and the European community. Software for project analysis and project management.

ENGINEERING ETHICS

Course objectives: The aim of the course is the acquisition of knowledge that contribute to the development of ethical norms and acceptance of the principles of engineering ethics among PhD students. In point of fact, students will be able to professionally and responsibly fulfill their tasks - taking into account the consequences of their activities. This can apply to short-term and local consequences as well as to those that occur over a longer period of time and may include the regional and global environment.

Learning outcomes: The ability of future doctors of science to responsibly discern when performing professional practice, to use the knowledge acquired during the course in everyday interference with scientific, technical, social and ecological environment in which they work, and for which they are responsible.

Course content: *Theoretical lessons:* Ancient, medieval and Christian attitude towards work and professional ethics. The Protestant Ethic and the Spirit of Capitalism. Three traditions of normative ethics significant for engineering business ethics. Engineering ethics in Serbia in the 19th century. Understanding professional ethics in the 20th century (the ideology of new occupations). Engineering ethics: organization and development, professional ethics and the spirit of globalization. Ethical dimensions of technical knowledge; professional ethics as a basis for integration of knowledge society. Engineering ethics in the context of modern business. Engineering ethics and environmental safety - engineering ethics and local, regional and global environmental problems. Codes of Engineering (U.S. and Serbian code of engineering ethics). The consequences of applying technique and science.

Practical classes: Exercises, Other forms of teaching, Study Research Work

Auditory lessons. Seminar paper

KNOWLEDGE MANAGEMENT AND DECISION-MAKING IN WORKING ENVIRONMENT

Course objectives: To familiarize students with contemporary theoretical and methodological approaches in knowledge management and decision-making strategies in safety.

Learning outcomes: Developed competence and methodological qualification for knowledge management and decision-making in safety.

Course content: Knowledge as a factor in the acquisition, creation and sustainability of safety and competitive advantage. Epistemology (the history of knowledge, data, information, knowledge, types of knowledge - explicit/implicit). Knowledge management (intellectual capital, knowledge cycle, knowledge economy). The essence and the process of knowledge management (history, concepts, importance, life cycle, approaches and knowledge models, association with a teaching organization). A framework for creating successful knowledge management programmes. Technologies for knowledge management. Structure and processes for knowledge management. The life cycle of knowledge management. Implementation of knowledge management strategy. Development of human resources and knowledge management. Knowledge bases and ontologies in the field of occupational safety. Knowledge management in occupational safety. Communities of practice in occupational health based on knowledge. Control and knowledge management (concept, process and types of controls, knowledge control in the chain of knowledge, knowledge control in practice). Organizations based on knowledge. Knowledge management and decision-making. Structure and decision-making processes. Decision-making models. Decision-making under uncertainty and risk. Multiple criteria decision making (Multi Attribute Decision Making and Multi Objective Decision Making). Decision support technology. Software tools and decision support systems. Decision-making in the field of occupational safety. Decision support systems in occupational safety.

STUDY RESEARCH WORK 1

Course objectives: Deepening the theoretical and methodological, scientific-technical and vocationally applicative knowledge in the field of occupational safety engineering.

Learning outcomes: Training students to make independent associations in the subject matter of doctoral studies, to comprehensively view and analyze the problems in the field of occupational safety and publish the results of their research.

Course content: The content is developed individually in accordance with the needs of further work. A student examines scientific literature, and if necessary performs laboratory, experimental and simulation research in the field of a study programme, conducts scientific research projects in the field of occupational safety engineering, participate at seminars and conferences, and publishes scientific papers.

STUDY RESEARCH WORK 2

Course objectives: The application of basic theoretical-methodological, scientific-technical and professional-applicative knowledge in solving specific problems within the selected field of doctoral studies.

Learning outcomes: Training students to independently and creatively apply previously acquired knowledge in various fields with the aim to understand the structure of the original problem, perform systematic analysis of the problem, and consider the possible directions of problem-solving and choice of optimal or, in the given conditions, satisfactory solution.

Course content: The content is developed individually in accordance with the selected areas and needs for further research. A student examines scientific literature, performs the analysis with the aim to find solutions to a specific problem which is defined by the instructions from the professors at doctoral studies or mentors. If necessary, a student performs laboratory, experimental and simulation research, conducts scientific research projects in the field of occupational safety engineering, participate at seminars and conferences, and publishes scientific papers.

STUDY RESEARCH WORK 3

Course objectives: The application of the acquired theoretical-methodological, scientific-technical and professional-applicative knowledge to solve specific problems within the selected topic of the Ph.D thesis.

Learning outcomes: Developed skills of critical thinking and the ability of students to independently, creatively and innovatively apply the acquired knowledge in various fields with the aim to solve the problems identified in the area of occupational safety, by developing alternative solutions, their simulation, the analysis of advantages and disadvantages and the choice of the appropriate, optimal or a satisfactory solution in given circumstances.

Course content: The content is designed individually in accordance with the approved topic of doctoral dissertation. The student examines scientific and professional literature, performs the analyses with the aim to find a solution to a specific problem defined by the mentor. A student performs laboratory, experimental and simulation research, conducts scientific research projects, participates at seminars and conferences by communicating his/her research results and publishes scientific papers in international journals.

STUDY PROGRAMME

ENVIRONMENTAL ENGINEERING

THE PURPOSE OF THE STUDY PROGRAMME

- Developing and connecting fundamental and applied scientific disciplines in environmental engineering in interdisciplinary and multidisciplinary context and modern scientific research trends worldwide. The ultimate intention is to improve the theory and practice of environmental safety at all levels, starting from the individual, the organization, local community to the society, in the context of conception and strategy of sustainable development.
- Development of competence for independent, scientifically and socially relevant research and their application in practice of environmental safety and creating sustainable solutions.
- Qualifying experts with high scientific culture that requires the abilities of critical thinking and analyses, creativity, originality, inventiveness and innovation in various fields of professional activity.

STUDY PROGRAMME OBJECTIVES

- Training for critical analysis and research of the domains, strenghts and responsibilities of science and environmental safety practice in implementing the conception and strategies of sustainable development.
- Developing scientific knowledge, competence and academic skills for interdisciplinary and multidisciplinary approach, critical examination and studying fundamental problems of environmental safety based on modern paradigms, as well as dealing with the key issues of environmental safety practice.
- Developing critical thinking and active reflection necessary for the development, conceptualization and implementation of environmental safety policies and strategies and educational interventions in social , industrial, ecological and educational context in Serbia, and a critical approach to the possibilities of implementing modern achievements worldwide in environmental safety theory and practice in the national context.
- Training for self-organizing, managing and implementation of scientific research, the involvement in both national and international projects and competent communication of research results.
- Developing the ability for associating, improvement and advancement of knowledge gained at basic and master studies, and raising awareness about the need for lifelong learning and continuous professional development.

STUDY PROGRAMME OUTCOMES

The study programme of doctoral studies enables students to, after completing the studies, acquire knowledge, skills and developed abilities to:

- understand and use modern knowledge in the field of environmental safety engineering,
- organize and implement innovative, developmental and scientific research,
- verify the results through patents and new technical solutions,
- individually solve theoretical and practical problems in the field of environmental engineering,
- develop new technologies and procedures for air, water, soil protection,
- critical thinking, creative and independent actions,
- respect ethical principles and good scientific practice,
- connect on a professional level in communicating scientific research results at scientific conferences and in scientific journals,
- develop scientific disciplines – environmental engineering and science in general through critical analysis, evaluation and synthesis of new and complex ideas, and
- promote technical - technological progres, sustainable development and culture of environmental safety in academic and professional environment.

After completing the study programme, the student shall acquire the following competencies for:

- thorough knowledge and understanding of environmental safety engineering,
- solving problems using scientific methods,
- associating basic knowledge in various fields and their application in environmental engineering,
- following contemporary professional achievements,
- developing skills and competence in using knowledge for protecting natural and cultural values,
- the use of information and communication technologies, and
- working in multidisciplinary teams .

The students' competence shall be verified during the study through publication of scientific research within the selected scientific areas in reference scientific journals.

THE STRUCTURE OF THE STUDY PROGRAMME

ID		COURSE	S	Status	Active classes		ECTS
					L	SRW	
FIRST YEAR							
1		Scientific Research Methods	1	C	4	2	10
2		Selected Areas of Mathematics	1	C	4	2	10
3		Systems Risk Analysis	1	C	4	2	10
4		Optional course	2	B	3	3	10
		Physical and Chemical Processes in Living Environment		E	3	3	10
		Methods of Environmental Safety Management		E	3	3	10
5		*Study Research Work 1*	2	C	0	16	20
Total active classes per year = 40							
Total ECTS credits= 60							
SECOND YEAR							
6	Within the same group of elective courses	*Elective course*	3	B	3	3	10
7		*Elective course*	3	B	3	3	10
		Elective Courses, Block 1					
		Air Quality Monitoring and Management	3	E	3	3	10
		Monitoring and Management of Air Pollution Emission	3	E	3	3	10
		Air Pollution and Health Risk	3	E	3	3	10
		Air Protection and Sustainable Energy Systems	3	E	3	3	10
		Economic Valorization of the Projects in the Living Environment	3	E	3	3	10
		Environmental Ethics	3	E	3	3	10

	Elective Courses, Block 2					
	Energy Processes in the Living Environment	3	E	3	3	10
	Electromagnetic Radiation in the Living Environment	3	E	3	3	10
	Alternative Energy Sources	3	E	3	3	10
	Selected Chapters from the Sustainable Development Theory	3	E	3	3	10
	Living Environment and Health	3	E	3	3	10
	Economic Valorization of the Projects in the Living Environment	3	E	3	3	10
	Risk Management in Energetics	3	E	3	3	10
	Electrotechnical Safety Systems	3	E	3	3	10
	Elective Courses, Block 3					
	Technogenic Risk Management	3	E	3	3	10
	Human Reliability	3	E	3	3	10
	Ecological Risk Management	3	E	3	3	10
	Risk, Crisis and Emergency Management	3	E	3	3	10
	Risk Assessment of Fire and Explosion in the Living Environment	3	E	3	3	10
	Living Environment and Health	3	E	3	3	10
	Soil Pollution and Remediation	3	E	3	3	10
	Selected Chapters from the Sustainable Development Theory	3	E	3	3	10
	Collaborative Information Systems	3	E	3	3	10
	Elective Courses, Block 4					
	Waste Management	3	E	3	3	10
	Bioclimatic Planning	3	E	3	3	10
	Selected Chapters from Urban Ecology	3	E	3	3	10
	Integrated Environmental Management	3	E	3	3	10
	Diagnostics and Mapping Acoustic Processes	3	E	3	3	10
	Designing Noise Protection Systems	3	E	3	3	10
	Water Quality Management	3	E	3	3	10
	Water Pollution and Health Risk	3	E	3	3	10

	Environmental Ethics	3	E	3	3	10
	Selected Chapters from the Sustainable Development Theory	3	E	3	3	10
	Knowledge Management and Decision-making in Working Environment	3	E	3	3	10
	Electromagnetic Radiation in the Living Environment	3	E	3	3	10
8	Study Research Work 2	3	C	0	8	10
	Study Research Work 3-1	4	C	0	20	30
Total active classes per year = 40						
Total ECTS credits = 60						
THIRD YEAR						
9	Study Research Work 3-2	5	C	0	20	30
	Study Research Work 3-3	6	C	0	20	20
10	Doctoral Dissertation Writing and Defense	6	C	0	0	10
Total active classes per year = 40						
Total ECTS credits = 60						

S – semester, L – lectures, SRW – Study Research Work, C - compulsory course; E - elective course; B – block courses

CURRICULUM

SCIENTIFIC RESEARCH METHODS

Course objectives: Understanding the concept of scientific truth, the goals of scientific research, basic methodological tools and methodological novelties of the ruling scientific paradigms with the aim to find the answers how to grasp the nature of current phenomena and processes in technical and technological sciences.

Learning outcomes: Theoretical and practical knowledge about the methods, tools and techniques for conducting scientific research. Students' ability to think scientifically and creatively, to determine and methodologically study diverse phenomena and issues; and be methodologically competent to individually make scientific discoveries and to place them at the disposal of others.

Course content: The concept and the subject of research methodology. The significance of scientific research. The basic epistemological issues and problems. Division of sciences. The objectives and characteristics of research. Types of scientific research. The facts, hypotheses, laws and theories in scientific research. Theoretical and methodological basis of scientific research. The term, important features and classification of scientific research. The basic structure of the research. Research design: conceptualization and reconceptualization. The choice of research topic. Research project as scientific and operational-organizational document. The structure of the draft of scientific idea. Methods, techniques, procedures and instruments of scientific research. Research design: problem formulation, the subject and the goals of scientific research. Ethical issues in scientific research. The interdependence of teaching and research in the field of safety. Writing and publishing scientific paper. Doctoral thesis writing. Evaluation of scientific results.

SELECTED AREAS OF MATHEMATICS

Course objectives: Acquiring knowledge in mathematics needed for analysis, making models and simulation of structures and processes in living and working environment.

Learning outcomes: Students' ability to independently and/or in a team analyze mathematical problems in modeling and simulation of structures and processes in living and working environment. Adopting methods for choosing the software programmes for the analysis of risks and safety system in living and working environment.

Course content: Combinatorics and graph theory. Logic in computer science. Discrete matehematics. Theory of financial mathematics. Data processing and analysis. Statistics and random processes. Differential and difference equations. Numerical methods. Operational research. Optimization methods. Mathematical modeling. Risk simulation. The selected chapters from the theory of engineering experiments.

SYSTEMS RISK ANALYSIS

Course objectives: Gaining knowledge about continuous and discrete processes in living and working environment, their analysis, modeling and simulation, as well as the risk management of these processes using the method of systems analysis.

Learning outcomes: Individual and/or team problem solving in assessing partial and aggregate risks in living and working environment.

Course content: Basic systems concepts. Systems analysis. Continuous and discrete processes. Stochastic processes. Modelling and simulation of processes. Functional and network modelling. Ambiguity and risk. Risk, vulnerability, resilience and robustness of the system. Risk and vulnerability management. Business risks. Environmental risks. Risks in emergency situations. Risk aggregation. Extension of methods of risk analysis by organizational, individual and social factors. Hybrid models for risk analysis in complex systems. Application of the methods of multicriteria analysis, optimization and decision making in the selection of risk reducing options. Risk assessment software. Decision support systems in managing risks in complex systems.

PHYSICAL AND CHEMICAL PROCESSES IN LIVING ENVIRONMENT

Course objectives: Acquiring scientific competence, academic skills and creative abilities to improve the processes that would minimize the generation of chemical and physical hazards. The deepening of theoretical knowledge and principles for the protection from mechanical, electromagnetic, thermogenic and chemical processes.

Learning outcomes: Students should acquire skills to learn and understand the origin of physical and chemical hazards in work processes, characteristics of complex sources of hazards and their mutual negative effects, to understand and apply the methods for analysis, description and prediction, and to be able to design passive and active safety systems.

Course content: Principles of protection from natural hazards in the living environment. Hazards in mechanical processes – noise and vibration. Hazards in electromagnetic processes – non-ionizing and ionizing radiation. Hazards in thermogenic processes – thermal comfort. The processes of chemical pollution of the ambient air (ground deposition; photochemical, homogeneous and heterogeneous processes; ozone distribution; reactions of sulfur dioxide, organic compounds, nitrogen oxides, oxidoreduction processes; processes that overheat the atmosphere). Physical and chemical processes in the hydrosphere: homogeneous and heterogeneous chemical processes in natural waters. The flow of matter in water. Solar radiation effect. Detecting water constituents. Hydrologic cycles. The processes of chemical soil contamination (processes of solid, liquid and gaseous phases of soil and the phase interaction; chemical reactions of soil colloids, chemical reactions of soil pollution). Chemical processes between the environmental spheres.

METHODS OF ENVIRONMENTAL SAFETY MANAGEMENT

Course objectives: Mastering the theoretical knowledge about the methods, methodologies and mechanisms for environmental safety. Application of voluntary tools and less formal approaches to environmental safety management.

Learning outcomes: Students will be competent to examine the methods and principles of environmental management, to design and implement the concepts of environmental management, environmental safety mechanisms and tools to improve the environmental safety.

Course content: The living environment today and concepts of safety - sustainable development, sustainable development indicators. Ecological crisis and the response of the international community: aspects and impacts. Evaluation of the significant environmental aspects. The situational analysis and impact analysis. Trends in environmental safety management. Tools for environmental management on a voluntary basis (standards). Methods of control and management of environmental safety: types of control, waste management, chemicals management, wastewater management, air quality management, energy impact management. Less formal approaches for environmental management. Environmental performance evaluation. Clean production. Energy efficiency and energy efficiency management. Environmental auditing. Life cycle assessment. Integrated product policy. Environmental performance indicators. Reporting on the Environment. Risk assessment and risk management. Monitoring for the purpose of environmental safety management: monitoring and measuring environmental impact, indicators of the environmental performance, environmental quality. Emergency situations and emergency response in terms of environmental safety management.

AIR QUALITY MONITORING AND MANAGEMENT

Course objectives: Studying modern methods for the assessment of air quality, strategies of ambient air pollutant monitoring and principles of air quality management based on monitoring.

Learning outcomes: Qualifications for a multidisciplinary and integrated approach to monitoring ecological status of the atmosphere, planning and implementation of air quality monitoring programmes, as well as making management decisions based on the monitoring results.

Course content: Monitoring and management: The term and the indicators of air quality. Monitoring and measuring air quality indicators. Air quality assessment methods.

Monitoring system planning: The role of monitoring. Monitoring objectives. Functions. Air quality assurance and air quality control. Air monitoring network plans.

Monitoring strategies of certain pollutants: carbon monoxide, ozone, nitrogen dioxide, suspended particulate matter (PM10, PM2,5, PM1, benzene, polycyclic aromatic hydrocarbons, lead, atmospheric cadmium). Monitoring systems: Elements and functions of the system. Types of monitoring systems (centralized and distributed). Monitoring levels (organizational, local, national, international). Critical analysis of the existing monitoring systems. Software for air quality monitoring.

Quality modeling and decision-making: Air quality and pollution sources - from assessment to management. Ambient air quality modelling. Atmospheric dispersion pollution. Receptor-based models. Statistical models. Personal exposure models. Decision based on air quality indicator monitoring. Decision support software.

MONITORING AND MANAGEMENT OF AIR POLLUTION EMISSION

Course objectives: Studying modern methods for assessing air pollution emissions from stationary and mobile sources of air pollution, strategies for reducing pollutant emission by purification techniques and introducing cleaner technologies and principles of air pollution emission management based on monitoring.

Learning outcomes: Qualification for a multidisciplinary and integrated approach to research, design and establishing air pollution monitoring systems in planning and implementing emission reduction programmes by using purified gases and zero emission technologies.

Course content: Monitoring of air pollution emissions; Classification of monitoring. Standardizing pollution soures. Planning and functioning of the source emissions monitoring systems. Determining total emission. Monitoring of diffuse and fugitive emissions. Monitoring of emergency emissions. Data collection system; Derived parameters; Reporting on measurement results. Terms and conditions of control implementation; Type and volume of control; The criteria that determine the fulfillment of the conditions. Register of emission sources. Air pollution emission management: the separation of contaminants, transformation of contaminants, reducing emissions by choosing raw material, the choice of technologies that do not require the use of air and water, the use of regenerative technologies, application of nanotechnology.

AIR POLLUTION AND HEALTH RISK

Course objectives: Introduction to modern scientific methods of causality assessment of developmental, spatial and temporal correlation between air pollution and health risks in the exposed population, as well as the application of scientific methods of health risk assessment and classification. Understanding biochemical mechanisms of air pollutants with the aim to evaluate the consequences of the effects of air pollution on health and life quality of the exposed population.

Learning outcomes: Competence for adopting scientific, multidisciplinary and integrated conclusions about materially-substantial content, temporal, genetic-developmental and causal relationship between air pollution and health risks, as well as the possibility of adequate measures for protection of health of the exposed population.

Course content: Health risk assessment through the stages of assessment, dose- response relationship, hazard identification, exposure assessment and risk characterization phase. Evaluation of potential dose, accepted doses and internal inhaled doze of air pollutants. Evaluation of substance toxicity, the assessment of the level of the reference dose and exposure assessment. Modern epidemiological methods of studying causal relationship between health problems and air pollution. Planning and functioning of biomonitoring in terms of health risk assessment. Identification of health risk areas and implementation of protective measures.

AIR PROTECTION AND SUSTAINABLE ENERGY SYSTEMS

Course objectives: The study of basic principles, thermodynamic conditions and limitations of the processes of obtaining, transmitting and transformation of energy, energy and environmental importance of energy efficiency. Studying the possibilities of improving energy processes, raising their energy efficiency in order to reduce the environmental impact on air and global climate as well.

Learning outcomes: Competence for research and creative implementation of knowledge in scientific research of eficient energy use, increasing the quality of processes and energy saving through improving energy efficiency, with the purpose of reducing pollutant emission.

Course content: Energy efficiency: Energy efficiency and sustainable development. Energy efficient technologies. Problems and possibilities of using cogeneration and trigeneration. The use of waste heat. Energy management: Energy management programmes. Measurement, management and visualization of processes. Air protection and sustainable development: Environmental impact assessment studies. IPPC recommendations. The BAT (Best Available Techniques) Reference Document (BREF). Implementation of international standards. Implementation of the Kyoto Protocol. The EU Directive on renewable energy. Activities and initiative in air protection and climate change. Reducing emissions of air pollution with the aim to use sustainable energy systems: Treatment and utilization of waste materials from energy processes. Concepts and projects of cleaner production. The use of waste materials as fuel. The use of local fuels. The use of renewable energy sources. The replacement of fuel and the use of alternative fuels. The application of the product life cycle analysis.

ECONOMIC VALORIZATION OF THE PROJECTS IN THE LIVING ENVIRONMENT

Course objectives: To educate PhD students to master economic categories related to the achievement of the objectives connected to the improvement of the living environment.

Learning outcomes: Acquiring knowledge and skills required in this area.

Course content: The position of economics in the study of environmental problems. Economic crisis and the possibility of its solutions. Economic, social and cultural aspect. Economic and cultural aspects of the living environment safety. Economic indicators of environmental safety performance. Sources of data and information for economic analysis of environmental protection. The methodology and methods for making the policy plans of feasibility studies and other projects in the field of living environment protection. Methods for the economic evaluation of the projects in the living environment. Impact analysis of project implementation on the condition of occupational safety and health. Software for project analysis and project management

ENVIRONMENTAL ETHICS

Course objectives: A focus on the value of life and its quality refers to the necessity of expanding traditional ethical categories in ecological sense. Acquisition of theoretical knowledge about the basic starting points of environmental ethics which are useful for the development of ecological discourse on the relationship between man and nature. The goal of the course content is to raise the level of environmental awareness, which contributes to the responsible action and avoiding environmental risk in the performance of professional engineering activities.

Learning outcomes: Acquiring the ability to make conclusions in professional actions by accepting the principles of engineering environmental ethics, which will help future doctors of science in their everyday activities and their facing with scientific, technical, social and environmental challenges, and enable them to make the right decisions and act responsibly, not only in relation to the present moment and the human race, but also with respect to future generations and everything that surrounds the man.

Course content: *Theoretical Lessons* - Antique, medieval and New Age beliefs of values of the nature and attittude of society towards nature. Ethics and environmental ethics. Nature as the value for itself and for others. Ecological-ethical principles: anthropocentrism, ecocentrism, individualism. Animoetics. Bioethics. Geaethics. Deep ecology. Ecofeminism. Ecology and religion. Contemporary perspective of environmental ethics. Environmental ethics and social development. Environmental ethics and sustainable development. Ecological-ethical principles and the development of science and technology. Ecological consequences of dealing with science and technology. Professional ethics of engineers. Eco - humanization of professional engineering ethics.

Practical classes: Exercise classes, Other forms of teaching, Study Research Work

Auditory lessons in these areas. Seminar paper

ENERGY PROCESSES IN THE LIVING ENVIRONMENT

Course objectives: Acquiring knowledge about energy processes in the living environment. Training students to perform exergy analysis of energy processes and their environmental impact. Optimization of parameters of energy processes in the energy system in the stages of planning, design, exploitation, as well as the environmental impact assessment.. The influence on the policy of reducing pollutant emissions.

Learning outcomes: The ability to use the acquired knowledge along with the knowledge, understanding and implementation of basic laws of energy processes in the environment. Understanding and promoting energy processes as a significant element of the environmental impact, along with the analysis of economic and environmental parameters. Promotion of energy efficiency and renewable energy, and the practical application of knowledge in this field.

Course content: Energy consumption and the environmental impact. Efficiency and the first law of thermodynamics. Efficiency and the second law of thermodynamics. Exergy analysis of thermal processes. Non-renewable energy sources and environmental impact. Renewable energy (solar, biomass and geothermal energy). Combustion and environmental impact. Ecological modernisation and renewable energy sources. Energy storage. Climate and climate change. Environmental impact of energy production. The policy of reducing pollutant emissions.

ELECTROMAGNETIC RADIATION IN THE LIVING ENVIRONMENT

Course objectives: Acquiring theoretical and practical knowledge necessary to explore the issues of electromagnetic radiation in the living environment.

Learning outcomes: Students will be able to recognize the evidence of radiation impact on the environment , and also find optimal ways of protection from the effects of electromagnetic fields and radiation from non-ionizing radiation (UV, LF and HF electrical radiation) and ionizing radiation (X-rays and nuclear).

Course content: Macroscopic electromagnetic field. The general concept of antenna and the radiation of electromagnetic energy. Sources of low frequency electromagnetic radiation. Sources of high frequency electromagnetic radiation (radio and TV frequency, satellite and mobile communication, radar frequency, electrothermy, basis of laser technique). Sources of infrared and ultraviolet radiation, harmful effects and ways of protection. Biological effects of the effects of electromagnetic fields on living systems. Calculation of electromagnetic field. Modeling of electromagnetic field propagation process. The penetration of electromagnetic waves into buildings and biological organisms. Modelling penetration of electromagnetic waves in buildings and biological organisms. Biological harmful effect on biological systems, animals and humans. Standardizing magnitude of the EM field. Standards in the field of electromagnetic radiation. Continuous monitoring of electromagnetic radiation. National regulations in the field of protection from hazardous non-ionizing radiation. Electromagnetic compatibility. The impact of electromagnetic radiation on technological and utility systems. Methods to eliminate electromagnetic interference in utility systems.

ALTERNATIVE ENERGY SOURCES

Course objectives: Acquiring knowledge about energy systems based on alternative energy sources. Energy balance. Calculation of losses and the degree of efficiency of the systems with alternative energy sources. Feasibility studies, design, selection and installation of systems with alternative energy sources.

Learning outcomes: The ability to use already acquired knowledge. Knowledge, understanding and inplementation of energy, economic and environmental analysis of the justification for installing alternative energy systems. Preparation of documentation for obtaining the status of preferential electricity producer for plants that are using renewable energy sources.

Course content: Solar radiation at the Earth's surface. The conversion of solar radiation into heat. Conversion of sunlight into electricity. Elements for the use of solar energy. Material properties - absorption, emission, reflection. Selective surfaces. Flat-plate solar collectors. Concentric solar collectors. Photovoltaic cells. Accumulation of heat. Solar-technical systems. The use of solar energy for technical purpose: sanitary water heating, heating and cooling premises, obtaining hydrogen, desalination and distillation. Passive heating. Geothermal energy. Ways of using. Biomass; types, sources, ways of use. Heat pumps. Analysis and determination of operating cost based on modeling. Environmental energy, elements for its use.

SELECTED CHAPTERS FROM THE SUSTAINABLE DEVELOPMENT THEORY

Course objectives: Training students for independent scientific and scientific-professional work by presenting the latest knowledge in the area of sustainable development and in-depth understanding of the existing theoretical and research achievements, in order to allow an objective, systematic and critical study of phenomena and problems in economic, social and environmental field, as well as their mutual connections and interactions.

Learning outcomes : The acquisition of subject- specific competencies for fundamental knowledge and understanding of the concept of sustainable development, as well as solving problems using scientific methods and procedures. Linking basic knowledge in various fields related to economic and social development and environmental safety, their application in practice, and following recent developments in the aforementioned areas, especially the following:

- For independent research and implementation of scientific and applied results in the field of sustainable development, using modern research methods with a critical assessment of the results of other studies;
- For transferring knowledge into practice in the advisory (consulting) agencies, research units, institutes or faculties;
- For independent solving practical problems in the design, planning, implementation and monitoring practical policies of sustainable development, within implementation of theoretical knowledge and research skills.

Course content: ***1. Resources, environment and economic development.*** Correlation between economic growth and the environment. Will economic growth threaten the limits of endurance of our planet? How can economic development become ecologically sustainable? ***2. Social well-being and sustainable development.*** The concept of production, societal wealth, growth and development. Factors of societal welfare. The concept of capital. Social capital. Capital flows, capital stock and societal wealth creation. Different types of growth. Growth and development. ***3. Environmental sustainability.*** Sustainability: definitions and general determinants. Sustainability ethics. The dimensions of sustainability. The concept of environmental sustainability. The principles and standards of sustainability. ***4. Sustainable development and social justice.*** Interdependence of sustainability and poverty reduction. Climate changes and social justice. ***5. Green economy.*** Political context. Economy and identities: sustainable values vs. monetary values. Green economy and sustainable development. The policy of ensuring green economy. Globalization and trade. Ways of achieving green economy - "harmful subsidies", "green taxes". ***6. Urban Sustainability.*** Cities and globalization. Cities and sustainability. Cities as sustainable communities. Management in cities. ***7. Sustainable Development Indicators.***

LIVING ENVIRONMENT AND HEALTH

Course objectives: Acquiring knowledge about the significance of the impact of environmental factors on human health and quality of life and assessment of their importance in the overall burden of disease and excessive mortality.

Learning outcomes: Students will be qualified to perform the assessment of environmental risk factors (chemical, biological and physical agents that pollute the water, air, soil and food) on the health of the population; to determine those factors that pose the greatest risk; to determine entry routes, transport and deposition in the target organs and systems, as well as the mechanisms in the body. Prediction and implementation of preventive measures that will prevent or reduce the occurrence of diseases, improve the quality of life and reduce excessive mortality.

Course content: Environmental risk factors (chemical, biological and physical agents that pollute the water, air, soil, or food). Determining the mechanisms of health impact of environmental factors. Assessment of exposure and health outcomes in relation to the amount of exposure. Health outcomes (disease development, hospitalizations and mortality) in exposure to certain agents. The use of biomonitoring in health risk assessment. Descriptive epidemiological methods in studying health disorders induced by environmental hazards, descriptive epidemiological studies (cohort studies, clinical history studies, environmental studies). Assessment of burden of disease and excessive mortality. Preventive measures.

ECONOMIC VALORIZATION OF PROJECTS IN THE LIVING ENVIRONMENTAL

Course objectives: To educate PhD students to master economic categories related to the achievement of the objectives connected to the improvement of the living environment.

Learning outcomes: Acquiring knowledge and skills required in this area.

Course content: The position of economics in the study of environmental problems. Economic crisis and the possibility of its solutions. Economic, social and cultural aspect. Economic and cultural aspects of the living environment safety. Economic indicators of environmental safety performance. Sources of data and information for economic analysis of environmental safety. The methodology and methods for making the policy plans of feasibility studies and other projects in the field of living environment safety. Methods for the economic valorization of the projects in the living environment. Impact analysis of project implementation on the condition of occupational safety and health. Software for project analysis and project management.

RISK MANAGEMENT IN ENERGETICS

Course objectives: The aim of the course is to master modern techniques of risk management in the energy sector. Training students for identification, analysis, assessment and management of risks in the energy industry, as well as their practical implementation with the aim to reduce human and material losses.

Learning outcomes: The outcome of the course is training students for independent and teamwork in all stages of risk management projects in the energy industry. The ability to apply already acquired knowledge in practice and the application of feedback in the process of risk management. Proper reporting.

Course content: Theoretical basis for risk analysis in energetics. Approaches to risk analysis. Existing standards of risk analysis in the energy industry. Project management of risk analysis (risk identification, risk assessment procedures, risk control methods, risk reporting methods). Quantitative risk analysis (defining and distinguishing the concepts of probability and unpredictability, deterministic and stochastic risk assessment in energetics). Decision analysis and risk analysis. Probability and probability distributions. The central limit theorem (CLT). Bayes' theorem. Determination of probability distributions for input parameters in risk assessment. Experiences and limitations.

ELECTROTECHNICAL SAFETY SYSTEMS

Course objectives: Acquiring the knowledge required for the use, design and research of electro-technical systems of occupational safety and fire protection in the working and living environment.

Learning outcomes: Students will develop competence to analyze, control, monitor and design the systems together with the engineers with diverse expertise, and to develop knowledge for generating methods and procedures for management of integrated safety systems that include electro-technical systems.

Course content: Lighting protection electrical systems. Electrical systems for protection from the harmful effects of electricity. Electromagnetic compatibility. Grounding and bonding electrical systems. Static electricity and elimination systems. Electrical systems for fire protection, protection from burglary and protection in emergency situations. Integration and collaboration of electrical systems in occupational and environmental safety. Electrical systems and pollution of workplace environment. Electrical systems and their impact on human health.

TECHNOGENIC RISK MANAGEMENT

Course objectives: Acquiring the knowledge necessary for the analysis of technological processes with regard to the minimization of waste materials and energy released; in other words, preventing degradation and environmental threats.

Исход предмета: Knowledge and skills for application of methods, methodologies and procedures for collecting and processing data and presenting the results of the effect of technological processes on the environment.

Course content: Fundamentals of risk management in technological systems. Identification of hazards. Exposure assessment, characterization and classification of risk. Risk impact assessment in technological systems. The balancing of technological systems as an element of risk assessment (mass, energy and exergy analyses). Choice of technological processes and operations for the development of systems in accordance with the optimizing principles of material-energy flows and environmental pollution. The development of the principles of wasteless technologies. Perception of the risk situation of environmental pollution from technological systems and creating models. Models for defining exposure to risk situations.

HUMAN RELIABILITY

Course objectives: Acquiring knowledge for practical implementation of human reliability assessment methods.

Learning outcomes: Upon successful completion of this course, students should be able to: identify the nature of human behavior and describe the causes of human error; determine the factors that influence human reliability, as well as the main indicators of operator reliability; choose and apply the appropriate method for assessing human reliability; assess human reliability individually or as a team, depending on the nature of the job and the organization being analyzed; create database of human errors, formulate error mechanisms and performance shaping factors; design procedures and strategies for reducing human errors and explore new areas in which they can be applied; critically analyze and interpret significant facts about investigated accidents and human errors.

Course content: Development of methods human reliability assessment. Theories about accidents and disaster overview. Development of "human–machine system". Reliability of "man – machine" system. Probability of safety assessment. Identification and presentation of human error. Methods of human reliability: Cognitive Reliability and Error Analysis Method; Assessment method for the performance of safety operations; Technique for Human Error Analysis; Human Reliability Management System; Human Cognitive Reliability; Simplified Plant Analysis Risk Human Reliability Assessment; Nuclear Action Reliability Assessment; Controller Action Reliability Assessment- Socio-Technical Assessment of Human Reliability, etc. Trends in the development of methods for human reliability assessment. Case studies - practical application of commonly used methods.

ENVIRONMENTAL RISK MANAGEMENT

Course objectives: The study of environmental risk and modern systems of environmental safety in the context of sustainable quality of life, the integrity of the living environment, prevention and response to ecologically generated processes by preventing negative consequences on the living environment.

Learning outcomes: Qualification to perform research in the form of identification, assessment, monitoring, and management in the field of a wide range of safety challenges and threats, primarily environmental dangers and risks regarding the use of natural resources, pollution and degradation.

Course content: The modern concepts of global safety and environmental risks and threats. Specific environmental risks facing the Earth (drought, loss of biodiversity, overpopulation, accidents). Strategies and doctrines about the environmental safety in the EU. The assessment of environmental risk. Environmental risk assessment planning. Problem formulation phase. The analysis phase. Characterization of environmental risk. Influence of environmental information to the decisions of risk managers. Environmental risk management phases. Risk management based on risk minimization. Environmental risk management of continuous pollutant emissions. Environmental risk management of accidental pollutant effluents. Managing environmental risks of fire and explosion. Human health risk assessment. Exposure assessment. The components of the exposure assessment. Toxicity assessment. Toxicity assessment of non-cancer effects. Toxicity assessment of cancer effects. Risk characterization. Risk characterization of non-cancer effects. Risk characterization for cancer effects.

RISK, CRISIS AND EMERGENCY MANAGEMENT

Course objectives: The study of crises and emergencies and modern systems of environmental safety in the context of sustainable life quality, the integrity of the environment, prevention and response to crises and emergencies along with the prevention of negative environmental consequences.

Learning outcomes: Students will be qualified for research based on identification, assessment, monitoring, and management in the field of a wide range of safety challenges and threats, primarily risks, crises and emergencies in terms of environmental safety.

Course content: The concept of crisis and emergency situations. Planning the prevention of potential crises and accidents. Risk management - crisis prevention management. Risk assessment methods. General principles of risk assessment. Prevention measures. Review of risk management models worldwide. Risk management strategies and monitoring. Crisis management: Data collection and evaluation of data sources. Decision making under uncertainty. Methods of analysis and prediction of crises and emergencies. Project planning and implementation. Crisis management and information technology. Activities and tasks in crisis and emergency situations. Humanitarian aid in crisis and emergencies. Crisis simulation as a crisis management tool. Development stages of the crisis. Operations rooms/ control centers. Safety operations in crisis management. Preparation of crisis negotiation team. Coercive and non-coercive methods of response to crisis. Crisis management instruments. International aspects of crisis management. Emergencies: Classification of emergencies. Stages of development and the factors of negative impact of emergencies on safety and the environment. Social and normative context of emergencies. Emergency management, concept, process and management system. The concept of management system. Overview of management systems, Subjects in the system of emergency management.

RISK ASSESSMENT OF FIRE AND EXPLOSION IN THE LIVING ENVIRONMENT

Course objectives: Acquiring the knowledge required for fire and explosion analysis and risk assessment; preparing students for implementation of scientific and technical achievements in solving the problems of fire and explosion and development and management of ire and explosion safety systems in the living environment.

Learning outcomes: Students will be qualified to conduct fire and explosion risk assessment with the aim of implementing an integrated fire and explosion protection system.

Course content: *Theoretical Classes* - Fire hazards (primary and secondary). Fire risk as a result of the probability of fire and estimated loss and damage. Fire risk assessment (probability of occurrence and development). Determining the level of fire risk (potential and acceptable). Factors of fire risk assessment (fire load, fire location, ventilation factor, fire spread, the level of preventive safety). Methods for risk assessment (analytical, algebraic, numeric, etc.). Fire risk assessment of open air fires (Fire risk index. Ignition index. Hazard risk index (meteorological parameters, vegetation parameters, relief (terrain) parameters, sociological parameters)). Modelling open air fires (physical, empirical, models of mathematical analogies and simulation models). Risk assessment explosions caused by flammable substances (danger zones). Risk assessment in places threatened by explosive atmospheres. Fire and explosion risk assessment management in the living environment

Practical classes: Exercises. Other forms of teaching, Study Research Work: Mentor tutorials

Study Research Work: Project tasks

LIVING ENVIRONMENT AND HEALTH

Course objectives: Acquiring knowledge about the significance of the impact of environmental factors on human health and quality of life and assessment of their importance in the overall burden of disease and excessive mortality.

Learning outcomes: Students will be qualified to perform the assessment of environmental risk factors (chemical, biological and physical agents that pollute the water, air, soil and food) on the health of the population; to determine those factors that pose the greatest risk; to determine entry routes, transport and deposition in the target organs and systems, as well as the mechanisms in the body. Prediction and implementation of preventive measures that will prevent or reduce the occurrence of diseases, improve the quality of life and reduce excessive mortality.

Course content: Environmental risk factors (chemical, biological and physical agents that pollute the water, air, soil, or food). Determining the mechanisms of health impact of environmental factors. Assessment of exposure and health outcomes in relation to the amount of exposure. Health outcomes (disease development, hospitalizations and mortality) in exposure to certain agents. The use of biomonitoring in health risk assessment. Descriptive epidemiological methods in studying health disorders induced by environmental hazards, descriptive epidemiological studies (cohort studies, clinical history studies, environmental studies). Assessment of burden of disease and excessive mortality. Preventive measures.

SOIL POLLUTION AND REMEDIATION

Course objectives: The students of doctoral studies should, by acquiring scientific knowledge, competence and academic skills, master modern methods of identifying types of pollutants, pollution intensity, contaminated sites, as well as the procedure of selecting optimal methods of soil remediation.

Learning outcomes: Students will be able to scientifically, independently, or as a team , comprehensively consider the problems of soil pollution and remediation: from determining the source, through the identification of types of pollutants and their transformation, to preventing soil pollution and remediation.

Course content: Soil as a complex of environmental factors. Soil processes and soil pollution. Risk assessment of chemical soil pollution . Methods of sampling and testing contaminated soil . Sampling plants from contaminated soil. The processes of plant adaptation to different soil types. The dependence of the yield of aromatic and alkaloid plants from soil quality . Types and methods of soil remediation . Remediation of soil contaminated by organic and inorganic substances . Remediation - basis for sustainable development . Legislation and regulations

SELECTED CHAPTERS FROM THE SUSTAINABLE DEVELOPMENT THEORY

Course objectives: Training students for independent scientific and scientific-professional work by presenting the latest knowledge in the area of sustainable development and in-depth understanding of the existing theoretical and research achievements, in order to allow an objective, systematic and critical study of phenomena and problems in economic, social and environmental field, as well as their mutual connections and interactions.

Learning outcomes: The acquisition of subject- specific competencies for fundamental knowledge and understanding of the concept of sustainable development, as well as solving problems using scientific methods and procedures. Linking basic knowledge in various fields related to economic and social development and environmental safety, their application in practice, and following recent developments in the aforementioned areas, especially the following:

- For independent research and implementation of scientific and applied results in the field of sustainable development, using modern research methods with a critical assessment of the results of other studies;
- For transferring knowledge into practice in the advisory (consulting) agencies, research units, institutes or faculties;
- For independent solving practical problems in the design, planning, implementation and monitoring practical policies of sustainable development, within implementation of theoretical knowledge and research skills.

Course content: ***1. Resources, environment and economic development.*** Correlation between economic growth and the environment. Will economic growth threaten the limits of endurance of our planet? How can economic development become ecologically sustainable?. ***2. Social well-being and sustainable development.*** The concept of production, societal wealth, growth and development. Factors of societal welfare. The concept of capital. Social capital. Capital flows, capital stock and societal wealth creation. Different types of growth. Growth and development. ***3. Environmental sustainability.*** Sustainability: definitions and general determinants. Sustainability ethics. The dimensions of sustainability. The concept of environmental sustainability. The principles and standards of sustainability. ***4. Sustainable development and social justice.*** Interdependence of sustainability and poverty reduction. Climate changes and social justice. ***5. Green economy.*** Political context. Economy and identities: sustainable values vs. monetary values. Green economy and sustainable development. The policy of ensuring green economy. Globalization and trade. Ways of achieving green economy - "harmful subsidies", "green taxes". ***6. Urban Sustainability.*** Cities and globalization. Cities and sustainability. Cities as sustainable communities. Management in cities. ***7. Sustainable Development Indicators.***

COLLABORATIVE INFORMATION SYSTEMS

Course objectives: To familiarize students with contemporary theoretical and practical aspects of Collaborative Information Systems, information technologies for support to management and decision-making processes, basic methods, techniques and tools for the development of information and collaborative systems management in working and living environment protection.

Learning outcomes: Knowledge and understanding of the role, fundamentals, concepts and structure of collaborative information systems. Practical knowledge and skills about the methods, techniques and software tools for design management of collaborative information systems. Practical knowledge and skills in implementing modern software solutions of artificial intelligence, expert systems. DSS decision support systems in living and working environment. Knowledge about information systems as a basis for monitoring networks in the living and working environment. Application of collaborative information systems in living and working environmental protection. The use of collaborative information systems in change management of living and working environmental protection.

Course content: Information and data for risk analysis and risk assessment in the workplace. The acquisition, storage, and processing of information from the living and working environment. Models for data processing and data analysis. The organizational aspects of information systems. Structures and processes in local and distributed information systems. Information and communication technologies as technical foundation of information systems. Network architecture, network hardware and software. Information systems as a basis for monitoring networks in the workplace. Safety techniques in computer networks and distributed systems. Protecting data about human resources. Systemic approach to collaboration. Interoperability of systems. The structure and elements of collaborative systems. Processes and flows in collaborative systems. Standards and standardization of collaborative systems. Technological aspects of collaboration. Modeling of collaborative systems. Managing collaborative processes and process integration. Multimedia collaboration systems. Collaborative systems intended for heterogeneous systems. Organizational and procedural aspects of collaboration. Organizational structure in relation to collaboration. Collaborative chains and multi-collaboration organization. The human factor as the limiting factor of collaboration. The use of collaborative systems in working environment protection.

WASTE MANAGEMENT

Course objectives: Training PhD students for systematic and interdisciplinary examination, identifying opportunities and preconditions for effective treatment of production residues; training students for the improvement and development of methods for solving problems of preventing the occurrence, treatment and the use of secondary material. Knowledge and understanding of the problems of waste management aimed at environmental protection.

Learning outcome: By mastering the course content, the students of doctoral studies shall gain knowledge and skills to research and identify the shortcomings of modern methods of industrial and municipal waste treatment, as well as the knowledge for the evaluation of the possibilities of improving industrial processes and products in order to efficiently use the resources and optimal recycling of secondary raw materials. Acquiring modern scientific knowledge and mastering methods that would allow efficient management of waste materials.

Course content: Municipal solid waste: sources of generation, characterization, solid waste treatment and disposal. Industrial waste: sources of generation, industrial waste treatment and disposal. Hazardous waste: treatment and disposal. Medical waste: sources of generation, classification, handling, treatment methods, storage, transport and disposal. Radioactive waste: sources of generation, treatment and disposal. Waste treatment: mechanical treatment (size reduction, compaction, separation, etc.), thermal treatment (incineration, sintering, pyrolysis, gasification, etc.), physical and chemical methods (solidification of hazardous waste, liquid-solid separation) and biological processing methods (aerobic composting, anaerobic digestion, etc.). Landfills: landfill sites, systems for filtrate collecting, systems for collecting landfill gas, landfill closure. Regulations in the field of waste handling.

BIOCLIMATIC PLANNING

Course objectives: Knowledge and understanding of energy efficient design - bioclimatic planning with the ultimate goal of energy saving and environmental protection.

Learning outcome: Acquiring modern scientific knowledge and mastering principles necessary for finding energy efficient solutions in the stages of conception, planning, the design of buildings and urban structures.

Course content: Site selection and planning (the analysis of geographic and climate conditions of the site; the analysis of the conditions of natural environment for the use of energy; identifying opportunities for the existing infrastructure; the analysis of the conditions of the built environment, etc.). Bioclimatic elements and planning. Location configuration, the orientation of energy- efficient buildings and urban planning. Orientation of energy efficient buildings and architectural design. The impact of wind on energy efficiency of buildings. Mutual relationship between the buildings. Buildings with passive solar systems. Energy saving and energy efficiency of buildings. Factors that contribute to global climate change and air pollution.

SELECTED CHAPTERS FROM URBAN ECOLOGY

Course objectives: Analyzing conditions and environmental processes in urban areas, with the aim of predicting possible changes and applying the concepts of sustainable solutions for environmental protection.

Learning outcome: Acquiring modern scientific knowledge regarding the environmental issues in urban areas, creating potential changes and proposing environmental protection measures from the aspect of ecological optimization.

Course content: The analysis of the state of natural conditions important for the city development. City, urban functions and functional zoning in cities . Housing and sustainable development in urban areas. Industry and industrial impact on the environment in urban areas. Energy and energy processes in degradation of urban environments . Development of traffic and its impact on the environment in urban areas . The use of alternative energy sources with the purpose of environmental protection in urban areas . Bioclimatic planning and solar architecture, ecological importance of the use of active and passive solar systems . The use of modern methods in municipal solid waste treatment in urban areas .

INTEGRATED ENVIRONMENTAL MANAGEMENT

Course objectives: Acquiring knowledge about the current trends in integrated prevention and the control of environmental quality, the assessment of environmental status of ecological systems, tracking changes, trend analysis and forecasting environmental conditions, especially threats of natural resources.

Learning outcome: Qualifications for a multidisciplinary and integrated approach to the study and monitoring of environmental quality, ecological status and integrity of ecosystems, planning and creating programmes for protection and improvement of environmental quality, conservation and improvement of natural resources, as well as managerial decision making.

Course content: Integrated prevention and control of environmental pollution. Objectives and characteristics of the directive. Integrated pollution prevention and control in the EU countries . Integrated pollution prevention and control in Serbia . Integrated Process Control. Efficient resource management in accordance with the polluter pays principle . Response to pollution sources by reducing emissions . Defining the emission limit values by best available techniques . The development of information exchange processes. Best practice technique. Technical and environmental efficiency . Energy efficiency . Integral cadastre of polluters – pollutant register . Cleaner production . The strategy of cleaner production.

DIAGNOSTICS AND MAPPING OF ACOUSTIC PROCESSES

Course objectives: The acquisition of scientific competence, academic skills and creative abilities for the diagnostics of acoustic processes, modeling noise sources and noise mapping.

Learning outcome: Students will develop knowledge and understanding of acoustic processes and their characteristics; knowledge, understanding and implementation of methods for the diagnostics of acoustic processes, modeling noise sources and noise mapping by using the appropriate methods and software; knowledge, understanding and application of the basic principles of noise management and environmental noise impact assessment.

Course content: Acoustic processes: noise radiation, noise propagation, noise transmission through the barrier, noise absorption. Methods for the diagnostics of acoustic processes: sound pressure method, sound intensity method, the method of surface vibration, correlation/coherence method, acoustic holography. Noise mapping - demonstration and comparison between different physical models for sound propagation. Standards for the prediction of noise emissions: road, rail, air, traffic and industry. Standards for noise propagation prediction. Creating noise maps. Noise exposure maps. Conflict maps. Acoustic mapping and acoustic map calibration. Software aplication in acoustic mapping. Acoustic zoning. Environmental Noise Management. Environmental noise impact assessment.

DESIGNING NOISE PROTECTION SYSTEMS

Course objectives: The acquisition of scientific competence, academic qualifications and creative skills to solve specific problems in the living environment caused by noise sources through identification and characterization of sources and passive and active noise control.

Learning outcome: Students will gain knowledge and understanding of noise generation and characteristics of complex noise sources; knowledge, understanding and implementation of methods for analyzing, describing and predicting noise, measurement and analysis of noise, design of passive and active systems for noise protection.

Course content: Sources of noise: basic characteristics, interaction of solid structures and sound waves, sound generation, sound transmission into enclosed and open spaces. Models of noise sources: monopole, dipole, quadrupole, cylindrical source of noise. Noise propagation modelling: analytical techniques, models, software. Numerical methods: finite element method. Sound fields: one-dimensional and three-dimensional sound field, wave propagation in mobile media. Advanced measurement techniques: time domain analysis, frequency domain analysis, analog and digital signal analysis. Methods for the identification of noise sources: conventional methods in time domain and frequency domain, cepstral analysis, envelope analysis, sound intensity method, acoustic holography. Passive methods for noise control: partitions, booths, barriers, vibro- insulation materials, acoustic treatment of rooms, sound- absorbing materials. Active methods for noise control: active control of sound propagation in ducts, active control of radiation from vibrating structures, active control of sound propagation in enclosed spaces, active vibration isolation, barriers with active systems. Active systems with and without feedback. Design of passive and active systems for noise protection.

WATER QUALITY MANAGEMENT

Course objectives: The aim of the course is to achieve scientific competence, develop creative abilities and acquire updated scientific-professional knowledge of the issues in the field of monitoring, water quality criteria and water quality management.

Learning outcome: Training students for scientific research in the field of monitoring and determining water quality with regard to integral safety and sustainable management of water resources. Students should be able to implement new technologies and procedures, critically and comprehensively confront the problems and act creatively. Also, they should be able to report their results at scientific conferences and publish their articles in scientific journals, thus contributing to the development of scientific thinking.

Course content: Characteristics of surface and groundwater. Physical, chemical and microbiological indicators of water quality. Physiochemical and biochemical processes in aquatic environments. Analytical and biological methods of water quality control. Ecohydrology - pollution and water protection. Technological development and water quality. Water - the element of sustainable development. Emission limit values. Wastewater management in plants/companies. Water quality monitoring. Water quality criteria. Correlation between the criteria of surface water quality. Real and demanding water quality. The Water Framework Directive of the European Parliament and the Euroepan Council. Indicators of water quality management - water quality index. Sustainable management of water resources.

WATER POLLUTION AND HEALTH RISK

Course objectives: The aim is to develop students' competence in acquiring creative skills and gaining the knowledge about the latest scientific-technical issues in the field of water pollution and health risks, with regard to environmental protection and providing safe drinking water. Furthermore, one of the objectives is mastering the knowledge about the impact of water quality on the health of living systems and the assessment of health risks.

Learning outcome: Students will be able to explore the issues of water pollution with the aim to eliminate risks to human health and the environment.

Course content: General characteristics of water, the water cycle. The importance and use of water. Ecohydrology - pollution and water protection. Waste waters, origin and dynamics of the formation, characterization, purification. Specific organic and inorganic matter in the water. The limits of pollutant concentration in water. Risk indicators for water quality. The quality of drinking water, standards and norms. Chemical substances in drinking water and their impact on health. Drinking water disinfection agents and their impact on health. Health safety of drinking water. Recommendations of the World Health Organization. The Water Framework Directive of the European Parliament and the European Council. Water pollution and the impact on health. The effects of water contaminants on the organs and systems in the human body. The influence of mutual dependence between polluted soil, water and food on the health of the population. Biomonitoring and health risk assessment. Health outcome (disease development, hospitalizations and mortality depending on the exposure). Epidemiological methods in the study of health disorders resulting from the effects of pollutants. Possible solutions to certain environmental problems and their impact on health. Prevention.

ENVIRONMENTAL ETHICS

Course objectives: A focus on the value of life and its quality refers to the necessity of expanding traditional ethical categories in ecological sense. Acquisition of theoretical knowledge about the basic starting points of environmental ethics which are useful for the development of ecological discourse on the relationship between man and nature. The goal of the course content is to raise the level of environmental awareness, which contributes to the responsible action and avoiding environmental risk in the performance of professional engineering activities.

Learning outcomes: Acquiring the ability to make conclusions in professional actions by accepting the principles of engineering environmental ethics, which will help future doctors of science in their everyday activities and their facing with scientific, technical, social and environmental challenges, and enable them to make the right decisions and act responsibly, not only in relation to the present moment and the human race, but also with respect to future generations and everything that surrounds the man.

Course content: *Theoretical Lessons* - Antique, medieval and New Age beliefs of values of the nature and attittude of society towards nature. Ethics and environmental ethics. Nature as the value for itself and for others. Ecological-ethical principles: anthropocentrism, ecocentrism, individualism. Animoetics. Bioethics. Geaethics. Deep ecology. Ecofeminism. Ecology and religion. Contemporary perspective of environmental ethics. Environmental ethics and social development. Environmental ethics and sustainable development. Ecological-ethical principles and the development of science and technology. Ecological consequences of dealing with science and technology. Professional ethics of engineers. Eco - humanization of professional engineering ethics.

Practical classes: Exercise classes, Other forms of teaching, Study Research Work

Auditory lessons in these areas. Seminar paper

KNOWLEDGE MANAGEMENT AND DECISION-MAKING IN LIVING ENVIRONMENT

Course objectives: To familiarize students with contemporary theoretical and methodological approaches in knowledge management and decision-making strategies in safety.

Learning outcome: Developed expertise and methodological competency in knowledge management and decision-making in safety.

Course content: Knowledge as a factor in acquisition, creation and sustainability of safety and competitive advantage. Epistemology (the history of knowledge, data, information of knowledge, types of knowledge - explicit/implicit). Knowledge management (intellectual capital, knowledge cycle, knowledge economy). The essence of the process of knowledge management (history, concepts, importance, life cycle, approaches and models of knowledge, association with a teaching organization). A framework for creating successful knowledge management programmes. Knowledge management technologies. Structure and processes for knowledge management. The life cycle of knowledge management. Implementation of knowledge management strategy. Development of human resources and knowledge management. Knowledge bases and ontologies in the field of occupational safety. Knowledge management in occupational safety. Communities of practice in safety based on knowledge. Knowledge control and management (concept, process and types of controls, knowledge control in the chain of knowledge, knowledge control in practice). Organizations based on knowledge. Knowledge management and decision-making. The structure and decision-making processes. Models of decision-making. Decision-making under conditions of uncertainty and risk. Multiple criteria (multiple criteria and multi-target) decision-making. Technology for decision support. Software tools and decision support systems. Decision-making in the field of occupational safety. Decision support systems in occupational safety.

ELECTROMAGNETIC RADIATION IN THE LIVING ENVIRONMENT

Course objectives: Acquiring theoretical and practical knowledge necessary to explore the issues of electromagnetic radiation in the living environment.

Learning outcomes: Students will be able to recognize the evidence of radiation impact on the environment , and also find optimal ways of protection from the effects of electromagnetic fields and radiation from non-ionizing radiation (UV, LF and HF electrical radiation) and ionizing radiation (X-rays and nuclear).

Course content: Macroscopic electromagnetic field. The general concept of antenna and the radiation of electromagnetic energy. Sources of low frequency electromagnetic radiation. Sources of high frequency electromagnetic radiation (radio and TV frequency, satellite and mobile communication, radar frequency, electrothermy, basis of laser technique). Sources of infrared and ultraviolet radiation, harmful effects and ways of protection. Biological effects of the effects of electromagnetic fields on living systems. Calculation of electromagnetic field. Modeling of electromagnetic field propagation process. The penetration of electromagnetic waves into buildings and biological organisms. Modelling penetration of electromagnetic waves in buildings and biological organisms. Biological harmful effect on biological systems, animals and humans. Standardizing magnitude of the EM field. Standards in the field of electromagnetic radiation. Continuous monitoring of electromagnetic radiation. National regulations in the field of protection from hazardous non-ionizing radiation. Electromagnetic compatibility. The impact of electromagnetic radiation on technological and utility systems. Methods to eliminate electromagnetic interference in utility systems.

STUDY RESEARCH WORK 1

Course objectives: Deepening the theoretical and methodological, scientific-technical and vocationally applicative knowledge in the field of environmental engineering.

Learning outcomes: Training students to make independent associations in the subject matter of doctoral studies, to comprehensively view and analyze the problems in the field of environmental safety and publish the results of their research.

Course content: The content is developed individually in accordance with the needs of further work. A student examines professional literature, and if necessary performs laboratory, experimental and simulation research in the field of a study programme, conducts scientific research projects in the field of environmental safety engineering, participate at seminars and conferences, and publishes scientific papers.

STUDY RESEARCH WORK 2

Course objectives: The application of basic theoretical-methodological, scientific-technical and professional-applicative knowledge in solving specific problems within the selected field of doctoral studies.

Learning outcomes: Training students to independently and creatively apply previously acquired knowledge in various fields with the aim to understand the structure of the original problem, perform systematic analysis of the problem, and consider the possible directions of problem-solving and choice of optimal or, in the given conditions, satisfactory solution.

Course content: The content is developed individually in accordance with the selected areas and needs for further research. A student examines scientific literature, performs the analysis with the aim to find solutions to a specific problem which is defined by the instructions from the professors at doctoral studies or mentors. If necessary, a student performs laboratory, experimental and simulation research, conducts scientific research projects in the field of environmental engineering, participate at seminars and conferences, and publishes scientific papers.

STUDY RESEARCH WORK 3

Course objectives: The application of the acquired theoretical-methodological, scientific-technical and professional-applicative knowledge to solve specific problems within the selected topic of the Ph.D thesis.

Learning outcomes: Developed skills of critical thinking and the ability of students to independently, creatively and innovatively apply the acquired knowledge in various fields with the aim to solve the problems identified in the area of occupational safety, by developing alternative solutions, their simulation, the analysis of advantages and disadvantages and the choice of the appropriate, optimal or a satisfactory solution in given circumstances.

Course content: The content is designed individually in accordance with the approved topic of doctoral dissertation. The student examines scientific and professional literature, performs the analyses with the aim to find a solution to a specific problem defined by the mentor. A student performs laboratory, experimental and simulation research, conducts scientific research projects, participates at seminars and conferences by communicating his/her research results and publishes scientific papers in international journals.

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