COURSE DESCRIPTIONS/
KARTY PRZEDMIOTÓW

second-level studies/ studia II stopnia
main field of study/ kierunek studiów:
Mining and Geology/ Górnictwo i Geologia

specjalność/specialisation:
Entrepreneurship, Innovation and Technology Integration in Mining

Track LUT – WUST

Semester 1
LUT

Lappeenranta-Lahti University of Technology LUT

Course title	Modelling of Unit Operations W06GIG-SM3056G		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 2h/week (2 ECTS), laboratory: 3h/week (3 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	Modeling and parameter estimation using Matlab in chemical engineering and applied mathematics in general. The course presents some of the most common unit operations of chemical engineering, including batch reactors, continuously stirred tank reactors (CSTRs), both in dynamic and steady-state; tubular plug flow reactors, flash distillations, and modelling of temperature dependence of reactions and elements of heat transfer. The models are limited to ones that do not require solving partial differential equations (PDEs).		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - Matlab software usage in chemical engineering and applied mathematics, - most common unit operations of chemical engineering, including batch reactors, continuously stirred tank reactors (CSTRs), both in dynamic and steady-state - tubular plug flow reactors, - flash distillations, and modelling of the temperature dependence of reactions and elements of heat transfer, - basic chemical processes in chemical engineering. Skills Upon completion of the course, a student is able to - describe steady-state and transient unit operations with mathematical models, - validate models and estimate their parameters from experimental data, - apply models in process development and design, including sizing, optimization, and scale-up, - use mathematical and simulation software.		
Assessment methods and criteria	Homework and class assignments as well as quizzes passed. No exam. Grades: 0-5. Half of the grade for the laboratory is decided by the share of exercises completed by the student, and the other half by the quality of the lab work reports and homework assignments. The course is built around practical laboratory work solved individually or in groups by the students. The lectures constitute the theoretical support for assignment reports and written quizzes during the semester. The lecture i.e. the ability to explain the unit operations of chemical engineering is checked with quizzes during the semester. The practical classes: the ability to analyze and apply these processes in real cases is tested with practical examples that are given both individually and in the group.		
Recommended readings	Lecture notes and links to supplementary material are given in Moodle(Sisu student tools https://sisu.lut.fi/student/courseunit/otm.....); selected examples from international literature. Online material.		
TU Coordinator	Arto Laari, Arto.Laari@lut.fi; Miracle Amadi, Miracle.Amadi@lut.fi; Tuomas Sihvonen, Tuomas.Sihvonen@lut.fi, Esko Lahdenperä, Esko.Lahdenpera@lut.fi,		

Course title	Advanced Process Design W06GIG-SM3057G		
European Credits (ECTS)	5	**Time (hours) given to the students**	75
Type (lecture, classes, laboratory, project, seminar)	lecture: 2h/week (1 ECTS), classes: 1h/week (2 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	Chemical and physical properties, determination of chemical components in process simulation; Property estimation methods; Chemical process material and energy balances, sizing, costing, and economical evaluation; Process performance analysis, process evaluation, and optimization; Chemical process synthesis; Biorefinery process synthesis: objectives and steps; Synthesis of separation sequences; Energy integration in process design.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - what kind of design activities are required during the process design, - and understands how product design and process design are related, - what is the design of processes: what it is aiming at and what are the steps, - and understands the role of modern simulation packages during the process life cycle. Skills Upon completion of the course, a student is able to: - apply simulation packages to support every step during process design, - validate models and estimate their parameters from experimental data, - apply models in process development and design.		
Assessment methods and criteria	Homework and class assignments as well as quizzes passed. No exam. Grades: 0-5. Group work and reports 50%, individual assignments 50%. The lecture: the ability to explain activities required during the process design is checked with quizzes during the semester. The practical classes: the ability to analyze and apply these processes in real cases is tested with practical examples that are given both individually and in the group.		
Recommended readings	Basic study material is delivered in Moodle (Sisu student tools https://sisu.lut.fi/student/courseunit/otm.....). Online material.		
TU Coordinator	Kristian Melin, Kristian.Melin@lut.fi; Nima Rezaei, Nima.Rezaei@lut.fi; Tuomas Koiranen, Tuomas.Koiranen@lut.fi,		

Course title	Research Methodology W06GIG-SM3058G		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), classes: 1h/week (2 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	This course includes the use of scientific databases to find research results and knowledge including critical source assessment. The students make individual or group workshops on selected research topics where they find knowledge of what is known today and based on that formulate the knowledge gap and relevant objectives for the research they have in mind, identify the relevant scientific methods, and make their research plan to study a pre-selected topic. They understand how to process the results to find the facts. The presentation of the research results in a scientifically credible way is part of the course.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - the use of scientific databases to find research results and the current knowledge, - and understands critical source assessment, - how to process the results to find the facts, - the basics of data analysis. Skills Upon completion of the course, a student is able to: - search for scientific knowledge - assess the reliability of different sources of knowledge and data, - make a research plan to reach the objectives, - make a design of experiments, - do the data analysis, - present the research results, - organize and carry out the workshop, - write a scientific report or article.		
Assessment methods and criteria	Homework and class assignments as well as quizzes passed. No exam. Grades: 0-5. Online lectures and exercises, Moodle assignments, personal and group assignments. Group work and reports 50%, individual assignments 50%. The lecture: the ability to explain activities required during the process design is checked with quizzes during the semester. The practical classes: the ability to analyze and apply these processes in real cases is tested with practical examples that are given both individually and in the group.		
Recommended readings	Basic study material is delivered in Moodle (Sisu student tools https://sisu.lut.fi/student/courseunit/otm.....). Online material. Lecture notes and links to supplementary material are given in Moodle; selected examples from international literature.		
TU Coordinator	Marja Talikka, Marja.Talikka@lut.fi; Nima Rezaei, Nima.Rezaei@lut.fi,		

Course title	Circular Economy for Materials Processing W06GIG-SM3059G		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (3 ECTS), seminar: 1h/week (1 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	Circular economy and resource efficiency are important aspects of sustainable development within the industry. The course aim is that students gain the skills needed to ensure that circular economy concepts become adopted into the design, development and operation of mainly metal production processes, during their application, end-of-life stage and recycling. Students carry out project work in groups. The topics are from industry, for example, side stream processing in the metal and steel producing industry, circular economy, and eco-design. Different aspects are emphasized in different projects, depending on the topic.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and understands basic concepts of circular economy, materials flow (raw materials, processing, manufacturing until end-of-life recycling and re-usage), issues and drivers for changes, - and recognizes the impacts (environmental, economic and social) of the current practice of materials processing from a sustainability aspect. Skills Upon completion of the course, a student is able to: - create new business opportunities to re-enter materials into the circular economy, - apply processing technologies to accelerate the implementation during business creation, - recognize the impacts (environmental, economic and social) of the current practice of materials processing from a sustainability aspect, - work as a team member in a development project.		
Assessment methods and criteria	Homework and class assignments as well as quizzes passed. Moodle exam (lecture). Grades: 0-5. Online lectures and exercises, Moodle assignments, personal and group assignments. The project class: group project work and meetings, and reports 70%, quizzes 30%. The seminar: presentation of the project work. The lecture: the ability to explain basic concepts of circular economy is checked with exam quizzes. The practical classes: the ability to adopt circular economy concepts into the design, development and operation of mainly metal production processes.		
Recommended readings	Basic study material is delivered in Moodle (Sisu student tools https://sisu.lut.fi/student/courseunit/otm-......). Online material. Lecture notes and links to supplementary material are given in Moodle; selected examples from international literature, and data from the industry.		
TU Coordinator	Miia John, Miia.John@lut.fi,		

Course title	Technology and Innovation Management: Introduction W06GIG-SM3060G		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), classes: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	Innovation as a core business process. Innovative organisation. Development of technology and innovation strategy. Innovation networks. Decision-making in technological and market uncertainty. Creation of new products and services. Innovation performance and learning. Sustainability and innovation.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - various methods of technology and innovation strategy, - the process of creation of new products and services, - and identifies as well as understands the main innovation and technology management concepts and their linkages to the innovation process, innovation and technology strategy and innovative organization management, - sustainability and innovation basics. Upon completion of the course, a student is able to: - analyze and design technology and innovation strategy of a company, - analyze the usability of various methods of innovation and technology, - recognize and apply the main innovation and technology management concepts to innovative organization management.		
Assessment methods and criteria	Homework and class assignments passed. Self-learning based on online materials and online assignments. Online exam (lecture). Grades: 0-5. Online lectures and exercises, Moodle assignments, personal and group assignments. The project class: group project work and meetings, and reports 100%). The lecture: the ability to explain basic concepts of innovation as a core business process. The practical classes: the ability to recognize and apply the main innovation and technology management concepts to innovative organization management.		
Recommended readings	Joe Tidd and John Bessant. Managing Innovation – Integrating Technological, Market and Organizational Change, 6th ed. (2018), (including e-learning material), or previous editions (2009, 2013). Online material. Moodle (Sisu student tools https://sisu.lut.fi/student/courseunit/otm ....).		
TU Coordinator	Ville Ojanen, ville.ojanen@lut.fi,		

Course title	Solid-Liquid Separation W06GIG-SM3061G		
European Credits (ECTS)	4	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1ECTS), classes: 1h/week (2 ECTS), lab: 2h/week (2 ECTS), blended learning, Distance learning is possible, except for laboratory work measurements	**Student whole working time (hours)**	100
Description of content	The topics are as follows: Fundamentals of solid-liquid separation, filtration methods, operation of filters, cake formation and washing, deliquoring, design and modelling of filters and scale-up. Filter media and blinding. Experimental design in filtration test work.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - the fundamental phenomena in solid-liquid separation, - different methods and equipment used for solid-liquid separation, - different filter media used in filtration, Skills Upon completion of the course, a student is able to: - select and size suitable equipment for separation processes based on suspension properties and data from laboratory tests, - explain the effects of the characteristics of the solid material and the liquid on the separation and post-treatment processes, - make a preliminary selection of a medium for different cases, - perform an experimental test on a laboratory scale, - write a scientific report.		
Assessment methods and criteria	Homework, laboratory work plus report, literature review and class assignments passed. Moodle exam. Grades: 0-5. Lecture exam 60%, laboratory work and report 20%, literature review 20%. The lecture: the ability to explain the fundamental phenomena, methods, and equipment in solid-liquid separation is checked during the Moodle Exam. The practical classes: the ability to perform an experimental test on a laboratory scale and write a scientific report.		
Recommended readings	Basic study material is delivered in Moodle (Sisu student tools https://sisu.lut.fi/student/courseunit/otm.....). Online material.		
TU Coordinator	Antti Häkkinen, Antti.Hakkinen@lut.fi,		

ELECTIVE SUBJECTS
BLOCK I

Lappeenranta-Lahti University of Technology LUT

Course title	Artificial Inventiveness W06GIG-SM3070		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	It is an online course for all interested in creativity, in systematic tools of ideation. The modules contain basic TRIZ (Theory for Inventive Problem Solving) tools for idea generation. Have you ever thought about why it is hard to find a new idea sometimes? How to analyze the situation where you need an out of box solution? How to deliver the list of concepts to improve a product or a service? This self-paced course includes the following modules: Introduction, Function Definition, Ideal Final Result, Function-oriented Search, and Contradictions. This course is a brief introduction to creativity and idea generation with elements of theory, everyday life examples, and tests for self-check.		
Intended Intended Learning Outcomes	Upon completion of the course, a student is able to - identify inventive problems in the complex process of product development - apply several tools for systematic idea generation (Function modelling, Ideal final result, Function-oriented search, Contradictions analysis) - act step-by-step when creative and out-of-box ideas are needed		
Assessment methods and criteria	Video lectures and examples, assessment tests, and discussion forums. Homework and class assignments as well as quizzes passed. No exam. Grades: fail/pass. The course is built around practical problems solved individually. The lectures constitute the theoretical support for assignment reports and written quizzes during the semester.		
Recommended readings	Lecture notes and links to supplementary material are given in Moodle. Course videos are available on the CEPHEI platform.		
TU Coordinator	Anastasia Chakir, Anastasia.Chakir@lut.fi, Leonid Chechurin, Leonid.Chechurin@lut.fi,		

Course title	Entrepreneurship and Career Opportunities in Raw Material Sector W06GIG-SM3071		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	Most industrial sectors are facing a new era that requires companies to transform their operations, create new business models, and foster a digital culture. In this context, the industry is facing a changing talent landscape, necessitating new skill sets in their workforce. Companies need to ensure that their staff are properly constituted to support this transformation process. During the course, entrepreneurship skills as well as innovative thinking for engineers will be trained using examples from the raw material sector. Case studies will bring the understanding of skills and competencies of the future workforce and current trends of the industrial revolution.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and recognizes entrepreneurship and career opportunities in the raw material sector, - and understands the primary sector of the raw materials value chain (geology, mining, mineral processing, metallurgy, and the environment). Skills Upon completion of the course, a student is able to - apply design thinking tools to enhance the creativity and innovation capacity of engineers, - develop skills and competencies to improve the mindset of entrepreneurship.		
Assessment methods and criteria	Online lectures, workshops, exercises, design thinking training, assignments, self-study. Homework and class assignments as well as quizzes passed. No exam. Grades: pass/fail. Group work and individual assignments. 25% lectures and quizzes, 25% training, 25% workshop, 25% self-study.		
Recommended readings	Lecture notes, and articles related to the topics.		
TU Coordinator	Maria Mamelkina, Maria.Mamelkina@lut.fi,		

Course title	Sustainable Water Use W06GIG-SM3072		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	Sustainability challenges of water use. Water footprint. Water risk assessment. Water supply, water use in different sectors and loading of water systems. Wastewater treatment in industry and municipalities. Sludge treatment. Production of drinking water. Protection of groundwater deposits. Legislation on water quality and sludge treatment. Economic efficiency of different water treatment methods. Reclaimed water.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and defines the key concepts of water pollution control, - and recognizes the main factors affecting water footprint and sustainability of water use, - and explains the operation of essential process technology and equipment related to the control of water pollution, - and recognizes means to protect groundwater and reduce the environmental load of surface waters, - and understands methods for the environmentally friendly management of side-product flows from water treatment. Skills Upon completion of the course, a student is able to: - apply risk analysis methods related to water issues, - implement different methods for water footprint calculation, - compare and give grounded proposals for water treatment methods and processes applicable to different situations, - analyze the sustainability of water management systems.		
Assessment methods and criteria	Lectures, tutorials and independent exercises. Moodle assignments. Moodle quizzes. Homework and class assignments as well as quizzes passed. Grades: 0-5. Moodle quizzes 50%, assignment 50%. Possibility to get a higher grade by giving a presentation of a scientific article - 5 points.		
Recommended readings	handouts provided by the lecturer, course environment on Moodle, Tchobanoglous: Wastewater Engineering. Treatment and Reuse, 2003		
TU Coordinator	Heli Kasurinen, Heli.Kasurinen@lut.fi, Mariia Zhaurova, Mariia.Zhaurova@lut.fi, Risto Soukka, Risto.Soukka@lut.fi,		

Semester 2
LUT

Lappeenranta-Lahti University of Technology LUT

Course title	Fluid Dynamics in Chemical Engineering W06GIG-SM3065G		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 2h/week (2 ECTS), classes: 1h/week (1 ECTS), project 2 h/week (2 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	Design methods and scale-up of fluid mixers, rheology, and mixing effects in chemical reactors. Theoretical basics of CFD (Computational Fluid Dynamics) in chemical engineering aspects and ability to solve basic mixing problems with CFD. COMSOL software for Multiphysics Simulation (FEM).		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - theoretical basics of CFD (Computational Fluid Dynamics) in chemical engineering, - design methods and scale-up of fluid mixers, rheology, and mixing effects in chemical reactors, - understand the basics of fluid rheology Skills Upon completion of the course, a student is able to - select, size and scale up different mixing devices (stirred tanks, in-line mixers) for blending and multiphase mixing (solid-liquid mixing, liquid and gas dispersions) based on short-cut design methods, - and can adapt the basics of fluid rheology to mixing design, - solve basic fluid mixing problems with CFD programs (COMSOL software), - calculate heat transfer, chemical reactions, laminar and turbulent flow in CFD, - analyze relevant cases in Power-to-X chemicals production technologies.		
Assessment methods and criteria	Homework and class assignments as well as quizzes passed. No exam. Exercise-based lecturing (MS-TEAMS or classroom lecture), home exercises and quizzes 70 h (online in Moodle). 3 homework tasks (Lectures 1-3) will be about hands-on calculations (fluid mixing short-cut methods, engineering maths and calculations). 4 CFD exercises (Lectures 4-7), using COMSOL Multiphysics. Grades: 0-5. 50 % of the grade is from homework (each homework grading 0-100 %, 25 % of the Quizzes (each weekly Quiz 0-100 %), 25 % of Project work. The overall grade for passing the course should be at least 1.0. The course is built around practical calculation work solved individually by the students. The lectures constitute the theoretical support for assignment reports and written quizzes during the semester.		
Recommended readings	Lecture materials in Moodle. Mixing Device Design Perry's Chemical Engineers' Handbook, Perry, R.H., Green, D.W., Maloney J.O. (Eds.), McGraw-Hill, New York; Handbook of Industrial Mixing, Science and Practice, Paul, E.L., Atiemo-Obeng, V.A., Kresta, S.M., (Edits.), John Wiley & Sons, USA, 2004; EKATO-Handbook of Mixing Technology, EKATO Rühr- und Mischtechnik GmbH, Schopfheim; Zlokarnik, M., Stirring: Theory and Practice, Wiley-VCH, Weinheim, 2001; CFD Material Tu, J., Yeoh, G. H. & Liu, C. (2013). Computational fluid dynamics: A practical approach (2nd ed.). Amsterdam; Boston: Elsevier/Butterworth-		

	Heinemann (e-book); An introduction to computational Fluid Dynamics–The finite volume method, 2nd Edition, H. K. Versteeg and W. Malalasekera, 2007; An introduction to computational Fluid Dynamics –The finite volume method, Second Edition, H. K. Versteeg and W. Malalasekera, 2007 (book); Comsol Multiphysics User's Guide (inside Software); www.cfd-online.com; www.bakker.org;
TU Coordinator	Tuomas Koiranen, Tuomas.Koiranen@lut.fi,

Course title	Process Intensification W06GIG-SM3066G		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 2h/week (2 ECTS), classes: 1h/week (2 ECTS), seminar: 1h/week (1 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	The course covers different process intensification methods and their theoretical background. Teaching involves lectures, assignments, meetings and seminars. The main work will be carried out as a process design project assignment where students will work in teams aiming to intensify a process given by the teacher. Each team will write a report and present their results in the seminar. The topics focus mainly on the intensification of different Power-to-X processes, such as the production of E-fuels, carbon-neutral products, energy storage etc.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and explains intensified reactors and separation equipment, combination of reaction and separation, hybrid separation, alternative energy sources, transformation of batch processes to continuous ones, - and explains the principles and goals of process intensification, - and recognizes possibilities to intensify processes and apply novel technology to existing processes (the production of E-fuels, carbon-neutral products, energy storage, etc.), - and understands how product design and process design are related, - and describes the advantages of process intensification and typical intensification methods. Skills Upon completion of the course, a student is able to: - apply intensified reactors and separation equipment, the combination of reaction and separation, hybrid separation, alternative energy sources, the transformation of batch processes to continuous ones, - carry out process design to intensify a process given by the teacher, - write a report and present their results, - work in a team.		
Assessment methods and criteria	Lectures, seminars and exercises passed. Group work, self-studies, preparation for the seminars and the examinations. Grades: 0-5. Written examination 50%, seminar report and exercises 50%. The lecture: the ability to explain different process intensification methods and their theoretical background. The practical classes: the ability to carry out a process design project assignment in teams aiming to intensify a process given by the teacher. The ability to lead the seminar and produce the presentation.		
Recommended readings	Lecture notes. Online material.		
TU Coordinator	Arto Laari, Arto.Laari@lut.fi,		

Course title	Current Issues in Enabling Technologies for Circular Economy W06GIG-SM3067G		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (2 ECTS), classes: 1h/week (2 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	The course will introduce the most important processing technologies that enable the implementation of a circular economy, such as recycling and recovery as well as separation and purification technologies. The approach of the course is mainly solution-based and thus aims to show practical examples of the utilization of different technologies in solving different kinds of challenges in the circular economy. A special emphasis is laid on topical themes, such as recycling and upgrading of plastic, electric, packaging and textile waste as well as on the production of biofuels. The course will also introduce the concept of ecodesign as a tool to manage the complex value chains in the circular economy.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and understands basic concepts of circular economy (raw materials, processing, manufacturing until end-of-life recycling and reuse) and the drivers for change from linear to circular economy, - and understands the processing technologies of materials in the context of the circular economy. Skills Upon completion of the course, a student is able to: - evaluate the processing technologies of materials in the context of circular economy, - recognize and compare impacts (environmental, economic and social) of processing technologies when assessing the current (linear) practice of material processing vs circular value chains, - apply the transferable skills of life cycle thinking (ecodesign) to evaluate processing technologies in circular value chains.		
Assessment methods and criteria	The students will prepare a team portfolio on one specific subject during this course that will be assessed. In the preparation and assessment of the portfolios peer and self-evaluation will be utilized. In addition, students will answer individually two compulsory questions (at the beginning and the end of the course). Grades: 0-5. There is no exam. The students will prepare in teams a short pitching video and a report on one specific subject during this course that will be assessed. In the assessment peer and self-evaluation will be utilized. In addition, the course material includes compulsory or voluntary quizzes or questions related to the topic at hand.		
Recommended readings	Course material is available in Moodle and consists of video lectures and scientific and topical articles. The course material and the guidance to supplementary material are provided in connection with the different topics.		
TU Coordinator	Miia John, Miia.John@lut.fi,		

Course title	Start-ups and Venture Formation W06GIG-SM3068G		
European Credits (ECTS)	6	**Time (hours) given to the students**	75
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (3 ECTS), seminar: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	150
Description of content	Entrepreneurship theory and process, business ideas and opportunities, business models, entrepreneurial teams, start-ups and spin-offs, start-up process and development stages, start-up strategies and sequencing activities, start-up financing, testing of business ideas, business plans, and cases.		
Intended Learning Outcomes	Upon completion of the course, a student knows - business start-up theories and processes. Skills Upon completion of the course, a student is able to: - critically analyse different business ventures and is skilled in testing business ideas and models, - analyze business cases and prepare a business plan with its calculations as well as pitch the plan successfully, - work as a team member in a development project.		
Assessment methods and criteria	Individual assignments and preparing for Moodle exam, independent work. Group work. Grades 0-5. Evaluation 0-100 points. Individual assignments 60%, group work 30% (written business plan 20%, oral pitching 10%), Moodle exam 10%.		
Recommended readings	Barringer, B.R. & Ireland, R.D. (2006 or later edition). Entrepreneurship: successfully launching new ventures. Pearson Prentice Hall. Other materials will be distributed during the course.		
TU Coordinator	Noora Heino, Noora.Heino@lut.fi,		

Course title	Academic Entrepreneurship W06GIG-SM3069G		
European Credits (ECTS)	6	**Time (hours) given to the students**	75
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (3 ECTS), seminar: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	150
Description of content	- The central concepts of entrepreneurship, - The entrepreneurial mindset, motivations, resources and opportunity recognition, - The anatomy of the venturing process, - Commercializing academic skills and research activities, - Communicating entrepreneurial ventures		
Intended Learning Outcomes	The course aims to develop the student's awareness of their entrepreneurial mindset. The aims also include enhancing the students' understanding of entrepreneurial opportunities and routes for grasping them. Furthermore, the students learn new ways to commercialize their knowledge, skills and research activities.		
Assessment methods and criteria	Lectures and teamwork, tests and exercises, homework exercises, practising presentations of business cases, study visits or visitor lecturers. Grades: 0-5. 1-5 course assignments and an exam. Moodle assignments, individual and group assignments.		
Recommended readings	Shane, Scott (2003) A general theory of entrepreneurship. The individual-opportunity nexus. Edward Elgar. Other literature is to be announced during the course (including e-learning material). Online material.		
TU Coordinator	Tuuli Ikäheimonen, Tuuli.Ikaheimonen@lut.fi,		

ELECTIVE SUBJECTS
BLOCK II

Lappeenranta-Lahti University of Technology LUT

Course title	Intelligent Product-Service Systems W06GIG-SM3073		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	Product-Service Systems (PSS) and Product Lifecycle Management (PLM) trends and digital transformation. Different views on a product/service: structures – processes – lifecycles – data/information, challenges with lifecycle management, requirements management, and systems engineering. Product information modeling, change management, and configuration management through lifecycle (CLM). IoT-based data services for sustainability, features, and functionalities of PSS/PLM systems. PLM project and demos of systems utilization. Future of PSS in various industries.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and understands trends of product-service systems and digital transformation affecting manufacturing business, - and defines, and explains the concepts related to product data management and product life cycle management, - and recognizes the company's product and service processes and understands their interaction with the company's overall operations Skills Upon completion of the course, a student is able to - compare PLM and ERP systems' characteristics, technical features, and managerial functions and is able to see their role in product development and business management.		
Assessment methods and criteria	Lectures, project meetings, and intensive studies. Course assignments and quizzes. Grades 0-5. Quizzes 60 %, project assignment and participation 40 %.		
Recommended readings	Journal articles and lecture material. Sääksvuori-Immonen: Product Lifecycle Management, Springer 2008.		
TU Coordinator	Ilkka Donoghue, Ilkka.Donoghue@lut.fi, Lea Hannola, Lea.Hannola@lut.fi,		

Course title	Inventive Product Design and Advanced TRIZ W06GIG-SM3074		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	It is a course for all interested in creativity, in systematic tools of ideation. The modules contain basic and modern TRIZ (Theory for Inventive Problem Solving) tools for idea generation and other analytical tools that have proven their efficiency in the industry. Have you ever thought about why it is hard to find an idea that can save a product, project, or business? How to analyze the situation where you need an out of box solution? How to deliver systematically the list of patentable concepts to improve a product or a service? How to circumvent the patents of competitors and develop an IP strategy? The course includes the following modules: Introduction, Basics of Patenting, Function Definition, Function-oriented Search and Biomimetics, Contradictions, Function Modelling and Ttrimming, Cause-Effect Chain Analysis, Trends of Engineering System Evolution, Axiomatic Design, Design for Manufacturing and Assembly, Conclusion. There are about 20 case studies and 100+ examples of smart new product design, technology troubleshooting, and inventive solutions, many of which are coming from success and failure stories of technological giants. Most cases originate from the engineering domain, although basic knowledge like how car brakes work and what is inside a refrigerator...except food plus curiosity is enough to follow most.		
Intended Learning Outcomes	The aim of the course is to introduce the students to a wide range of existing design methods with a focus on design creativity and innovation. The participants will gain both theoretical competencies and practical skills, from the descriptive models for analyzing design processes and behaviours to the prescriptive tools that provide a structured and multi-disciplinary approach to design. Knowledge Upon completion of the course, a student knows - and distinguishes the conceptual design phase and its instruments, - and identifies the voice of the product and forecast technology evolution). Skills Upon completion of the course, a student is able to - search and analyze patent landscape, - modulate ideation algorithms, - design a new product and concept of the service on demand, - evaluate design concepts from managerial and production perspectives.		
Assessment methods and criteria	Lectures and project meetings, group work, individual work, and studies. Online lectures, exercises, assignments, self-study. Homework and class assignments passed. No exam. Grades: 0-5. Project work is 50% and individual work is 50%.		
Recommended readings	Study materials will be provided during the course, and open-access Internet resources are actively used.		
TU Coordinator	Anastasia Chakir, Anastasia.Chakir@lut.fi, Leonid Chechurin, Leonid.Chechurin@lut.fi,		

Course title	Knowledge Discovery and Process Data Analysis W06GIG-SM3075		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	Knowledge discovery refers to the overall process of discovering useful knowledge from data. The knowledge discovery process is interactive and iterative and involves several steps starting from studying the application domain and ending with to use of the information discovered. Process data analysis can be part of this process. Fundamental concepts - such as reliability of data, preprocessing (e.g., de-noising, handling missing data, and scaling strategy), data reduction, choosing a methodology, validation, modelling, etc - will be addressed in lectures, Moodle assignments, and discussions. Project work will be carried out in small groups that will define their working methodology. The course is suitable for distance learning.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - have acquired basic information on the main concept of the knowledge discovery process concerning industrial data. Skills Upon completion of the course, a student is able to: - be aware of the effect of digitalization and automation on the amount, nature, and quality of data from the chemical engineering point of view, - apply specified methods and methodology to data, - apply management and collaboration skills in the implementation of project work.		
Assessment methods and criteria	Online lectures, tutorials, online discussions, peer feedback, Moodle quizzes, and weekly assignments. Project work. Grades: 0-5. Project work 39 %, assignments 37 %, discussions in Moodle forum 24 %. Homework and class assignments as well as quizzes passed.		
Recommended readings	Tutorial videos, and online material distributed or announced in Moodle.		
TU Coordinator	Satu-Pia Reinikainen, Satu-Pia.Reinikainen@lut.fi, Tuomas Sihvone, Tuomas.Sihvonen@lut.fi,		

Course title	Development of New Sustainable Products and Solutions W06GIG-SM3076		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	The course contains an introduction with an overview of sustainable biobased products, bio-based barrier technologies for packaging applications, Biobased Hygenic Products and Solutions, Biomaterials for Printing, and Biobased tall oil products. and Biomaterials in food application. Fundamentals about biomaterial design, modification, synthesis, and use of fibers, cellulose (derivatives), and lignin in various products. Chemical and mechanical modification, separation methods, mixing and drying methods. Product specification requirements and characterization methods. In addition, the course contains an interesting topic of group and individual assignments related to modern trends of sustainable biobased products and solutions.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - various types of new sustainable product development and solutions, - tailoring of functionalities of biobased polymers to meet functionality needed for specific applications, - various renewable resources (biomaterials, biochemicals, cellulose, lignin, starch, carbohydrates, etc) based on sustainable product development and their applications, - material and molecular design and its role in product performance. Upon completion of the course, a student is able to: - use of forest resources and forest-derived biomaterials for food, pharmaceuticals, composites, industry, and other applications.		
Assessment methods and criteria	Mostly self-study and topic-based exercises, topic-based group, and individual assignments. Online lectures, tutorials, online discussions, peer feedback, Moodle quizzes, and weekly assignments. Project work. Grades: 0-5. Exercises (20%), group assignment (30%), video presentation of group assignment (20%) and individual assignment (30%).		
Recommended readings	Lecture material will be distributed via Moodle.		
TU Coordinator	Rama Layek, Rama.Layek@lut.fi,		

Semester 3
WUST

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish: Wspomagane komputerowo modelowanie geologiczne i geostatystyka.)
Name of subject in English: Computer-Aided Geological Modelling and Geostatistics
Main field of study: Mining and Geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management,
Mineral Resource Exploration,
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3002
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	crediting with grade	Examination / crediting with grade*	crediting with grade	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,8		1,9		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Mathematical Statistics,
2. Fundamentals of Geology and Mineral Deposits

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SUBJECT OBJECTIVES

C1 Developing basic skills in computer modelling of 3-D objects.
C2 Introduction of the principles of digital modelling of typical geological structures.
C3 Introduction to the methods of deposit parameters estimation and resources evaluation.

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 Estimation methods, principles of geostatistics, kriging estimators PEU_W02 Geostatistical modelling of the selected deposit parameters (domain analysis, variogram modelling, PEU_W03 Creating and validating 3-D models of various geological structures in the comprehensive dedicated software environment. relating to skills: PEU_U01 Application of relevant estimation methods for quality modelling of a deposit PEU_U02 Evaluating 3-D objects against structural and quality block models (volumes, tonnages, grades) PEU_U03 Describing the interpretation and applied approach, creating models, evaluation results, recommendations for possible enhancements relating to social competences: PEK_K01 The student can think and act in a creative and enterprising way

PROGRAMME CONTENT		
Lecture		Number of hours
Lec 1	Introduction to the course. Geological database and validation of the geological data.	2
Lec 2	Geology of the seam.	2
Lec 3	Structural model of the stratified deposit. Methods of the prediction of the surface layer parameters.	2
Lec 4	Spatial distribution of samples values. Regionalized variable.	2
Lec 5	BLUE Estimator of the mean value: Kriging.	2
Lec 6	Quality model of the deposit – block model of the parameter layers. Estimation and evaluation of the block model.	2
Lec 7	Reserves modelling and evaluation.	2
Lec 8	Mineral resources. International reporting. The JORC Code	1
	Total hours	**15**

Laboratory		Number of hours
La1	Determining the rules of work at the laboratory.	3
La2	Assignment of the individual dataset for the exercises and creating initial data files.	3
La3	Data validation and creating initial geological database.	3
La4	Construction of the structural wireframe model of stratigraphy layers.	3
La5	Construction of the block model of the deposit and overburden layers. Thickness and stripping ratio analysis.	3
La6	Data preparation to geostatistical analysis. Compositing of the samples.	3
La7	Domain analysis with the use of the statistical methods.	3
La8	Determination of the empirical variogram. Anisotropy analysis.	3

La9	Variogram modelling.	3
La10	Kriging Neighborhood Analysis - defining optimal parameters of the estimation procedure.	3
La11	Estimation of quality parameters in block model of the deposit layers. Validation of the estimation quality.	3
La12	Validation of the quality model and classification of the resources. Balance resources evaluation.	3
La13	Preparation of data for continuous surface mining ultimate pit design. Ultimate pit outlines generation	3
La14	Wireframe and block modelling of the ultimate pit	3
La15	Reserves evaluation, visualization and interrogation of created models	3
	Total hours	45

TEACHING TOOLS USED
N1. Form of lectures - traditional, multimedia presentations using specialized software and demonstrations of its application "live", individual development of specialist topics covered during the lecture, N2. individual development of project tasks within the laboratories frames, individual development of electronic reports concerning project tasks within the laboratories frames, N3. evaluation of laboratory tasks reports with multipoint grade of student's work, group analysis of the results obtained during laboratory tasks; preparation of conclusions concerning data dependencies and constraints of mining projects, skill control tests, duty hours in laboratory.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01, PEU_W02	Lecture grade on the basis of the written examination
F2	PEU_W03,	Laboratory task assessment: “structural modelling assessment
F3	PEU_U01	Laboratory task assessment: “geostatistical modelling”
F4	PEU_U02, PEU_U03	Laboratory task assessment: “reserves evaluation”.
P average of F1, F2, F3, F4		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] M. Armstrong, Basic Linear Geostatistics, Springer Verlag, 1998.
[2] P. Goovaerts: "Geostatistics for Natural Resource Evaluation", Oxford University Press, 1997.
[3] R. H. Grishong, Jr., 3-D Structural Geology, Springer Verlag, 2008
[4] K. Hefferan, J. O'Brien, Earth materials, Willey-Blacwell, Chichester U.K., 2010
[5] W. Hustrulid, M. Kuchta, Open pit mine planning and design. Chapter 3. Orebody description, Taylor&Francis, 2013.
[6] A. G. Journel, and C.J. Huijbregts, Mining Geostatistics, Academic Press, 1978.
[7] Ch.C. Plummer, D.H. Carlson, L. Hammersley, Physical geology, McGraw-Hill I.E. N.Y. 2010
[8] D.R. Prothero, R.H. Dott Jr., Evolution of the Earth, McGraw-Hill I.E. N.Y., 2010
[9] M.W. Rossi, C.V. Deutsch, Mineral Resources Estimation, Springer Verlag 2014.

SECONDARY LITERATURE:

[10] Handouts, tutorials.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. Krzysztof Hołodnik
Dr inż. Witold Kawalec

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Cyfrowa kopalnia
Name in English: Digital Mine
Main field of study: Mining and Geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
Mineral Resource Exploration,
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3006
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		15		
Number of hours of total student workload (CNPS)	25		25		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**1**		1		
including number of ECTS points for practical (P) classes			1		
Including number of ECTS points for direct teacher-student contact (BK) classes	0,8		0,8		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Computer literacy skills
2. Basic knowledge related to Mining Engineering and Mineral Processing
3. Programming

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SUBJECT OBJECTIVES

C1. Acquisition of the ability to create utility applications in the C / C ++ and LabVIEW environment
C2. Providing students with knowledge about embedded systems, their construction, selection of components, designing, programming and their exploitation.
C3. Familiarizing with the advances of technology & methods of future mining operations.
C4. Acquisition and consolidation of social competencies including emotional intelligence skills involving the cooperation in the group of students aiming to effectively solve problems. Responsibility, honesty and fairness in the proceedings; observance force in academia and society

SUBJECT EDUCATIONAL EFFECTS **relating to knowledge:** PEU_W01 A student has knowledge related to automation systems, control systems and measurement systems in various aspects of the mining industry. PEU_W02 The student has knowledge of the importance of automation and robotics systems in modern mining. **relating to skills:** PEU_U01 A student is able to select and integrate elements of a specialized measuring and control system including: control unit, executive system, measuring system as well as peripheral and communication modules PEU_U02 A student can design improvements in the existing design solutions for automation and robotics components and systems **relating to social competences:** PEU_K01 A student is aware of the need for a professional approach to technical issues, meticulous reading of documentation and knows environmental conditions in which devices and their components can function PEU_K02 The student has knowledge concerning the benefits of creation and implementation new solutions&technologies into mining industry

PROGRAMME CONTENT		
	Form of classes - lecture	**Number of hours**
Lec 1	Terminology (process, automation, robots, measurement devices, control systems). Definition of digital mine	2
Lec 2	Aims, benefits, drawbacks of automation. Industrial revolutions. Definition of industry 4.0. Overview of components of the 4th industrial revolution. Industry 4.0 and mining	2
Lec 3	Elements of technological process in mining. Automation of cyclic processes Measuring technologies in industry 4.0. Sensors systems. Data transmission and data storage technologies. Analytics in industry 4.0. Industrial BigData, Cloud Computing	2
Lec 4	Industrial Internet of Things. M2M communication, anti-collision systems, location of people underground	2
Lec 5	Virtual and augmented realities for industry. Simulators. Digital Twin. Digital models of processes and objects. Management information creation systems, reporting	2
Lec 6	Case study: Automation in open pit lignite mining (KTZ, Autonomous haulage (use case from Australia))	1
Lec 7	Case study: underground mine (Rock Vader – Sandvik project, other use cases from Sandvik, Epiroc, MineMaster, Zanam, AOT from ZGPS KGHM, KIC project on shaft inspection, …etc)	2
Lec 8	Case study: mineral processing (ConVis, FlowVis) in KGHM, OPMO project	2
	Total hours	**15**

Form of classes - laboratory		Number of hours
Lab1	Scope of the course, teaching purpose, crediting conditions, literature, data. Introduction to ARDUINO	3
Lab2	Basic sensors for physical parameters measurements	3
Lab3	Measurements in Labview	3
Lab4	Analysis and Visualization in Labview	3
Lab5	Control in labview	3
	Total hours	**15**

TEACHING TOOLS USED
N1. Type of lectures - traditional, illustrated with multimedia presentations with the usage of audio- visual equipment. N2. Discussion concerning lectures and laboratory. N3 Configuration on laboratory classes measuring systems (hardware and software), performing of measurements, teamwork N4. Projects defence - oral and written form. N5. Duty hours.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at the end of semester)	Educational effect number	Way of evaluating educational effect achievement
F1, P1	PEK_U02- PEK_U04	F1.1 Grade from laboratory work's performance and its merits F.1.2 Grade from laboratory work's oral or written defence P1.Final grade (weighted average of F1.1 - 60% and F1.2 - 40%).
F2, P2	PEK_U02- PEK_U04	F2.1 Grade from activity during the lecture (questions, discussions etc) F.2.2 Grade from written exam P2.Final grade (weighted average of F2.1 - 20% and F2.2 - 80%).

LITERATURE
PRIMARY LITERATURE: [1] LabVIEWTM Getting Started with LabVIEW http://www.ni.com/pdf/manuals/373427j.pdf [2] Monk Simon: Arduino dla początkujących. Podstawy i szkice, Anderson R., Cervo D., Helion, 2018 [3] Monk Simon: Arduino dla początkujących. Kolejny krok, Anderson R., Cervo D., Helion, 2015 **ONLINE LITERATURE:** [1] LabVIEW Tutorial [2] ARDUINO Tutorial [3] Materials prepared by Tutor [4] Internet websites
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Prof. dr hab. inż. Radosław Zimroz, radoslaw.zimroz@pwr.edu.pl **dr inż. Anna.Nowak-Szpak**

Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD
Name of subject in Polish: Geofizyka inżynierska
Name of subject in English: Engineering Geophysics
Main field of study: Mining and Geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management,
Mineral Resource Exploration,
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3004
Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			50	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	1			2	
including number of ECTS points for practical classes (P)				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,8			0,9	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES
1. has knowledge of fundamentals of applied geophysics, physics and geology.
2. knows fundamentals of soil and rock mechanics.
3. is able to use MS Office software.
4. is able to work in a team.

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SUBJECT OBJECTIVES
C1 familiarize with physical phenomena in geosphere of the Earth
C2 familiarize with engineering problems solved by means of geophysical surveying
C3 familiarize with various geophysical surveys.
C4 acquisition of skills to plan geophysical field surveying and to interpret its results.
C5 development of skills to work in a group.

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge:
PEU_W01 recognizes, names and explains engineering problems in different fields.

PEU_W02 identifies, describes and chooses geophysical surveying methods.
PEU_W03 analyses and assesses case studies from solving the engineering problems.
relating to skills:
PEU_U01 is able to coordinate team work, create field research plans and manage the work progress.
PEU_U02 is able to independently create solutions for complex practical problems in engineering and geoengineering applying knowledge about geophysical surveying, mining geophysics, utilizing modern methods in geophysical data acquisition and interpretation.
PEU_U03 is able to critically assess, process and interpreted results of the geophysical surveying and provide recommendations related to engineering problems in mining, civil engineering, engineering geology, municipal waste site, archeology, engineering properties of soil and rocks, hydrogeology, monitoring seepage in river dykes or dams.
PEU_U04 is able to solve geophysical problems.
PEU_U05 is able to conduct auto-didactical education related to detailed handling of typical software.
relating to social competences:
PEU_K01 understands the need to create and transfer to the society – among others by mass media- information and opinions related to mining engineering achievements and other activities of mining engineer; tries to transfer the information in commonly understood way, presenting different points of view; is aware of the quality and need to shape the work safety culture in mining and the responsibility for the health and life of other employees.

PROGRAMME CONTENT

	Lecture	Number of hours
Lec 1	Physical properties of rocks. Inter-relationships between the various subdisciplines of applied geophysics. Overview of geophysical methods, their physical principles and applications. Methodology of geophysical surveying.	1
Lec 2	Engineering problems solved with geophysical surveying. Case studies.	2
Lec 3	Electrical resistivity methods. Tomography and VSE. IP method. Physical principles. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
Lec 4	Electromagnetic methods. FDEM and TDEM methods. Magnetotelluric methods. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Lec 5	GPR surveying. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Lec 6	Seismic tomography. Seismic interferometry. Physical principles. Applications. Case studies.	2
Lec 7	Mine geophysics. Seismology. Seismic methods. Active and passive seismic tomography. Microgravimetry. Case studies.	2
Lec 8	Gravity and magnetic surveying. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
	Total hours	15

Project		Number of hours
Proj 1	One selected geophysical technique. Fundamentals and equipment. Field surveying	4
Proj 2	Processing and interpretation of field data.	3
Proj 3	Solving the geophysical problems.	8
	Total hours	15

TEACHING TOOLS USED

N1. N1.Lecture aided by presentation.
N2.Demonstration.
N3.Discussion and consultations
N3Calculations
N5Practical field surveying

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
P1	W01-W03	Test related to lecture content. Final grade.
F1	U01-U02, U05	Test. Project 1. Report on Project 1
F2	U03, U05	Test. Project 2. Report on Project 2
F3	U04, U05	Test. Solving geophysical problems
F1-F3, P2	U01-U05 K02	Grades are given for each of three project tasks including tests and reports. The final grade P2 for the project course is the weighted average grade of F1-F3.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Aki, K., Richards P.G., 1980. Quantitative Seismology: Theory and Methods. W.H. Freeman Co.. San Francisco.
[2] Burger, H.R., Sheehan, A.F., Jones, C.H., 2006. Introduction to Applied Geophysics: Exploring the Shallow Subsurface. W.W. Norton & Company, Inc.
[3] Mendecki, A.J. (ed.), 1997. Seismic Monitoring in Mines. Chapman & Hall.
[4] Reynolds, J.M., 2011. An Introduction to Applied and Environmental Geophysics. Wiley – Blackwell. John Wiley & Sons.
[5] Sharma, Prem V., 2002. Environmental and engineering geophysics. Cambridge University Press.
[6] Torge, W., 1989. Gravimetry. Water de Gruyter. Berlin. New York.
[7] Selected Journal Publications (for example journals: Progress in Geophysics, Engineering Geophysics Journal, Environmental and Engineering Geophysics, Journal of Geophysics and Engineering, Pure and Applied Geophysics).

SECONDARY LITERATURE:

[1] Lowrie, W., 2007. Fundamentals of Geophysics. Cambridge University Press.
[2] Milsom, J., 2003. Field Geophysics. John Wiley & Sons Ltd.
[3] Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990. Applied Geophysics. Cambridge University Press.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Zarządzanie Środowiskiem
Name in English: Environmental Management
Faculty of studies (if applicable): Mining and Geology
Specialisation (if applicable): Mining Engineering
Mineral Resource Exploration
Entrepreneurship, Innovation and Technology Integration in Mining
Level and form of studies: 2nd level, full-time
Subject Type: Obligatory
Subject code: W06GIG-SM3001
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in the University (ZZU)	**30**				**15**
Number of hours of total student workload (CNPS)	**50**				**25**
Form of crediting	**Crediting with grade**				**Crediting with grade**
For a group of courses mark (X) for the final course					
Number of ECTS points	**2**				**1**
including number of ECTS points for practical (P) classes					**1**
including number of ECTS points for direct teacher-student contact (BU) classes	**1,3**				**0,8**

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of issues related to ecology and environmental protection.

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SUBJECT OBJECTIVES

C1. To get students acquainted with systems of environmental management both in Poland and other EU countries.
C2. To prepare students for rational and sustainable management of environmental components.
C3. To get students acquainted with the genesis of environmental management systems in Poland, review and standardization of environmental management systems.
C4. To get students acquainted with benefits and obligations arising from the implementation

of an environmental management system. C5. To present the relationship between an environmental management system and a quality management system. C6. To provide an overview of informative methods of supporting the implementation of environmental management systems (possibilities and practical usage of computerised systems of environmental information management, decision support in the area of environmental protection and choice of methods and tools used to support the implementation of an environmental management system).

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 – Possesses systematic knowledge of the origins of environmental management systems, review and standardization of environmental management systems.
PEU_W02 - Possesses knowledge of the possibilities and practical applications of tools supporting the implementation of the environmental management system.
PEU_W03 - knows basic formal and legal regulations regarding the implementation and functioning of management systems, tools and instruments of environmental management.
PEU_W04 - Possesses knowledge for rational and sustainable management of environmental components.

relating to skills:
PEU_U01 – Possesses linguistic resources appropriate for specialised language and is able to use it in linguistic activities in order to communicate in the professional environment regarding the field of studies; is able to obtain necessary information and interpret and critically evaluate it, reads and understands professional literature, is able to formulate and comprehensively justify opinions, provide presentations of problems related to a studied discipline and also participate in scientific and professional discussions.
PEU_U02 – Is able to use methods and appropriate IT tools in system management of environmental components.

relating to social competencies:
PEU_K01 - Is able to think and act in a creative and enterprising way.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec.1	Basic concepts: - Environment, characteristics of individual elements of the environment - Characteristics of hazards for the natural environment which are a result of human activities - Environmental Management - The Environmental Management System	2
Lec.2	Legal aspects of environmental management	2
Lec.3	History and development of environmental management systems	2
Lec.4	Environmental management systems:	6

Lec.5 Lec.6	- Business Charter for Sustainable Development of the International Chamber of Commerce - ICC Business Charter for Sustainable Development - EMAS – Directive of the European Community Commission regarding the approval for voluntary participation by organisations in a community eco-management and eco-audit scheme - CP - Clean Production - BS 7750 - Specification for Environmental Management Systems - ISO 9000 - ISO 14000 - ISO 14001 Characteristics of selected Environmental Management Systems. The benefits of the implementation of the EMS for a company. Experiences of Polish enterprises from the implementation of EMS. Process of implementation of the selected EMS in a company with an example of EMAS.	
Lec.7 Lec.8	Basic tools of environmental management: - Legal and administrative instruments (laws, standards, licenses and permits) - Economic instruments (fees, taxes, deposit and refund systems, transferable rights, subsidies, liens, fines) - Instruments (techniques) social impact (ecological education, ecological propaganda) Examples of basic tools of environmental management: - Procedure for an assessment of environmental impact - Integrated permits - Audits - Safety Reports - Monitoring of the Environment	4
Lec.9 Lec.10	Design of an environmental management system	4
Lec.11 Lec.12	IT systems supporting environmental management: - Decision Support Systems - Expert systems - Simulation Models - Geographical Information Systems Selected types of information systems which support environmental management, their characteristics, examples of implementation both in Poland and in the world	4
Lec.13	The benefits of an implemented and functioning environmental management system	2
Lec.14	Costs of implementation and functioning of an environmental management system	1
Lec.14 Lec.15	Environmental management systems in practice	3
	Total hours	**30**

Form of classes - seminar	**Number of hours**

Se1	The scope and form of an essay and presentation, terms of crediting and literature. Assignment of seminar topics for individual students.	2
Se2 Se3 Se4 Se5 Se6 Se7 Se8	Student speeches with the use of multimedia presentations on the following issues: environmental management systems - specified examples, formal and legal conditions of administrative procedures (eg. receiving a decision on the environmental conditions of a project, an integrated decision etc.), life-cycle analysis of a selected company; fees, taxes, surcharges and environmental deposits; litter management systems, mineral resource management, renewable energy sources, selected monitoring systems, the institution of environmental protection in Poland and in the world and also alternative energy sources, etc. Group discussion on the content and form of speeches.	13
	Total hours	**15**

TEACHING TOOLS USED
N1. Informative lecture with elements of problematic lectures. N2. Multimedia presentations N3. Didactic discussion during lectures and seminars N4. Preparation of an essay in the form of a report N5. Presentation of the essay N6. Consultations

EVALUATION OF SUBJECT EDUCATIONAL OUTCOME ACHIEVEMENTS

Evaluation F – forming (during semester), P – concluding (at semester end)	Educational outcome number	Method of evaluating educational outcome achievement
F1- Grade from content value of an essay	PEU_U01 PEU_U02 PEU_K01	Text and graphical form of essay
F2 – Grade from presentation and issues included in an essay	PEU_U01 PEU_U02 PEU_K01	Presentation of essay
F3 – Grade from a written or oral test	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Positive grade
final grade from the subject (the weighted average, respectively: 35% for the substantive content of the essay, 25% for the presentation, 40% for the lecture)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Wilson, G. A., & Bryant, R. L., 2021, Environmental management. Routledge.
[2] Mitchell B., 2002, Resource and Environmental Management, Routledge, London
[3] Lukasheh A. F., Droste R. L., Warith M. A., 2001, Review of Expert System (ES), Geographic Information System (GIS), Decision Support System (DSS), and their applications in landfill design and management. W: Waste Management & Research nr 19,
[4] Gregory, R., Failing, L., Harstone, M., Long, G., McDaniels, T., & Ohlson, D., 2012, Structured decision making: a practical guide to environmental management choices. John Wiley & Sons.
[5] Schaltegger, S., Burritt, R., & Petersen, H., 2017, An introduction to corporate environmental management: Striving for sustainability. Routledge.

SECONDARY LITERATURE

[1] Uberoi, N. K., 2000, Environmental management. Excel Books India.
[2] Krishna, I. M., Manickam, V., Shah, A., & Davergave, N., 2017, Environmental management: science and engineering for industry. Butterworth-Heinemann.
[3] Wehrmeyer, W. (Ed.). 2017, Greening people: Human resources and environmental management. Routledge.
[4] Websites given during lectures and seminars

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr hab. inż. Justyna Woźniak
Dr hab. Inz. Katarzyna Pactwa,
Dr inż. Danuta Szyszka

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish Bezpieczeństwo i higiena pracy
Name of subject in English: Occupational Health and Safety
Main field of study (if applicable): Górnictwo i geologia.
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Mineral Resource Exploration
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W06GIG-SM3005
Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			25	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	**1**			1	
including number of ECTS points for practical classes (P)				1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,7			0,8	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Possesses basic knowledge of technologies used in open-pit mines and underground mines.
2. Is able to use Microsoft Office environment to prepare documents in Word, multimedia presentations in Power Point and work with Excel spreadsheets.
3. Is able to identify harmful, dangerous and nuisance factors in the workplace environment.

SUBJECT OBJECTIVES

O1**: Develop comprehensive knowledge of mining safety and regulations**: By the end of the course, students should be able to demonstrate a thorough understanding of local and international safety regulations governing the mining industry.

O2: **Apply risk assessment and mitigation strategies in mining environments:** Upon

completion of the course, students should be capable of conducting risk assessments, identifying hazards, and implementing effective mitigation strategies in diverse mining settings

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 Possesses general knowledge of rules of occupational risk assessment formulationPEU_W02 – Possesses knowledge of evaluating and determining the admissibility of occupational risk. PEU _W0 3 – Possesses general knowledge of corrective and preventive actions regardinghazards of typical work posts in the mining industry.… relating to skills: PEU_U01 Is able to identify hazards of harmful, dangerous and nuisance factors of typicalwork posts in the mining industry PEU_U02 Is able to estimate and determine risk acceptability with methods according toSTER software and the RISC SCORE method. PEU_U03 - Is able to plan corrective and preventive actions for hazards of typical work postsin the mining industry.… relating to social competences: PEU_K01 - Is able to work in a team and together complete occupational risk assessment anddevelop its results and the required documentation in the form of a team report

PROGRAMME CONTECT		
N	LECTURE	Number of hours
1	**Introduction to Mining Safety and Health Regulations**. The mining industry as one of the most hazardous occupations. Worldwide statistics. The evolution of safety standards in response to past failures or incidents. Overview of key regulations governing occupational safety and health in the mining industry. The importance of compliance with international safety standards. Definition of occupational hazards and risks. The key points of safety management system (SMS) in the mining industry.	3
2	**Hazard Identification in Mining Operations.** Exploration of hazard identification processes specific to mining environments. Analysis of common hazards in mining operations, including physical, chemical, and ergonomic hazards. Strategies for implementing control measures to mitigate identified hazards. Real-world examples of hazard control success stories in the mining industry.	3
3	**Occupational Risk Assessment in Mining.** Overview of the methods of identification, evaluation and management risks: Hazard Identification and Risk Assessment (HIRA), Job Safety Analysis (JSA) or Job Hazard Analysis (JHA), Fault Tree Analysis (FTA), Event Tree Analysis (ETA). Occupational exposure limits and their importance.	3
4	**Health risk assessment in the mining industry**. Health risks associated with mining activities. Methods for assessing occupational health risks, including exposure monitoring and health surveillance. The long-term health implications of exposure to various substances in mining. Strategies for preventing and mitigating occupational health risks in mining.	3
5	**Prevention and Control of Occupational Diseases in Mining.** Overview of common occupational diseases prevalent in the mining	3

	industry. Discussion on the identification of exposure pathways and risk factors leading to occupational diseases. Strategies for prevention and control, including the use of personal protective equipment, ventilation systems, and monitoring techniques.	
Total hours		**15**

PROJECT		
1	Developing a plan of safety management system (SMS) for roof bolting operation in underground mining.	3
2	Hazard identification for the haul truck operation in a surface mining operation.	3
3	Occupational risk assessment (by HIRA method) for the machine processing stonemason.	3
4	Occupational risk assessment (by JHA method) for manual processing stonemason.	3
5	Health risk assessment for the workplace of drilling operator.	3
Total hours		**15**

TEACHING TOOLS USED

1	Informative lectures
2	Multimedia presentations
3	Didactic discussions forums
4	Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomesachievement
F1	PEU_W01-W03	grade from a test
F2	PEU_W01-W03 PEU_U01- U03	grade from a presentation
P2	PEU_W01-W03 PEU_U01- U03	final grade from project classes (arithmeticaverage of F1 and F2)

PRIMARY AND SECONDARY LITERATURE

1	*ILO Guidelines on occupational safety and health management systems, ILO–OSH 2001.*
2	*ILO code of practice: Safety and health in opencast mines*. International Labour Office, Geneva, 2018
3.	Mansdorf S.Z. (Ed.).(2019) Handbook of Occupational Safety and Health. 3rd edn. Wiley.
4.	Koradecka, D. (Ed.). (2010). Handbook of Occupational Safety and Health (1st ed.). CRC Press. https://doi.org/10.1201/EBK1439806845

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Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD
Name in Polish: Modele Decyzyjne w Zarządzaniu
Name in English: Operations Research
Main field of study: Mining and Geology
Specialization: Mining Engineering,
Mineral Resource Exploration
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3000
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**15**		**15**		
Number of hours of total student workload (CNPS)	**25**		**50**		
Form of crediting	**crediting with grade**		**Crediting with grade**		
For group of courses mark (X) final course					
Number of ECTS points	1		**2**		
including number of ECTS points for practical (P) classes of practical character (P)			**2**		
including number of ECTS points for direct teacher-student contact (BU) classes	**0,8**		**0,7**		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCIES

1. The student has basic knowledge of mining systems, technological and organizational systems in mining
2. The student has basic knowledge concerning economics in mining
3. The student has basic knowledge concerning mathematical analysis necessary to understand mathematical issues in science having engineering and economic character.
4. The student has basic knowledge and skills of using probability theory models and mathematical statistics
5. The student can use an Excel spreadsheet
6. The student understands the need and knows the possibilities of lifelong learning, improving professional, personal and social skills

SUBJECT OBJECTIVES

C1 Acquiring basic knowledge, taking into consideration its applicational aspects concerning mathematical decision models used in management:
    C1.1 Linear programming models

C1.2 Models of planning, deposits and costs of projects
C1.3 Queuing system models
C1.4 Digital simulation models

C2. Learning of qualitative understanding, interpretation and quantitative analysis with applications of selected issues concerning optimisation

C2.1. Production systems:
C2.2. Transport issues
C2.3. Flows in networks.
C2.4. Project schedules
C2.5. Queuing system models

C3. Acquiring and consolidating the competencies of thinking and acting in a systematic way.

SUBJECT LEARNING OUTCOMES

Subject educational effect (knowledge)

PEU_W01 The student has knowledge concerning basic decision models in management
PEU_W02 The student has knowledge concerning line programming models.
PEU_W03 The student has knowledge concerning models for planning and monitoring of activities, deposits, and costs of projects
PEU_W04 The student has knowledge concerning queuing system models
PEU_W05 The student has knowledge concerning simulation models.

Subject educational effect (skills)

PEU_U01 The student has the ability to apply and interpret models using linear programming applications
PEU_U02 The student has the ability to apply and interpret models of planning and monitoring of activities, deposits, and costs of projects with the use of programming applications
PEU_U03 The student has the ability to apply and interpret queuing system models using programming applications
PEU_U04 The student has the ability to apply and interpret simulation models using programming applications

Subject educational effect (social)

PEU_K01 The student can think and act in a system, creative and enterprising way
PEU_K02 The student is able to identify and solve problems with the use of decision models and applications.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Le1	Rules of participation in the course.	1
Le2	Introduction to modelling systems and optimization methods in decisions problems.	2
Le3	Linear Programming – fundamental principles. The application of LP in transportation issues and resource utilization.	2
Le4	Network programming (CPM and PERT). Planning and resource balancing in a project.	2
Le5	Simulation of random processes. Monte Carlo method.	2
Le6	Queueing theory and models of queueing systems.	2
Le7	Phases of simulation project and model building.	2
Le8	Digital twins – case analysis.	1
Le9	Final test.	1
	Total hours	**15**

Form of classes - laboratory		Number of hours
La1	Terms of participation in laboratory classes.	1
La2	Defining linear programming problems.	2
La3	Solving LP production optimization.	2
La4	Projects scheduling.	2
La5	Monte Carlo method. Models of queueing system.	2
La6	Simulation building: spatial layout and objects in the system.	2
La7	Processes defining in the model.	2
La8	Simulation experiments and results analysis.	2
	Total hours	**15**

TEACHING TOOLS USED
N1. Interactive lecture with slides and discussion N2. Laboratory exercises with the use of IT applications - discussion concerning solutions N3. Laboratory exercises - short written tests (calculating tasks, tests of knowledge) N4. Office hours N5. Own work - preparation for laboratory classes, solving additional tasks N6. Own work - own literature studies.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at the end of semester)	Educational effect number	Way of evaluating educational effect achievement
F1	PEU_U01-02	written test
F2	PEU_U03-04	report
P=(F1+F2)/2 (laboratory)	PEU_U01-04	
P (lecture)	PEU_W01-05 PEU_K01-02	written test

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE

[1] Operations Research. Applications and Algorithms. 4th Edition. Winston W. Cengage Learning. 2022.
[2] Operations Research. Theory and Applications, 6th Edition, Sharma J. K. Trinity Press.
[3] Operations Research. Examples and Exercises. Kukuła i in. PWN. Warszawa. 2011.
[4] Simulation Modeling Handbook. A Practical Approach. Chung Ch. A. CRC Press. 2004.

SECONDARY LITERATURE

[1] Operations Research. An Introduction. 10th Edition. Taha H. A. Pearson Education Limited. 2017
[2] Operations Research, Yadav S.R. Malik A. Oxford University Press. 2014.
[3] A Review of Operations Research in Mine Planning. Newman et al. Interfaces 40(3). pp. 222-245. INFORMS. 2010.
[4] Modelling and Simulation Fundamentals. Theoretical Underpinnings and Practical Domains. Sokolowski J. A. Banks C. M. John Wiley & Sons. 2010.
[5] Discrete-Event System Simulation. Banks et al. Prentice-Hall. 2014.

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Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish: Zarządzanie projektami, ocena ich opłacalności i ryzyka..
Name of subject in English: Project Management, Appraisal and Risk Evaluation.
Main field of study: Mining and Geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Mineral Resource Exploration
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3003G
Group of courses: Yes

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30	15	
Number of hours of total student workload (CNPS)	25		50	25	
Form of crediting	Examination				
For group of courses mark (X) final course	X				
Number of ECTS points	4				
including number of ECTS points for practical classes (P)	3				
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	3,1				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of basic mathematical analysis, probability and statistical models
2. Skills in using Excel spreadsheets
3. Understanding of the need of lifelong learning and the importance of application of Economics, Management and Social Sciences in engineering.

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SUBJECT OBJECTIVES

The course combines two groups of topics: basics of mineral economics and financial management and introduction to project management.
Part A: The purpose of the course is
C1 to introduce basic concepts of Microeconomics and financial management
C2 to introduce the concept of time value of money and present the methods used to evaluate investment projects. Different techniques are illustrated by examples and case studies. The range of application as well as the advantages and disadvantages of each method are

discussed. The issues of inflation and risk analysis are included.
Part B:
C3 Introduction to project management basic concepts, methods and tools.
C4 Presentation of given project management areas: Project scope management, Project time management, Project cost management, Project risk management. Project planning, scheduling and control using Microsoft Project.
C5 Presentation of the issues of effective communication in project teams, group behaviour and leadership.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows the concepts of demand, supply and price elasticities, understands how they affect markets

PEU_W02 knows the concepts of costs in economics and accounting, understands how they differ

PEU_W03 knows the main cost categories and cost accounting methods

PEU_W04 has basic knowledge about the contents of financial statements

PEU_W05 has basic knowledge about the method of ratio analysis of financial statements

PEU_W06 knows and understands the concepts of Present Value and Future Value for simple cash flows and annuities.

PEU_W07 knows the capital budgeting methods (NPV, IRR, PBP) and understand how to interpret the results

PEU_W08 has basic knowledge about the project risk evaluation methods

relating to skills:

PEU_U01 is able to analyze the causes and effects of demand and supply changes

PEU_U02 is able to interpret and use information presented in financial statements also by means of ratio analysis

PEU_U03 is able to use different cost analysis methods and make decisions based on the rsults

PEU_U03 can calculate Future and Present value, also for annuities and solve simple calculation problems

PEU_U04 is able to perform discounted cash flow analysis and draw conclusions based on the results

PEU_U05 is able to carry out sensitivity analysis and scenario analysis using a financial model of an investment

PEU_U06 is able to work out basic project documentation and initiate a project

PEU_U07 is able to use basic methods of project management, monitoring and project risk management

PEU_U08 is able to implement basic conflict management methods in a project group

PEU_U09 is able to use basic group management methods, can undertake and shape the leadership position

relating to social competences:

PEU_K01 is able to think and act in a systematic, creative and entrepreneurial way

PEU_K02 has an established attitude of economic operation and decision-making based on available financial information and forecasts

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec.1	Supply and demand, equilibrium price, changes in demand and supply. Stock and commodity markets used by mineral industries	2
Lec.2	Costs in economics and in accounting. Cost and money outflow. Relevant cost, incremental cost, marginal cost, alternative cost. Short-term decision making.	2
Lec.3	Costs as the subject of cost accounting, different systems of cost accounting Different methods of cost data presentation (by types, divided into direct and indirect costs). Cost allocation	2
Lec.4	Variable and fixed costs. Break-even point. Cost-volume –profit analysis.	1
Lec.5	Basics of financial accounting. Income statement and cash flow statement. Balance sheet. Working capital. Examples of financial statements of mining companies	2
Lec.6	Financial ratio analysis. Liquidity, profitability, activity and debt ratios. Financial and operating leverage.	2
Lec.7	The concept of time value of money. Computation of future and present value of money by means of spreadsheet functions. Basics of capital budgeting. Evaluation of different methods.	2
Lec.8	The concept of risk and return. Quantification of risk. Risk analysis in project evaluation: sensitivity analysis, scenario analysis, other methods.	2
	Total hours	15

Project		**Number of hours**
Pr 1	Issues of understanding communication: Definitions Models (Schramm model, Berlo's SMCR (source, message, channel, receiver) model, McCroskey model, Reusch and Bateson model, Westley-MacLean model)	3
Pr 2	Conflict Sources of conflicts Kilmann and Thomas classification of conflict Kilmann and Thomas test Different styles of conflict solving Roles of conflict in group development.	3
Pr3	Team roles Team roles Belbin perspective Discussion group roles Effective managerial behaviour in the context of team roles	3
Pr4	Leadership Hersey and Blanchard theory Black and Mouton approach to leadership Fiedler theory and his Least Preferred Coworker Scale Situational leadership self-assessment	3
Pr5	Summary;	3

	Effective managerial behaviour from the different contexts.	
	Total hours	15

Laboratory		**Number of hours**
Part A		
La1	Supply and Demand curves. Elasticity of demand.	2
La2	Economic costs. Cost curves. Profit maximization cases.	2
La3	Managerial cost accounting. Decision making cases.	2
La4	Basic financial accounting. Creation of simple Balance Sheet, Profit and Loss Statement and Cash Flow Statement	2
La5	Ratio analysis based on financial statements of companies	2
La6	Time value of money and capital budgeting – calculation by means of Excel functions	2
La7	Financial model of an investment. Sensitivity and Scenario analysis.	3
Part B		
La8	Basic concepts (process, project, project management, management by projects, critical factors for project success, competencies). Preparing and initiation of the project. Project analysis (project environment, stakeholders, project objectives).	3
La9	Planning and estimating of the project. Project phases and life cycle	3
La10	Project organization. Project scope management. Planning of activities, resources and costs.	3
La11	Project risk management. Project monitoring. Project management methodologies.	3
La12	Quality management. Change control. Project closing.	3
	Suma godzin	**30**

TEACHING TOOLS USED
N1. Interactive lecture with the use of multimedia and discussion
N2. Laboratory classes: individual problem solving with the use of Excel spreadsheet
N3. Laboratory classes part B and project classes: case studies solving in groups and individually. Project presentations, discussion
N4. Consultation
N5. Self-study: solving assigned problems, literature studies

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01-W08 PEU_K01-K02	Assesment of student class activity
F2	PEU_U01-U10 PEU_K01-K02	Evaluation of student's assignements
P1	PEU_W01-W08 PEU_U01-U10 PEU_K01-K02	Written test

PRIMARY AND SECONDARY LITERATURE
<u>PRIMARY LITERATURE:</u> 1. Erhardt M., Brigham E.: Financial Management Theory and Practice. South-Western Cengage Learning, USA 2. Brigham E., Glapenski L.: Financial Management, 1997 3. Johnson H.: Making Capital Budgeting Decisions – Maximising the Value of the Firm. Financial Times/Prentice Hall (April 15, 1999) 4. Jonson H.: Strategic Capital Budgeting: Developing and Implementing the Corporate Capital Allocation Program, January 1994. 5. Lock Dennis, Project Management, Published April 11, 2013 by Routledge **<u>SECONDARY LITERATURE:</u>** 1. Jonson H.: Determining Cost of Capital: The Key to Firm Value. Apr 1999. 2. A Guide to Project Management Body of Knowledge (PMBOK®Guide Fourth Edition), Project Management Institute, 2008 (2004). wydanie polskie, MT&DC Warszawa, 2009 (2006) 3. Johnson H.: Global Financial Institutions and Markets. December 1999
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Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Zasady i zastosowania InSAR oraz GIS w górnictwie
Name in English: Principles and Application of InSAR and GIS in Mining
Main field of study: Mining and Geology
Specialization: Geomatics for Mineral Resources Management,
Mineral Resource Exploration,
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3007
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	Examination		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		
including number of ECTS points for practical (P) classes			3		
Including number of ECTS points for direct teacher-student contact (BU) classes	1,4		2,0		

*niepotrzebne skreślić

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of C ++ and Python programming language.
2. Basic knowledge of GIS functions and spatial data acquisition techniques
3. Ability to use GIS software package
4. Basic knowledge of databases

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SUBJECT OBJECTIVES

C1 Presentation of knowledge of satellite radar interferometry, as well as the possibility of using it in the ground deformation measurements.
C2 Acquiring the ability to determine surface displacements based on satellite radar data.
C3 Presentation of information on the use of GIS in advanced analysis of objects, phenomena and processes occurring in space.

C4	Acquiring the ability to formulate and solve tasks using GIS analytical functions.
C5	Acquiring skills to use spatial data and services in accordance with the INSPIRE Directive

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 Has expanded knowledge in the field of using geoinformation systems to collect and process data used in modeling of both natural and anthropogenic phenomena and processes

PEK_W02 Knows the principles of construction and functioning of geoinformation systems in the mining industry and public administration

relating to skills:

PEK_U01 has the ability to use advanced GIS tools in mining, studies of natural phenomena, the impact of mining on the environment and space development,

PEK_U02 has the ability to formulate and solve spatial tasks in the GIS environment

PEK_U03 has the ability to interpret the results obtained and draw conclusions

relating to social competences:

PEU_K01 has the ability to formulate and transfer knowledge on the use of geoinformation systems in spatial analysis and presentation of their results

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Discussion of syllabus, requirements for passing the course, literature	2
Lec 2	Introduction to Microwave Signals for Earth Observation	2
Lec 3	Principles and Applications of Passive and Active Microwave Remote Sensing	2
Lec 4	Acquisition and processing of SAR data	2
Lec 5	SAR image theory (geometric properties, polarization)	2
Lec 6	Basics of SAR data calculation using the DInSAR and SBAS methods	2
Lec 7	Principles and applications of Interferometric SAR (monitoring surface activity, natural and anthropogenic phenomena)	2
Lec 8	Fundamental concepts of geographical information systems	2
Lec 9	Data modelling in GIS. Representation of spatial data. Spatial databases. Current status and development trends	2
Lec 10	Methods of spatial analysis in GIS	2
Lec 11	Spatial data interpolation	2
Lec 12	Map algebra. Surface analysis, local and zonal functions	2
Lec 13	Basics of spatial statistics	2
Lec 14	Spatial Information Infrastructure. Inspire Directive. Open Data	2
Lec 15	Examples of applications of geoinformation systems in mining and environmental protection	2
	Total hours	**30**

Laboratory		Number of hours
La1	Configuration of the environment for SAR calculations	3
La2-3	Introduction to radar data calculations - calculation tasks	6
La4	Acquiring radar data and calculating the interferogram - DInSAR method	3
La5	Unwrapping of the interferometric phase - calculations	3
La6-7	Presentation of results in the GMT environment	6
La8	Discrete data interpolation. Preparation of input data for analysis (e.g. deformation measurements in the mining area)	3
La9	Discrete data interpolation. Development mining area terrain deformation maps with various interpolation methods.	3
La10	Discrete data interpolation. Analysis and assessment of the quality and uncertainty of interpolation. Prediction map. Development of maps of changes between two periods using a raster calculator.	3
La11	Spatial analysis - assessment of the suitability of the area for the location	3
La12	of mining operation. Construction of a database of spatial location criteria	3
La13	Spatial analysis - assessment of the suitability of the area for the location	3
La14	of mining operation. Selection of analytical procedures and conducting analytical operations.	3
La15	Spatial analysis - assessment of the suitability of the area for the location	3
	Total hours	**45**

TEACHING TOOLS USED
N1. Lectures N2. Multimedia presentations N3. Preparation of individual written term paper on a given topic N4. Multimedia materials (MOOC) N5. Laboratory instructions N6. Reports from laboratory exercises N7. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F1 Final mark for the written examination F2 Mark for the written report, P Final mark for the lecture (weighted average of F1 and F2, where F1 – 80% and F2 - 20%)
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F3 Mark for the written assignment reports F4 Mark from written tests, P2 Final mark for the laboratory (weighted average of F3 and F4, where F3 – 80% and F4 - 20%)

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. 2015: Geographic Information Science and Systems, 4th Edition, John Wiley & Sons;
[2] Maguire D., Batty M., Goodchild M., 2005. GIS Spatial Analysis and Modelling. ESRI Press
[3] Berry J., 2007-2013. Beyond Mapping IV — GIS Modelling
[4] Satellite InSAR Data: Reservoir Monitoring from Space, A. Ferretti, EAGE; 1st edition, 2014
[5] GMTSAR: An InSAR Processing System Based on Generic Mapping Tools (Second Edition), D. Sandwell i in., Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, 2016
[6] InSAR Principles - Guidelines for SAR Interferometry Processing and Interpretation, ESA Publications, 2008

SECONDARY LITERATURE:

[1] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)
[2] Kennedy M., 2009: Introducing Geographic Information Systems with ArcGIS: A Workbook Approach to Learning GIS, Second Edition, John Wiley and Sons;
[3] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. W., 2006. GIS. Teoria i praktyka. Wydawnictwo Naukowe PWN, Warszawa
[4] Urbański J., 2010. GIS w badaniach przyrodniczych, Wydawnictwo Uniwersytetu Gdańskiego
[5] Dokumentacja środowiska GMT (Generic Mapping Tools) - http://gmt.soest.hawaii.edu/projects/gmt/wiki/Documentation

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Wojciech Milczarek, wojciech.milczarek@pwr.edu.pl
Jan Blachowski, jan.blachowski@pwr.edu.pl

Semester 4
WUST

Wroclaw University of Science and Technology WUST

Course title	Field Academy Student Project W06GIG-SM3064P		
European Credits (ECTS)	2	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar	Project-Practical classes, fieldwork: 3h/week (2 ECTS)	**Student whole working time (hours)**	50
Description of content	The goal of the course is that students should acquire a hands-on understanding of different field research methodologies, and how they can be integrated with innovation and technology in mining. Innovative techniques such as UAV (drones), UGV (robots), VR, GIS-based data analyses, lidar imaging, hyperspectral method as well as InSAR methods and digitalization trends will be explored by students. The students will investigate companies (raw materials, geological, geodesy, mining, processing plants, municipal objects, IT companies) in view of innovative management and techniques implementation.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and understands trends of product-service systems and digital transformation affecting manufacturing business, - and defines, and explains the concepts related to product data management and product life cycle management, - and recognizes the company's product and service processes and understands their interaction with the company's overall operations, - and understands the primary sector of the raw materials value chain (geology, mining, mineral processing, and the environment), - innovative techniques, digitalization trends, and the concept of innovation and technology integration in the raw material sector. Skills Upon completion of the course, a student is able to - compare systems' characteristics, technical features, and managerial functions, - see their role in product development and business management, - create new business models, and foster a digital culture, - implement innovative techniques in the raw materials chain.		
Assessment methods and criteria	The course is mainly connected with practice work in the field, but also with complementary short lectures and exercises. The investigation results will be assessed together with the report and project.		
Recommended readings	The complementary/introductory material will be provided on Moodle. The students will be responsible for the content of the material.		
TU Coordinator	Anna Gogolewska, anna.gogolewska@pwr.edu.pl		

Wroclaw University of Science and Technology WUST

Course title	Industrial Research Internship Project W06GIG-SM3062P		
European Credits (ECTS)	2	**Time (hours) given to the students**	30
Type (lecture, classes, laboratory, project, seminar, internship)	Project classes: 2h/week (2 ECTS), (Practice)	**Student whole working time (hours)**	50
Description of content	The aim of the course is to enable students to work in responsible workplaces and apply their skills and knowledge to promote entrepreneurship, innovation, and technology integration in the raw material sector. The students are to become work-ready professionals, who can implement innovative technologies and efficient managerial issues. They will learn how to actively participate in the affairs of the community and promote public interest, equality, and solidarity. The students will face environmental and technological problems such as the degradation of land, air, and water quality as a result of industrial activities. Therefore the students will be familiarized with the necessity of transparency and accountability standards in the raw materials sector and the strategy to meet them. Moreover, they will be exposed to the lack of effective information flow between the companies and society. In industrial or R&D companies the students will develop and implement innovative solutions to technological or managerial problems observed.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and understands trends of product-service systems and digital transformation affecting manufacturing business, - and defines, and explains the concepts related to product data management and product life cycle management, - and recognizes the company's product and service processes and understands their interaction with the company's overall operations, - and understands the primary sector of the raw materials value chain (geology, mining, mineral processing, and the environment), - innovative techniques, digitalization trends, and the concept of innovation and technology integration in the raw material sector. Skills Upon completion of the course, a student is able to - compare systems' characteristics, technical features, and managerial functions, - see their role in product development and business management, - create new business models, and foster a digital culture, - engage in an informal professional discussion and business communication, - implement innovative techniques in the raw materials chain.		
Assessment methods and criteria	Submission and defense of a project report		
Recommended readings			
TU Coordinator	Supervisors of the student’s Master thesis		

Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish: Zintegrowana analiza deformacji w geomechanice
Name of subject in English: Integrated Analysis of Deformations in Geomechanical Engineering
Main field of study: Mining and Geology
Specialization: Mining Engineering
Geomatics for Mineral Resources Management
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3063G
Group of courses: Yes

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	75		50		
Form of crediting (Examination/crediting with grade)	Examination				
For group of courses mark (X) final course	X				
Number of ECTS points	5				
including number of ECTS points for practical classes (P)	2				
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2,9				

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCIES

1. Introduction to Rock Mechanics
2. Basic knowledge about mining technologies
3. Fundamentals of monitoring of rock mass deformations

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SUBJECT OBJECTIVES

C1 Fundamental understanding of integrated analysis of deformations using the combination of monitoring and numerical modelling of deformations, which is essential for studying the processes occurring in engineering structures and in rock mass at the construction and post-construction stages.
C2 To understand the fully automated monitoring principles, data collection, and processing.
C3 Fundamental understanding of analysis of deformations, which is essential for studying the processes occurring in engineering structures and in rock mass at the construction and post-construction stages.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Is able to distinguish and describe the applications of deformation monitoring techniques in the spectrum of engineering disciplines such as mining and construction engineering

PEU_W02 Is able to characterize the rock mass and mining methods

PEU_W03 Has knowledge of empirical and deterministic analyzes of rock mass deformations using FEM

PEU_W04 Has knowledge of the basics and applications of the analysis of the integrated deterministic method with the results of geodetic measurements

relating to skills:

PEU_U01 Is able to determine the main assumptions for geodetic measurement of deformations caused by mining exploitation

PEU_U02 Is able to create a FEM model

PEU_U03 Is able to perform integrated analysis using deterministic modelling by means of the FEM method and using the results of geodetic and geotechnical measurements

…

relating to social competencies:

PEU_K01 Is able to assess the role of monitoring and prediction in sustainable mining throughout its entire cycle

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Introduction: course syllabus, methods of evaluation of the learning outcomes, literature	2
Lec 2	Introduction to integrated analysis of deformations. Rock mass and earth mass material characteristics; determination of in-situ rock mass parameters;	2
Lec 3	The role of monitoring in sustainable mining.	2
Lec 4	Description of physical phenomena: statics - dynamics, heat propagation, fluid flow, changes in gravitational force, applications	2
Lec 5	Geodetic and geotechnical monitoring of deformations; deterministic modelling	2
Lec 6	Deformation Monitoring Surveys, design and implementation of geodetic deformation monitoring system. Short review of monitoring requirements and available monitoring techniques.	2
Lec 7	Advantages and disadvantages of geodetic and geotechnical methods. The concept of integrated analysis.	2
Lec 8	Solid mechanics, boundary conditions problem	2
Lec 9	Principles of integrated analysis of deformations; analysis based on system theory; analysis based on continuum mechanics; approximate methods for solving continuum problems; Finite Element Method (FEM);	2
Lec. 10	Solving truss systems in FEM	2
Lec. 11	Large scale problems in rock mechanics. Empirical and deterministic methods of surface deformations modelling in underground and open pit mining. Utilization of the Finite Element Method	2
Lec 12	Examples of utilization of integrated analysis for slope stability problems in open pit mines in Chile and USA	2
Lec 13	Examples of integrated analysis used to control surface deformations caused by underground salt mining in Canada	2

Lec. 14	Problems of oil and gas mining (Venezuela, Canada)	2
Lec 15	Wrap up: conclusions, final remarks	2
	Total hours	30

Classes		Number of hours
Cl 1		
Cl 2		
	Total hours	

Laboratory		Number of hours
Lab 1	Presentation of the course scope, literature and assessment methods	2
Lab 2	Analysis of the impact of load on the rock mass – application of the GeoStudio software	2
Lab 3	In-situ stress analysis of rock mass and loaded rock mass	2
Lab 4	Designing a geodetic measurement in a mining area for underground mining based on FEM results. Discussion of the measurement project.	2
Lab 5	Determination of the mining area category. Discussion of the project results	2
Lab 6	Designing a geodetic measurement in an open-pit mine based on the FEM model. Discussion of the measurement project.	2
Lab 7	Designing a geodetic measurement of an earth dam based on an FEM model. Analysis, discussion	2
Lab 8-11	Task 1: Determining the FEM of rock mass deformations caused by underground mining, determining the terrain category. Elastic and nonlinear analysis. Monitoring overview. Summary	8
Lab 12-15	Task 2: Determination of the FEM of the deformation of the earth mound/dam in conditions of variable water level. Determination of the safety factor using Geostudio software. Monitoring overview. Summary	8
	Total hours	30

Project		Number of hours
Proj 1		
	Total hours	

Seminar		Number of hours
Semin 1		
Semin 2		
	Total hours	

TEACHING TOOLS USED
N1. Lecture, film N2. Individual problem solving with the use of software, teacher’s support N3. Group discussion

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEK_W01- PEK_W03	Marks for laboratory assignments and tasks
P	PEU_W01 – PEU_W04, PEU_U01 – PEU_U03	Examination - final mark for Lecture Final mark for laboratory classes – average from assignments and tasks

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Szostak-Chrzanowski, A., A. Chrzanowski,(2010), „INTEGETED ANALYSIS OF DEFORMATIONS IN GEOMECHANICS ", UNB, Fredericton, N.B., 220p.

SECONDARY LITERATURE:

[1] Szostak-Chrzanowski, A., A. Chrzanowski, M. Massiera (2005) "Use of deformation monitoring results in solving geomechanical problems – case studies ", Engineering Geology, vol. 79, Issues 1-2, pp. 3-12.

[2] Chrzanowski,A. (1993):"Modern Surveying Techniques for Mining and Civil Engineering" Chapter 33 in: Comprehensive Rock Engineering, Pergamon Press,Vol.3.Chapter 33, pp.773-809.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Prof. dr hab. inż. Anna Chrzanowska anna.chrzanowska@pwr.edu.pl

COURSE DESCRIPTIONS/
KARTY PRZEDMIOTÓW

second-level studies/ studia II stopnia
main field of study/ kierunek studiów:
Mining and Geology/ Górnictwo i Geologia

specjalność/specialisation:
Entrepreneurship, Innovation and Technology Integration in Mining

Track WUST – LUT

Semester 1
WUST

Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish: Geofizyka inżynierska
Name of subject in English: Engineering Geophysics
Main field of study: Mining and Geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management,
Mineral Resource Exploration,
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3004
Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			50	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	1			2	
including number of ECTS points for practical classes (P)				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,8			0,9	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. has knowledge of fundamentals of applied geophysics, physics and geology.
2. knows fundamentals of soil and rock mechanics.
3. is able to use MS Office software.
4. is able to work in a team.

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SUBJECT OBJECTIVES

C1 familiarize with physical phenomena in geosphere of the Earth
C2 familiarize with engineering problems solved by means of geophysical surveying
C3 familiarize with various geophysical surveys.
C4 acquisition of skills to plan geophysical field surveying and to interpret its results.
C5 development of skills to work in a group.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 recognizes, names and explains engineering problems in different fields.

PEU_W02 identifies, describes and chooses geophysical surveying methods.
PEU_W03 analyses and assesses case studies from solving the engineering problems.
relating to skills:
PEU_U01 is able to coordinate team work, create field research plans and manage the work progress.
PEU_U02 is able to independently create solutions for complex practical problems in engineering and geoengineering applying knowledge about geophysical surveying, mining geophysics, utilizing modern methods in geophysical data acquisition and interpretation.
PEU_U03 is able to critically assess, process and interpreted results of the geophysical surveying and provide recommendations related to engineering problems in mining, civil engineering, engineering geology, municipal waste site, archeology, engineering properties of soil and rocks, hydrogeology, monitoring seepage in river dykes or dams.
PEU_U04 is able to solve geophysical problems.
PEU_U05 is able to conduct auto-didactical education related to detailed handling of typical software.
relating to social competences:
PEU_K01 understands the need to create and transfer to the society – among others by mass media- information and opinions related to mining engineering achievements and other activities of mining engineer; tries to transfer the information in commonly understood way, presenting different points of view; is aware of the quality and need to shape the work safety culture in mining and the responsibility for the health and life of other employees.

PROGRAMME CONTENT

	Lecture	Number of hours
Lec 1	Physical properties of rocks. Inter-relationships between the various subdisciplines of applied geophysics. Overview of geophysical methods, their physical principles and applications. Methodology of geophysical surveying.	1
Lec 2	Engineering problems solved with geophysical surveying. Case studies.	2
Lec 3	Electrical resistivity methods. Tomography and VSE. IP method. Physical principles. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
Lec 4	Electromagnetic methods. FDEM and TDEM methods. Magnetotelluric methods. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Lec 5	GPR surveying. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Lec 6	Seismic tomography. Seismic interferometry. Physical principles. Applications. Case studies.	2
Lec 7	Mine geophysics. Seismology. Seismic methods. Active and passive seismic tomography. Microgravimetry. Case studies.	2
Lec 8	Gravity and magnetic surveying. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
	Total hours	15

	Project	Number of hours
Proj 1	One selected geophysical technique. Fundamentals and equipment. Field surveying	4
Proj 2	Processing and interpretation of field data.	3
Proj 3	Solving the geophysical problems.	8
	Total hours	15

TEACHING TOOLS USED

N1. N1.Lecture aided by presentation.
N2.Demonstration.
N3.Discussion and consultations
N3Calculations
N5Practical field surveying

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
P1	W01-W03	Test related to lecture content. Final grade.
F1	U01-U02, U05	Test. Project 1. Report on Project 1
F2	U03, U05	Test. Project 2. Report on Project 2
F3	U04, U05	Test. Solving geophysical problems
F1-F3, P2	U01-U05 K02	Grades are given for each of three project tasks including tests and reports. The final grade P2 for the project course is the weighted average grade of F1-F3.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Aki, K., Richards P.G., 1980. Quantitative Seismology: Theory and Methods. W.H. Freeman Co.. San Francisco.
[2] Burger, H.R., Sheehan, A.F., Jones, C.H., 2006. Introduction to Applied Geophysics: Exploring the Shallow Subsurface. W.W. Norton & Company, Inc.
[3] Mendecki, A.J. (ed.), 1997. Seismic Monitoring in Mines. Chapman & Hall.
[4] Reynolds, J.M., 2011. An Introduction to Applied and Environmental Geophysics. Wiley – Blackwell. John Wiley & Sons.
[5] Sharma, Prem V., 2002. Environmental and engineering geophysics. Cambridge University Press.
[6] Torge, W., 1989. Gravimetry. Water de Gruyter. Berlin. New York.
[7] Selected Journal Publications (for example journals: Progress in Geophysics, Engineering Geophysics Journal, Environmental and Engineering Geophysics, Journal of Geophysics and Engineering, Pure and Applied Geophysics).

SECONDARY LITERATURE:

[1] Lowrie, W., 2007. Fundamentals of Geophysics. Cambridge University Press.
[2] Milsom, J., 2003. Field Geophysics. John Wiley & Sons Ltd.
[3] Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990. Applied Geophysics. Cambridge University Press.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

ANNA BARBARA GOGOLEWSKA, anna.gogolewska@pwr.edu.pl

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD
Name of subject in Polish: Wspomagane komputerowo modelowanie geologiczne i geostatystyka.)
Name of subject in English: Computer-Aided Geological Modelling and Geostatistics
Main field of study: Mining and Geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management,
Mineral Resource Exploration,
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3002
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	crediting with grade	Examination / crediting with grade*	crediting with grade	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,8		1,9		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Mathematical Statistics,
2. Fundamentals of Geology and Mineral Deposits

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SUBJECT OBJECTIVES

C1 Developing basic skills in computer modelling of 3-D objects.
C2 Introduction of the principles of digital modelling of typical geological structures.
C3 Introduction to the methods of deposit parameters estimation and resources evaluation.

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 Estimation methods, principles of geostatistics, kriging estimators PEU_W02 Geostatistical modelling of the selected deposit parameters (domain analysis, variogram modelling, PEU_W03 Creating and validating 3-D models of various geological structures in the comprehensive dedicated software environment. relating to skills: PEU_U01 Application of relevant estimation methods for quality modelling of a deposit PEU_U02 Evaluating 3-D objects against structural and quality block models (volumes, tonnages, grades) PEU_U03 Describing the interpretation and applied approach, creating models, evaluation results, recommendations for possible enhancements relating to social competences: PEK_K01 The student can think and act in a creative and enterprising way

PROGRAMME CONTENT		
	Lecture	**Number of hours**
Lec 1	Introduction to the course. Geological database and validation of the geological data.	2
Lec 2	Geology of the seam.	2
Lec 3	Structural model of the stratified deposit. Methods of the prediction of the surface layer parameters.	2
Lec 4	Spatial distribution of samples values. Regionalized variable.	2
Lec 5	BLUE Estimator of the mean value: Kriging.	2
Lec 6	Quality model of the deposit – block model of the parameter layers. Estimation and evaluation of the block model.	2
Lec 7	Reserves modelling and evaluation.	2
Lec 8	Mineral resources. International reporting. The JORC Code	1
	Total hours	**15**

	Laboratory	**Number of hours**
La1	Determining the rules of work at the laboratory.	3
La2	Assignment of the individual dataset for the exercises and creating initial data files.	3
La3	Data validation and creating initial geological database.	3
La4	Construction of the structural wireframe model of stratigraphy layers.	3
La5	Construction of the block model of the deposit and overburden layers. Thickness and stripping ratio analysis.	3
La6	Data preparation to geostatistical analysis. Compositing of the samples.	3
La7	Domain analysis with the use of the statistical methods.	3
La8	Determination of the empirical variogram. Anisotropy analysis.	3

La9	Variogram modelling.	3
La10	Kriging Neighborhood Analysis - defining optimal parameters of the estimation procedure.	3
La11	Estimation of quality parameters in block model of the deposit layers. Validation of the estimation quality.	3
La12	Validation of the quality model and classification of the resources. Balance resources evaluation.	3
La13	Preparation of data for continuous surface mining ultimate pit design. Ultimate pit outlines generation	3
La14	Wireframe and block modelling of the ultimate pit	3
La15	Reserves evaluation, visualization and interrogation of created models	3
	Total hours	45

TEACHING TOOLS USED
N1. Form of lectures - traditional, multimedia presentations using specialized software and demonstrations of its application "live", individual development of specialist topics covered during the lecture, N2. individual development of project tasks within the laboratories frames, individual development of electronic reports concerning project tasks within the laboratories frames, N3. evaluation of laboratory tasks reports with multipoint grade of student's work, group analysis of the results obtained during laboratory tasks; preparation of conclusions concerning data dependencies and constraints of mining projects, skill control tests, duty hours in laboratory.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01, PEU_W02	Lecture grade on the basis of the written examination
F2	PEU_W03,	Laboratory task assessment: “structural modelling assessment
F3	PEU_U01	Laboratory task assessment: “geostatistical modelling”
F4	PEU_U02, PEU_U03	Laboratory task assessment: “reserves evaluation”.
P average of F1, F2, F3, F4		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] M. Armstrong, Basic Linear Geostatistics, Springer Verlag, 1998. [2] P. Goovaerts: "Geostatistics for Natural Resource Evaluation", Oxford University Press, 1997. [3] R. H. Grishong, Jr., 3-D Structural Geology, Springer Verlag, 2008 [4] K. Hefferan, J. O'Brien, Earth materials, Willey-Blacwell, Chichester U.K., 2010 [5] W. Hustrulid, M. Kuchta, Open pit mine planning and design. Chapter 3. Orebody description, Taylor&Francis, 2013. [6] A. G. Journel, and C.J. Huijbregts, Mining Geostatistics, Academic Press, 1978. [7] Ch.C. Plummer, D.H. Carlson, L. Hammersley, Physical geology, McGraw-Hill I.E. N.Y. 2010 [8] D.R. Prothero, R.H. Dott Jr., Evolution of the Earth, McGraw-Hill I.E. N.Y., 2010 [9] M.W. Rossi, C.V. Deutsch, Mineral Resources Estimation, Springer Verlag 2014. **SECONDARY LITERATURE:** [10] Handouts, tutorials.
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr inż. Krzysztof Hołodnik **Dr inż. Witold Kawalec**

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Cyfrowa kopalnia
Name in English: Digital Mine
Main field of study: Mining and Geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
Mineral Resource Exploration,
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3006
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		15		
Number of hours of total student workload (CNPS)	25		25		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**1**		1		
including number of ECTS points for practical (P) classes			1		
Including number of ECTS points for direct teacher-student contact (BK) classes	0,8		0,8		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Computer literacy skills
2. Basic knowledge related to Mining Engineering and Mineral Processing
3. Programming

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SUBJECT OBJECTIVES

C1. Acquisition of the ability to create utility applications in the C / C ++ and LabVIEW environment
C2. Providing students with knowledge about embedded systems, their construction, selection of components, designing, programming and their exploitation.
C3. Familiarizing with the advances of technology & methods of future mining operations.
C4. Acquisition and consolidation of social competencies including emotional intelligence skills involving the cooperation in the group of students aiming to effectively solve problems. Responsibility, honesty and fairness in the proceedings; observance force in academia and society

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 A student has knowledge related to automation systems, control systems and measurement systems in various aspects of the mining industry. PEU_W02 The student has knowledge of the importance of automation and robotics systems in modern mining. **relating to skills:** PEU_U01 A student is able to select and integrate elements of a specialized measuring and control system including: control unit, executive system, measuring system as well as peripheral and communication modules PEU_U02 A student can design improvements in the existing design solutions for automation and robotics components and systems **relating to social competences:** PEU_K01 A student is aware of the need for a professional approach to technical issues, meticulous reading of documentation and knows environmental conditions in which devices and their components can function PEU_K02 The student has knowledge concerning the benefits of creation and implementation new solutions&technologies into mining industry

PROGRAMME CONTENT		
	Form of classes - lecture	**Number of hours**
Lec 1	Terminology (process, automation, robots, measurement devices, control systems). Definition of digital mine	2
Lec 2	Aims, benefits, drawbacks of automation. Industrial revolutions. Definition of industry 4.0. Overview of components of the 4th industrial revolution. Industry 4.0 and mining	2
Lec 3	Elements of technological process in mining. Automation of cyclic processes Measuring technologies in industry 4.0. Sensors systems. Data transmission and data storage technologies. Analytics in industry 4.0. Industrial BigData, Cloud Computing	2
Lec 4	Industrial Internet of Things. M2M communication, anti-collision systems, location of people underground	2
Lec 5	Virtual and augmented realities for industry. Simulators. Digital Twin. Digital models of processes and objects. Management information creation systems, reporting	2
Lec 6	Case study: Automation in open pit lignite mining (KTZ, Autonomous haulage (use case from Australia))	1
Lec 7	Case study: underground mine (Rock Vader – Sandvik project, other use cases from Sandvik, Epiroc, MineMaster, Zanam, AOT from ZGPS KGHM, KIC project on shaft inspection, …etc)	2
Lec 8	Case study: mineral processing (ConVis, FlowVis) in KGHM, OPMO project	2
	Total hours	**15**

Form of classes - laboratory		Number of hours
Lab1	Scope of the course, teaching purpose, crediting conditions, literature, data. Introduction to ARDUINO	3
Lab2	Basic sensors for physical parameters measurements	3
Lab3	Measurements in Labview	3
Lab4	Analysis and Visualization in Labview	3
Lab5	Control in labview	3
	Total hours	**15**

TEACHING TOOLS USED
N1. Type of lectures - traditional, illustrated with multimedia presentations with the usage of audio- visual equipment. N2. Discussion concerning lectures and laboratory. N3 Configuration on laboratory classes measuring systems (hardware and software), performing of measurements, teamwork N4. Projects defence - oral and written form. N5. Duty hours.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at the end of semester)	Educational effect number	Way of evaluating educational effect achievement
F1, P1	PEK_U02- PEK_U04	F1.1 Grade from laboratory work's performance and its merits F.1.2 Grade from laboratory work's oral or written defence P1.Final grade (weighted average of F1.1 - 60% and F1.2 - 40%).
F2, P2	PEK_U02- PEK_U04	F2.1 Grade from activity during the lecture (questions, discussions etc) F.2.2 Grade from written exam P2.Final grade (weighted average of F2.1 - 20% and F2.2 - 80%).

LITERATURE

PRIMARY LITERATURE:

[1] LabVIEWTM Getting Started with LabVIEW http://www.ni.com/pdf/manuals/373427j.pdf
[2] Monk Simon: Arduino dla początkujących. Podstawy i szkice, Anderson R., Cervo D., Helion, 2018
[3] Monk Simon: Arduino dla początkujących. Kolejny krok, Anderson R., Cervo D., Helion, 2015

ONLINE LITERATURE:

[1] LabVIEW Tutorial
[2] ARDUINO Tutorial
[3] Materials prepared by Tutor
[4] Internet websites

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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dr inż. Anna.Nowak-Szpak

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Zarządzanie Środowiskiem
Name in English: Environmental Management
Faculty of studies (if applicable): Mining and Geology
Specialisation (if applicable): Mining Engineering
Mineral Resource Exploration
Entrepreneurship, Innovation and Technology Integration in Mining
Level and form of studies: 2nd level, full-time
Subject Type: Obligatory
Subject code: W06GIG-SM3001
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in the University (ZZU)	**30**				**15**
Number of hours of total student workload (CNPS)	**50**				**25**
Form of crediting	**Crediting with grade**				**Crediting with grade**
For a group of courses mark (X) for the final course					
Number of ECTS points	**2**				**1**
including number of ECTS points for practical (P) classes					**1**
including number of ECTS points for direct teacher-student contact (BU) classes	**1,3**				**0,8**

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of issues related to ecology and environmental protection.

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SUBJECT OBJECTIVES

C1. To get students acquainted with systems of environmental management both in Poland and other EU countries.
C2. To prepare students for rational and sustainable management of environmental components.
C3. To get students acquainted with the genesis of environmental management systems in Poland, review and standardization of environmental management systems.
C4. To get students acquainted with benefits and obligations arising from the implementation

of an environmental management system.
C5. To present the relationship between an environmental management system and a quality management system.
C6. To provide an overview of informative methods of supporting the implementation of environmental management systems (possibilities and practical usage of computerised systems of environmental information management, decision support in the area of environmental protection and choice of methods and tools used to support the implementation of an environmental management system).

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 – Possesses systematic knowledge of the origins of environmental management systems, review and standardization of environmental management systems.
PEU_W02 - Possesses knowledge of the possibilities and practical applications of tools supporting the implementation of the environmental management system.
PEU_W03 - knows basic formal and legal regulations regarding the implementation and functioning of management systems, tools and instruments of environmental management.
PEU_W04 - Possesses knowledge for rational and sustainable management of environmental components.

relating to skills:
PEU_U01 – Possesses linguistic resources appropriate for specialised language and is able to use it in linguistic activities in order to communicate in the professional environment regarding the field of studies; is able to obtain necessary information and interpret and critically evaluate it, reads and understands professional literature, is able to formulate and comprehensively justify opinions, provide presentations of problems related to a studied discipline and also participate in scientific and professional discussions.
PEU_U02 – Is able to use methods and appropriate IT tools in system management of environmental components.

relating to social competencies:
PEU_K01 - Is able to think and act in a creative and enterprising way.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec.1	Basic concepts: - Environment, characteristics of individual elements of the environment - Characteristics of hazards for the natural environment which are a result of human activities - Environmental Management - The Environmental Management System	2
Lec.2	Legal aspects of environmental management	2
Lec.3	History and development of environmental management systems	2
Lec.4	Environmental management systems:	6

Lec.5 Lec.6	- Business Charter for Sustainable Development of the International Chamber of Commerce - ICC Business Charter for Sustainable Development - EMAS – Directive of the European Community Commission regarding the approval for voluntary participation by organisations in a community eco-management and eco-audit scheme - CP - Clean Production - BS 7750 - Specification for Environmental Management Systems - ISO 9000 - ISO 14000 - ISO 14001 Characteristics of selected Environmental Management Systems. The benefits of the implementation of the EMS for a company. Experiences of Polish enterprises from the implementation of EMS. Process of implementation of the selected EMS in a company with an example of EMAS.	
Lec.7 Lec.8	Basic tools of environmental management: - Legal and administrative instruments (laws, standards, licenses and permits) - Economic instruments (fees, taxes, deposit and refund systems, transferable rights, subsidies, liens, fines) - Instruments (techniques) social impact (ecological education, ecological propaganda) Examples of basic tools of environmental management: - Procedure for an assessment of environmental impact - Integrated permits - Audits - Safety Reports - Monitoring of the Environment	4
Lec.9 Lec.10	Design of an environmental management system	4
Lec.11 Lec.12	IT systems supporting environmental management: - Decision Support Systems - Expert systems - Simulation Models - Geographical Information Systems Selected types of information systems which support environmental management, their characteristics, examples of implementation both in Poland and in the world	4
Lec.13	The benefits of an implemented and functioning environmental management system	2
Lec.14	Costs of implementation and functioning of an environmental management system	1
Lec.14 Lec.15	Environmental management systems in practice	3
	Total hours	**30**

Form of classes - seminar	**Number of hours**

Se1	The scope and form of an essay and presentation, terms of crediting and literature. Assignment of seminar topics for individual students.	2
Se2 Se3 Se4 Se5 Se6 Se7 Se8	Student speeches with the use of multimedia presentations on the following issues: environmental management systems - specified examples, formal and legal conditions of administrative procedures (eg. receiving a decision on the environmental conditions of a project, an integrated decision etc.), life-cycle analysis of a selected company; fees, taxes, surcharges and environmental deposits; litter management systems, mineral resource management, renewable energy sources, selected monitoring systems, the institution of environmental protection in Poland and in the world and also alternative energy sources, etc. Group discussion on the content and form of speeches.	13
	Total hours	**15**

TEACHING TOOLS USED
N1. Informative lecture with elements of problematic lectures. N2. Multimedia presentations N3. Didactic discussion during lectures and seminars N4. Preparation of an essay in the form of a report N5. Presentation of the essay N6. Consultations

EVALUATION OF SUBJECT EDUCATIONAL OUTCOME ACHIEVEMENTS

Evaluation F – forming (during semester), P – concluding (at semester end)	Educational outcome number	Method of evaluating educational outcome achievement
F1- Grade from content value of an essay	PEU_U01 PEU_U02 PEU_K01	Text and graphical form of essay
F2 – Grade from presentation and issues included in an essay	PEU_U01 PEU_U02 PEU_K01	Presentation of essay
F3 – Grade from a written or oral test	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Positive grade
final grade from the subject (the weighted average, respectively: 35% for the substantive content of the essay, 25% for the presentation, 40% for the lecture)		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Wilson, G. A., & Bryant, R. L., 2021, Environmental management. Routledge. [2] Mitchell B., 2002, Resource and Environmental Management, Routledge, London [3] Lukasheh A. F., Droste R. L., Warith M. A., 2001, Review of Expert System (ES), Geographic Information System (GIS), Decision Support System (DSS), and their applications in landfill design and management. W: Waste Management & Research nr 19, [4] Gregory, R., Failing, L., Harstone, M., Long, G., McDaniels, T., & Ohlson, D., 2012, Structured decision making: a practical guide to environmental management choices. John Wiley & Sons. [5] Schaltegger, S., Burritt, R., & Petersen, H., 2017, An introduction to corporate environmental management: Striving for sustainability. Routledge. **SECONDARY LITERATURE** [1] Uberoi, N. K., 2000, Environmental management. Excel Books India. [2] Krishna, I. M., Manickam, V., Shah, A., & Davergave, N., 2017, Environmental management: science and engineering for industry. Butterworth-Heinemann. [3] Wehrmeyer, W. (Ed.). 2017, Greening people: Human resources and environmental management. Routledge. [4] Websites given during lectures and seminars
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr hab. inż. Justyna Woźniak **Dr hab. Inz. Katarzyna Pactwa,** **Dr inż. Danuta Szyszka**

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish Bezpieczeństwo i higiena pracy
Name of subject in English: Occupational Health and Safety
Main field of study (if applicable): Górnictwo i geologia.
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Mineral Resource Exploration
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W06GIG-SM3005
Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			25	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	**1**			1	
including number of ECTS points for practical classes (P)				1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,7			0,8	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Possesses basic knowledge of technologies used in open-pit mines and underground mines.
2. Is able to use Microsoft Office environment to prepare documents in Word, multimedia presentations in Power Point and work with Excel spreadsheets.
3. Is able to identify harmful, dangerous and nuisance factors in the workplace environment.

SUBJECT OBJECTIVES

O1**: Develop comprehensive knowledge of mining safety and regulations**: By the end of the course, students should be able to demonstrate a thorough understanding of local and international safety regulations governing the mining industry.

O2: **Apply risk assessment and mitigation strategies in mining environments:** Upon

completion of the course, students should be capable of conducting risk assessments, identifying hazards, and implementing effective mitigation strategies in diverse mining settings

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 Possesses general knowledge of rules of occupational risk assessment formulationPEU_W02 – Possesses knowledge of evaluating and determining the admissibility of occupational risk. PEU _W0 3 – Possesses general knowledge of corrective and preventive actions regardinghazards of typical work posts in the mining industry.… relating to skills: PEU_U01 Is able to identify hazards of harmful, dangerous and nuisance factors of typicalwork posts in the mining industry PEU_U02 Is able to estimate and determine risk acceptability with methods according toSTER software and the RISC SCORE method. PEU_U03 - Is able to plan corrective and preventive actions for hazards of typical work postsin the mining industry.… relating to social competences: PEU_K01 - Is able to work in a team and together complete occupational risk assessment anddevelop its results and the required documentation in the form of a team report

PROGRAMME CONTECT		
N	LECTURE	Number of hours
1	**Introduction to Mining Safety and Health Regulations**. The mining industry as one of the most hazardous occupations. Worldwide statistics. The evolution of safety standards in response to past failures or incidents. Overview of key regulations governing occupational safety and health in the mining industry. The importance of compliance with international safety standards. Definition of occupational hazards and risks. The key points of safety management system (SMS) in the mining industry.	3
2	**Hazard Identification in Mining Operations.** Exploration of hazard identification processes specific to mining environments. Analysis of common hazards in mining operations, including physical, chemical, and ergonomic hazards. Strategies for implementing control measures to mitigate identified hazards. Real-world examples of hazard control success stories in the mining industry.	3
3	**Occupational Risk Assessment in Mining.** Overview of the methods of identification, evaluation and management risks: Hazard Identification and Risk Assessment (HIRA), Job Safety Analysis (JSA) or Job Hazard Analysis (JHA), Fault Tree Analysis (FTA), Event Tree Analysis (ETA). Occupational exposure limits and their importance.	3
4	**Health risk assessment in the mining industry**. Health risks associated with mining activities. Methods for assessing occupational health risks, including exposure monitoring and health surveillance. The long-term health implications of exposure to various substances in mining. Strategies for preventing and mitigating occupational health risks in mining.	3
5	**Prevention and Control of Occupational Diseases in Mining.** Overview of common occupational diseases prevalent in the mining	3

	industry. Discussion on the identification of exposure pathways and risk factors leading to occupational diseases. Strategies for prevention and control, including the use of personal protective equipment, ventilation systems, and monitoring techniques.	
Total hours		**15**

PROJECT		
1	Developing a plan of safety management system (SMS) for roof bolting operation in underground mining.	3
2	Hazard identification for the haul truck operation in a surface mining operation.	3
3	Occupational risk assessment (by HIRA method) for the machine processing stonemason.	3
4	Occupational risk assessment (by JHA method) for manual processing stonemason.	3
5	Health risk assessment for the workplace of drilling operator.	3
Total hours		**15**

TEACHING TOOLS USED

1	Informative lectures
2	Multimedia presentations
3	Didactic discussions forums
4	Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomesachievement
F1	PEU_W01-W03	grade from a test
F2	PEU_W01-W03 PEU_U01- U03	grade from a presentation
P2	PEU_W01-W03 PEU_U01- U03	final grade from project classes (arithmeticaverage of F1 and F2)

PRIMARY AND SECONDARY LITERATURE

1	*ILO Guidelines on occupational safety and health management systems, ILO–OSH 2001.*
2	*ILO code of practice: Safety and health in opencast mines*. International Labour Office, Geneva, 2018
3.	Mansdorf S.Z. (Ed.).(2019) Handbook of Occupational Safety and Health. 3rd edn. Wiley.
4.	Koradecka, D. (Ed.). (2010). Handbook of Occupational Safety and Health (1st ed.). CRC Press. https://doi.org/10.1201/EBK1439806845

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Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Modele Decyzyjne w Zarządzaniu
Name in English: Operations Research
Main field of study: Mining and Geology
Specialization: Mining Engineering,
Mineral Resource Exploration
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3000
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**15**		**15**		
Number of hours of total student workload (CNPS)	**25**		**50**		
Form of crediting	**crediting with grade**		**Crediting with grade**		
For group of courses mark (X) final course					
Number of ECTS points	1		**2**		
including number of ECTS points for practical (P) classes of practical character (P)			**2**		
including number of ECTS points for direct teacher-student contact (BU) classes	**0,8**		**0,7**		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCIES

1. The student has basic knowledge of mining systems, technological and organizational systems in mining
2. The student has basic knowledge concerning economics in mining
3. The student has basic knowledge concerning mathematical analysis necessary to understand mathematical issues in science having engineering and economic character.
4. The student has basic knowledge and skills of using probability theory models and mathematical statistics
5. The student can use an Excel spreadsheet
6. The student understands the need and knows the possibilities of lifelong learning, improving professional, personal and social skills

SUBJECT OBJECTIVES

C1 Acquiring basic knowledge, taking into consideration its applicational aspects concerning mathematical decision models used in management:

C1.1 Linear programming models

C1.2 Models of planning, deposits and costs of projects
C1.3 Queuing system models
C1.4 Digital simulation models

C2. Learning of qualitative understanding, interpretation and quantitative analysis with applications of selected issues concerning optimisation
C2.1. Production systems:
C2.2. Transport issues
C2.3. Flows in networks.
C2.4. Project schedules
C2.5. Queuing system models

C3. Acquiring and consolidating the competencies of thinking and acting in a systematic way.

SUBJECT LEARNING OUTCOMES

Subject educational effect (knowledge)

PEU_W01 The student has knowledge concerning basic decision models in management
PEU_W02 The student has knowledge concerning line programming models.
PEU_W03 The student has knowledge concerning models for planning and monitoring of activities, deposits, and costs of projects
PEU_W04 The student has knowledge concerning queuing system models
PEU_W05 The student has knowledge concerning simulation models.

Subject educational effect (skills)

PEU_U01 The student has the ability to apply and interpret models using linear programming applications
PEU_U02 The student has the ability to apply and interpret models of planning and monitoring of activities, deposits, and costs of projects with the use of programming applications
PEU_U03 The student has the ability to apply and interpret queuing system models using programming applications
PEU_U04 The student has the ability to apply and interpret simulation models using programming applications

Subject educational effect (social)

PEU_K01 The student can think and act in a system, creative and enterprising way
PEU_K02 The student is able to identify and solve problems with the use of decision models and applications.

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Le1	Rules of participation in the course.	1
Le2	Introduction to modelling systems and optimization methods in decisions problems.	2
Le3	Linear Programming – fundamental principles. The application of LP in transportation issues and resource utilization.	2
Le4	Network programming (CPM and PERT). Planning and resource balancing in a project.	2
Le5	Simulation of random processes. Monte Carlo method.	2
Le6	Queueing theory and models of queueing systems.	2
Le7	Phases of simulation project and model building.	2
Le8	Digital twins – case analysis.	1
Le9	Final test.	1
	Total hours	**15**

Form of classes - laboratory		Number of hours
La1	Terms of participation in laboratory classes.	1
La2	Defining linear programming problems.	2
La3	Solving LP production optimization.	2
La4	Projects scheduling.	2
La5	Monte Carlo method. Models of queueing system.	2
La6	Simulation building: spatial layout and objects in the system.	2
La7	Processes defining in the model.	2
La8	Simulation experiments and results analysis.	2
	Total hours	**15**

TEACHING TOOLS USED
N1. Interactive lecture with slides and discussion N2. Laboratory exercises with the use of IT applications - discussion concerning solutions N3. Laboratory exercises - short written tests (calculating tasks, tests of knowledge) N4. Office hours N5. Own work - preparation for laboratory classes, solving additional tasks N6. Own work - own literature studies.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at the end of semester)	Educational effect number	Way of evaluating educational effect achievement
F1	PEU_U01-02	written test
F2	PEU_U03-04	report
P=(F1+F2)/2 (laboratory)	PEU_U01-04	
P (lecture)	PEU_W01-05 PEU_K01-02	written test

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE

[1] Operations Research. Applications and Algorithms. 4th Edition. Winston W. Cengage Learning. 2022.
[2] Operations Research. Theory and Applications, 6th Edition, Sharma J. K. Trinity Press.
[3] Operations Research. Examples and Exercises. Kukuła i in. PWN. Warszawa. 2011.
[4] Simulation Modeling Handbook. A Practical Approach. Chung Ch. A. CRC Press. 2004.

SECONDARY LITERATURE

[1] Operations Research. An Introduction. 10th Edition. Taha H. A. Pearson Education Limited. 2017
[2] Operations Research, Yadav S.R. Malik A. Oxford University Press. 2014.
[3] A Review of Operations Research in Mine Planning. Newman et al. Interfaces 40(3). pp. 222-245. INFORMS. 2010.
[4] Modelling and Simulation Fundamentals. Theoretical Underpinnings and Practical Domains. Sokolowski J. A. Banks C. M. John Wiley & Sons. 2010.
[5] Discrete-Event System Simulation. Banks et al. Prentice-Hall. 2014.

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Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD
Name of subject in Polish: Zarządzanie projektami, ocena ich opłacalności i ryzyka..
Name of subject in English: Project Management, Appraisal and Risk Evaluation.
Main field of study: Mining and Geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Mineral Resource Exploration
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3003G
Group of courses: Yes

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30	15	
Number of hours of total student workload (CNPS)	25		50	25	
Form of crediting	Examination				
For group of courses mark (X) final course	X				
Number of ECTS points	4				
including number of ECTS points for practical classes (P)	3				
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	3,1				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES
1. Knowledge of basic mathematical analysis, probability and statistical models
2. Skills in using Excel spreadsheets
3. Understanding of the need of lifelong learning and the importance of application of Economics, Management and Social Sciences in engineering.

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SUBJECT OBJECTIVES

The course combines two groups of topics: basics of mineral economics and financial management and introduction to project management.
Part A: The purpose of the course is
C1 to introduce basic concepts of Microeconomics and financial management
C2 to introduce the concept of time value of money and present the methods used to evaluate investment projects. Different techniques are illustrated by examples and case studies. The range of application as well as the advantages and disadvantages of each method are

discussed. The issues of inflation and risk analysis are included.
Part B:
C3 Introduction to project management basic concepts, methods and tools.
C4 Presentation of given project management areas: Project scope management, Project time management, Project cost management, Project risk management. Project planning, scheduling and control using Microsoft Project.
C5 Presentation of the issues of effective communication in project teams, group behaviour and leadership.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows the concepts of demand, supply and price elasticities, understands how they affect markets
PEU_W02 knows the concepts of costs in economics and accounting, understands how they differ
PEU_W03 knows the main cost categories and cost accounting methods
PEU_W04 has basic knowledge about the contents of financial statements
PEU_W05 has basic knowledge about the method of ratio analysis of financial statements
PEU_W06 knows and understands the concepts of Present Value and Future Value for simple cash flows and annuities.
PEU_W07 knows the capital budgeting methods (NPV, IRR, PBP) and understand how to interpret the results
PEU_W08 has basic knowledge about the project risk evaluation methods

relating to skills:

PEU_U01 is able to analyze the causes and effects of demand and supply changes
PEU_U02 is able to interpret and use information presented in financial statements also by means of ratio analysis
PEU_U03 is able to use different cost analysis methods and make decisions based on the rsults
PEU_U03 can calculate Future and Present value, also for annuities and solve simple calculation problems
PEU_U04 is able to perform discounted cash flow analysis and draw conclusions based on the results
PEU_U05 is able to carry out sensitivity analysis and scenario analysis using a financial model of an investment
PEU_U06 is able to work out basic project documentation and initiate a project
PEU_U07 is able to use basic methods of project management, monitoring and project risk management
PEU_U08 is able to implement basic conflict management methods in a project group
PEU_U09 is able to use basic group management methods, can undertake and shape the leadership position

relating to social competences:

PEU_K01 is able to think and act in a systematic, creative and entrepreneurial way
PEU_K02 has an established attitude of economic operation and decision-making based on available financial information and forecasts

PROGRAMME CONTENT		
Lecture		Number of hours
Lec.1	Supply and demand, equilibrium price, changes in demand and supply. Stock and commodity markets used by mineral industries	2
Lec.2	Costs in economics and in accounting. Cost and money outflow. Relevant cost, incremental cost, marginal cost, alternative cost. Short-term decision making.	2
Lec.3	Costs as the subject of cost accounting, different systems of cost accounting Different methods of cost data presentation (by types, divided into direct and indirect costs). Cost allocation	2
Lec.4	Variable and fixed costs. Break-even point. Cost-volume –profit analysis.	1
Lec.5	Basics of financial accounting. Income statement and cash flow statement. Balance sheet. Working capital. Examples of financial statements of mining companies	2
Lec.6	Financial ratio analysis. Liquidity, profitability, activity and debt ratios. Financial and operating leverage.	2
Lec.7	The concept of time value of money. Computation of future and present value of money by means of spreadsheet functions. Basics of capital budgeting. Evaluation of different methods.	2
Lec.8	The concept of risk and return. Quantification of risk. Risk analysis in project evaluation: sensitivity analysis, scenario analysis, other methods.	2
	Total hours	15

Project		Number of hours
Pr 1	Issues of understanding communication: Definitions Models (Schramm model, Berlo’s SMCR (source, message, channel, receiver) model, McCroskey model, Reusch and Bateson model, Westley-MacLean model)	3
Pr 2	Conflict Sources of conflicts Kilmann and Thomas classification of conflict Kilmann and Thomas test Different styles of conflict solving Roles of conflict in group development.	3
Pr3	Team roles Team roles Belbin perspective Discussion group roles Effective managerial behaviour in the context of team roles	3
Pr4	Leadership Hersey and Blanchard theory Black and Mouton approach to leadership Fiedler theory and his Least Preferred Coworker Scale Situational leadership self-assessment	3
Pr5	Summary;	3

	Effective managerial behaviour from the different contexts.	
	Total hours	15

	Laboratory	Number of hours
	Part A	
La1	Supply and Demand curves. Elasticity of demand.	2
La2	Economic costs. Cost curves. Profit maximization cases.	2
La3	Managerial cost accounting. Decision making cases.	2
La4	Basic financial accounting. Creation of simple Balance Sheet, Profit and Loss Statement and Cash Flow Statement	2
La5	Ratio analysis based on financial statements of companies	2
La6	Time value of money and capital budgeting – calculation by means of Excel functions	2
La7	Financial model of an investment. Sensitivity and Scenario analysis.	3
	Part B	
La8	Basic concepts (process, project, project management, management by projects, critical factors for project success, competencies). Preparing and initiation of the project. Project analysis (project environment, stakeholders, project objectives).	3
La9	Planning and estimating of the project. Project phases and life cycle	3
La10	Project organization. Project scope management. Planning of activities, resources and costs.	3
La11	Project risk management. Project monitoring. Project management methodologies.	3
La12	Quality management. Change control. Project closing.	3
	Suma godzin	**30**

TEACHING TOOLS USED

N1. Interactive lecture with the use of multimedia and discussion
N2. Laboratory classes: individual problem solving with the use of Excel spreadsheet
N3. Laboratory classes part B and project classes: case studies solving in groups and individually. Project presentations, discussion
N4. Consultation
N5. Self-study: solving assigned problems, literature studies

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01-W08 PEU_K01-K02	Assesment of student class activity
F2	PEU_U01-U10 PEU_K01-K02	Evaluation of student’s assignements
P1	PEU_W01-W08 PEU_U01-U10 PEU_K01-K02	Written test

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: 1. Erhardt M., Brigham E.: Financial Management Theory and Practice. South-Western Cengage Learning, USA 2. Brigham E., Glapenski L.: Financial Management, 1997 3. Johnson H.: Making Capital Budgeting Decisions – Maximising the Value of the Firm. Financial Times/Prentice Hall (April 15, 1999) 4. Jonson H.: Strategic Capital Budgeting: Developing and Implementing the Corporate Capital Allocation Program, January 1994. 5. Lock Dennis, Project Management, Published April 11, 2013 by Routledge **SECONDARY LITERATURE:** 1. Jonson H.: Determining Cost of Capital: The Key to Firm Value. Apr 1999. 2. A Guide to Project Management Body of Knowledge (PMBOK®Guide Fourth Edition), Project Management Institute, 2008 (2004). wydanie polskie, MT&DC Warszawa, 2009 (2006) 3. Johnson H.: Global Financial Institutions and Markets. December 1999
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr inż. Gabriela Paszkowska, Gabriela.paszkowska@pwr.wroc.pl

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Zasady i zastosowania InSAR oraz GIS w górnictwie
Name in English: Principles and Application of InSAR and GIS in Mining
Main field of study: Mining and Geology
Specialization: Geomatics for Mineral Resources Management,
Mineral Resource Exploration,
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3007
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	Examination		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		
including number of ECTS points for practical (P) classes			3		
Including number of ECTS points for direct teacher-student contact (BU) classes	1,4		2,0		

*niepotrzebne skreślić

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of C ++ and Python programming language.
2. Basic knowledge of GIS functions and spatial data acquisition techniques
3. Ability to use GIS software package
4. Basic knowledge of databases

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SUBJECT OBJECTIVES

C1 Presentation of knowledge of satellite radar interferometry, as well as the possibility of using it in the ground deformation measurements.
C2 Acquiring the ability to determine surface displacements based on satellite radar data.
C3 Presentation of information on the use of GIS in advanced analysis of objects, phenomena and processes occurring in space.

C4	Acquiring the ability to formulate and solve tasks using GIS analytical functions.
C5	Acquiring skills to use spatial data and services in accordance with the INSPIRE Directive

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 Has expanded knowledge in the field of using geoinformation systems to collect and process data used in modeling of both natural and anthropogenic phenomena and processes

PEK_W02 Knows the principles of construction and functioning of geoinformation systems in the mining industry and public administration

relating to skills:

PEK_U01 has the ability to use advanced GIS tools in mining, studies of natural phenomena, the impact of mining on the environment and space development,

PEK_U02 has the ability to formulate and solve spatial tasks in the GIS environment

PEK_U03 has the ability to interpret the results obtained and draw conclusions

relating to social competences:

PEU_K01 has the ability to formulate and transfer knowledge on the use of geoinformation systems in spatial analysis and presentation of their results

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Discussion of syllabus, requirements for passing the course, literature	2
Lec 2	Introduction to Microwave Signals for Earth Observation	2
Lec 3	Principles and Applications of Passive and Active Microwave Remote Sensing	2
Lec 4	Acquisition and processing of SAR data	2
Lec 5	SAR image theory (geometric properties, polarization)	2
Lec 6	Basics of SAR data calculation using the DInSAR and SBAS methods	2
Lec 7	Principles and applications of Interferometric SAR (monitoring surface activity, natural and anthropogenic phenomena)	2
Lec 8	Fundamental concepts of geographical information systems	2
Lec 9	Data modelling in GIS. Representation of spatial data. Spatial databases. Current status and development trends	2
Lec 10	Methods of spatial analysis in GIS	2
Lec 11	Spatial data interpolation	2
Lec 12	Map algebra. Surface analysis, local and zonal functions	2
Lec 13	Basics of spatial statistics	2
Lec 14	Spatial Information Infrastructure. Inspire Directive. Open Data	2
Lec 15	Examples of applications of geoinformation systems in mining and environmental protection	2
	Total hours	**30**

Laboratory		Number of hours
La1	Configuration of the environment for SAR calculations	3
La2-3	Introduction to radar data calculations - calculation tasks	6
La4	Acquiring radar data and calculating the interferogram - DInSAR method	3
La5	Unwrapping of the interferometric phase - calculations	3
La6-7	Presentation of results in the GMT environment	6
La8	Discrete data interpolation. Preparation of input data for analysis (e.g. deformation measurements in the mining area)	3
La9	Discrete data interpolation. Development mining area terrain deformation maps with various interpolation methods.	3
La10	Discrete data interpolation. Analysis and assessment of the quality and uncertainty of interpolation. Prediction map. Development of maps of changes between two periods using a raster calculator.	3
La11	Spatial analysis - assessment of the suitability of the area for the location	3
La12	of mining operation. Construction of a database of spatial location criteria	3
La13	Spatial analysis - assessment of the suitability of the area for the location	3
La14	of mining operation. Selection of analytical procedures and conducting analytical operations.	3
La15	Spatial analysis - assessment of the suitability of the area for the location	3
	Total hours	**45**

TEACHING TOOLS USED
N1. Lectures N2. Multimedia presentations N3. Preparation of individual written term paper on a given topic N4. Multimedia materials (MOOC) N5. Laboratory instructions N6. Reports from laboratory exercises N7. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F1 Final mark for the written examination F2 Mark for the written report, P Final mark for the lecture (weighted average of F1 and F2, where F1 – 80% and F2 - 20%)
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F3 Mark for the written assignment reports F4 Mark from written tests, P2 Final mark for the laboratory (weighted average of F3 and F4, where F3 – 80% and F4 - 20%)

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. 2015: Geographic Information Science and Systems, 4th Edition, John Wiley & Sons; [2] Maguire D., Batty M., Goodchild M., 2005. GIS Spatial Analysis and Modelling. ESRI Press [3] Berry J., 2007-2013. Beyond Mapping IV — GIS Modelling [4] Satellite InSAR Data: Reservoir Monitoring from Space, A. Ferretti, EAGE; 1st edition, 2014 [5] GMTSAR: An InSAR Processing System Based on Generic Mapping Tools (Second Edition), D. Sandwell i in., Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, 2016 [6] InSAR Principles - Guidelines for SAR Interferometry Processing and Interpretation, ESA Publications, 2008 **SECONDARY LITERATURE:** [1] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) [2] Kennedy M., 2009: Introducing Geographic Information Systems with ArcGIS: A Workbook Approach to Learning GIS, Second Edition, John Wiley and Sons; [3] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. W., 2006. GIS. Teoria i praktyka. Wydawnictwo Naukowe PWN, Warszawa [4] Urbański J., 2010. GIS w badaniach przyrodniczych, Wydawnictwo Uniwersytetu Gdańskiego [5] Dokumentacja środowiska GMT (Generic Mapping Tools) - http://gmt.soest.hawaii.edu/projects/gmt/wiki/Documentation
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Wojciech Milczarek, wojciech.milczarek@pwr.edu.pl Jan Blachowski, jan.blachowski@pwr.edu.pl

Semester 2
LUT

Lappeenranta-Lahti University of Technology LUT

<table>
<tr><td>Course title</td><td colspan="3">Modelling of Unit Operations W06GIG-SM3056G</td></tr>
<tr><td>European Credits (ECTS)</td><td>5</td><td>Time (hours) given to the students</td><td>60</td></tr>
<tr><td>Type (lecture, classes, laboratory, project, seminar)</td><td>lecture: 2h/week (2 ECTS), laboratory: 3h/week (3 ECTS), blended learning</td><td>Student whole working time (hours)</td><td>125</td></tr>
<tr><td>Description of content</td><td colspan="3">Modeling and parameter estimation using Matlab in chemical engineering and applied mathematics in general. The course presents some of the most common unit operations of chemical engineering, including batch reactors, continuously stirred tank reactors (CSTRs), both in dynamic and steady-state; tubular plug flow reactors, flash distillations, and modelling of temperature dependence of reactions and elements of heat transfer. The models are limited to ones that do not require solving partial differential equations (PDEs).</td></tr>
<tr><td>Intended Learning Outcomes</td><td colspan="3">Knowledge
Upon completion of the course, a student knows
- Matlab software usage in chemical engineering and applied mathematics,
- most common unit operations of chemical engineering, including batch reactors, continuously stirred tank reactors (CSTRs), both in dynamic and steady-state
- tubular plug flow reactors,
- flash distillations, and modelling of the temperature dependence of reactions and elements of heat transfer,
- basic chemical processes in chemical engineering.
Skills
Upon completion of the course, a student is able to
- describe steady-state and transient unit operations with mathematical models,
- validate models and estimate their parameters from experimental data,
- apply models in process development and design, including sizing, optimization, and scale-up,
- use mathematical and simulation software.</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3">Homework and class assignments as well as quizzes passed. No exam. Grades: 0-5. Half of the grade for the laboratory is decided by the share of exercises completed by the student, and the other half by the quality of the lab work reports and homework assignments. The course is built around practical laboratory work solved individually or in groups by the students. The lectures constitute the theoretical support for assignment reports and written quizzes during the semester.
The lecture i.e. the ability to explain the unit operations of chemical engineering is checked with quizzes during the semester. The practical classes: the ability to analyze and apply these processes in real cases is tested with practical examples that are given both individually and in the group.</td></tr>
<tr><td>Recommended readings</td><td colspan="3">Lecture notes and links to supplementary material are given in Moodle (Sisu student tools https://sisu.lut.fi/student/courseunit/otm.....); selected examples from international literature. Online material.</td></tr>
<tr><td>TU Coordinator</td><td colspan="3">Arto Laari, Arto.Laari@lut.fi; Miracle Amadi, Miracle.Amadi@lut.fi; Tuomas Sihvonen, Tuomas.Sihvonen@lut.fi, Esko Lahdenperä, Esko.Lahdenpera@lut.fi,</td></tr>
</table>

Course title	Advanced Process Design W06GIG-SM3057G		
European Credits (ECTS)	5	**Time (hours) given to the students**	75
Type (lecture, classes, laboratory, project, seminar)	lecture: 2h/week (1 ECTS), classes: 1h/week (2 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	Chemical and physical properties, determination of chemical components in process simulation; Property estimation methods; Chemical process material and energy balances, sizing, costing, and economical evaluation; Process performance analysis, process evaluation, and optimization; Chemical process synthesis; Biorefinery process synthesis: objectives and steps; Synthesis of separation sequences; Energy integration in process design.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - what kind of design activities are required during the process design, - and understands how product design and process design are related, - what is the design of processes: what it is aiming at and what are the steps, - and understands the role of modern simulation packages during the process life cycle. Skills Upon completion of the course, a student is able to: - apply simulation packages to support every step during process design, - validate models and estimate their parameters from experimental data, - apply models in process development and design.		
Assessment methods and criteria	Homework and class assignments as well as quizzes passed. No exam. Grades: 0-5. Group work and reports 50%, individual assignments 50%. The lecture: the ability to explain activities required during the process design is checked with quizzes during the semester. The practical classes: the ability to analyze and apply these processes in real cases is tested with practical examples that are given both individually and in the group.		
Recommended readings	Basic study material is delivered in Moodle (Sisu student tools https://sisu.lut.fi/student/courseunit/otm.....). Online material.		
TU Coordinator	Kristian Melin, Kristian.Melin@lut.fi; Nima Rezaei, Nima.Rezaei@lut.fi; Tuomas Koiranen, Tuomas.Koiranen@lut.fi,		

Course title	Research Methodology W06GIG-SM3058G		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), classes: 1h/week (2 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	This course includes the use of scientific databases to find research results and knowledge including critical source assessment. The students make individual or group workshops on selected research topics where they find knowledge of what is known today and based on that formulate the knowledge gap and relevant objectives for the research they have in mind, identify the relevant scientific methods, and make their research plan to study a pre-selected topic. They understand how to process the results to find the facts. The presentation of the research results in a scientifically credible way is part of the course.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - the use of scientific databases to find research results and the current knowledge, - and understands critical source assessment, - how to process the results to find the facts, - the basics of data analysis. Skills Upon completion of the course, a student is able to: - search for scientific knowledge - assess the reliability of different sources of knowledge and data, - make a research plan to reach the objectives, - make a design of experiments, - do the data analysis, - present the research results, - organize and carry out the workshop, - write a scientific report or article.		
Assessment methods and criteria	Homework and class assignments as well as quizzes passed. No exam. Grades: 0-5. Online lectures and exercises, Moodle assignments, personal and group assignments. Group work and reports 50%, individual assignments 50%. The lecture: the ability to explain activities required during the process design is checked with quizzes during the semester. The practical classes: the ability to analyze and apply these processes in real cases is tested with practical examples that are given both individually and in the group.		
Recommended readings	Basic study material is delivered in Moodle (Sisu student tools https://sisu.lut.fi/student/courseunit/otm.....). Online material. Lecture notes and links to supplementary material are given in Moodle; selected examples from international literature.		
TU Coordinator	Marja Talikka, Marja.Talikka@lut.fi; Nima Rezaei, Nima.Rezaei@lut.fi,		

Course title	Circular Economy for Materials Processing W06GIG-SM3059G		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (3 ECTS), seminar: 1h/week (1 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	Circular economy and resource efficiency are important aspects of sustainable development within the industry. The course aim is that students gain the skills needed to ensure that circular economy concepts become adopted into the design, development and operation of mainly metal production processes, during their application, end-of-life stage and recycling. Students carry out project work in groups. The topics are from industry, for example, side stream processing in the metal and steel producing industry, circular economy, and eco-design. Different aspects are emphasized in different projects, depending on the topic.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and understands basic concepts of circular economy, materials flow (raw materials, processing, manufacturing until end-of-life recycling and re-usage), issues and drivers for changes, - and recognizes the impacts (environmental, economic and social) of the current practice of materials processing from a sustainability aspect. Skills Upon completion of the course, a student is able to: - create new business opportunities to re-enter materials into the circular economy, - apply processing technologies to accelerate the implementation during business creation, - recognize the impacts (environmental, economic and social) of the current practice of materials processing from a sustainability aspect, - work as a team member in a development project.		
Assessment methods and criteria	Homework and class assignments as well as quizzes passed. Moodle exam (lecture). Grades: 0-5. Online lectures and exercises, Moodle assignments, personal and group assignments. The project class: group project work and meetings, and reports 70%, quizzes 30%. The seminar: presentation of the project work. The lecture: the ability to explain basic concepts of circular economy is checked with exam quizzes. The practical classes: the ability to adopt circular economy concepts into the design, development and operation of mainly metal production processes.		
Recommended readings	Basic study material is delivered in Moodle (Sisu student tools https://sisu.lut.fi/student/courseunit/otm-......). Online material. Lecture notes and links to supplementary material are given in Moodle; selected examples from international literature, and data from the industry.		
TU Coordinator	Miia John, Miia.John@lut.fi,		

<table>
<tr><td>Course title</td><td colspan="3">Technology and Innovation Management: Introduction W06GIG-SM3060G</td></tr>
<tr><td>European Credits (ECTS)</td><td>3</td><td>Time (hours) given to the students</td><td>45</td></tr>
<tr><td>Type (lecture, classes, laboratory, project, seminar)</td><td>lecture: 1h/week (1 ECTS), classes: 2h/week (2 ECTS), blended learning</td><td>Student whole working time (hours)</td><td>75</td></tr>
<tr><td>Description of content</td><td colspan="3">Innovation as a core business process. Innovative organisation. Development of technology and innovation strategy. Innovation networks. Decision-making in technological and market uncertainty. Creation of new products and services. Innovation performance and learning. Sustainability and innovation.</td></tr>
<tr><td>Intended Learning Outcomes</td><td colspan="3">Knowledge
Upon completion of the course, a student knows
- various methods of technology and innovation strategy,
- the process of creation of new products and services,
- and identifies as well as understands the main innovation and technology management concepts and their linkages to the innovation process, innovation and technology strategy and innovative organization management,
- sustainability and innovation basics.
Upon completion of the course, a student is able to:
- analyze and design technology and innovation strategy of a company,
- analyze the usability of various methods of innovation and technology,
- recognize and apply the main innovation and technology management concepts to innovative organization management.</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3">Homework and class assignments passed. Self-learning based on online materials and online assignments. Online exam (lecture). Grades: 0-5. Online lectures and exercises, Moodle assignments, personal and group assignments. The project class: group project work and meetings, and reports 100%). The lecture: the ability to explain basic concepts of innovation as a core business process. The practical classes: the ability to recognize and apply the main innovation and technology management concepts to innovative organization management.</td></tr>
<tr><td>Recommended readings</td><td colspan="3">Joe Tidd and John Bessant. Managing Innovation – Integrating Technological, Market and Organizational Change, 6th ed. (2018), (including e-learning material), or previous editions (2009, 2013). Online material. Moodle (Sisu student tools https://sisu.lut.fi/student/courseunit/otm ....).</td></tr>
<tr><td>TU Coordinator</td><td colspan="3">Ville Ojanen, ville.ojanen@lut.fi,</td></tr>
</table>

Course title	Solid-Liquid Separation W06GIG-SM3061G		
European Credits (ECTS)	4	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1ECTS), classes: 1h/week (2 ECTS), lab: 2h/week (2 ECTS), blended learning, Distance learning is possible, except for laboratory work measurements	**Student whole working time (hours)**	100
Description of content	The topics are as follows: Fundamentals of solid-liquid separation, filtration methods, operation of filters, cake formation and washing, deliquoring, design and modelling of filters, and scale-up. Filter media and blinding. Experimental design in filtration test work.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - the fundamental phenomena in solid-liquid separation, - different methods and equipment used for solid-liquid separation, - different filter media used in filtration, Skills Upon completion of the course, a student is able to: - select and size suitable equipment for separation processes based on suspension properties and data from laboratory tests, - explain the effects of the characteristics of the solid material and the liquid on the separation and post-treatment processes, - make a preliminary selection of a medium for different cases, - perform an experimental test on a laboratory scale, - write a scientific report.		
Assessment methods and criteria	Homework, laboratory work plus report, literature review, and class assignments passed. Moodle exam. Grades: 0-5. Lecture exam 60%, laboratory work and report 20%, literature review 20%. The lecture: the ability to explain the fundamental phenomena, methods, and equipment in solid-liquid separation is checked during the Moodle Exam. The practical classes: the ability to perform an experimental test on a laboratory scale and write a scientific report.		
Recommended readings	Basic study material is delivered in Moodle (Sisu student tools https://sisu.lut.fi/student/courseunit/otm.....). Online material.		
TU Coordinator	Antti Häkkinen, Antti.Hakkinen@lut.fi,		

ELECTIVE SUBJECTS
BLOCK I

Lappeenranta-Lahti University of Technology LUT

Course title	Artificial Inventiveness W06GIG-SM3070		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	It is an online course for all interested in creativity, in systematic tools of ideation. The modules contain basic TRIZ (Theory for Inventive Problem Solving) tools for idea generation. Have you ever thought about why it is hard to find a new idea sometimes? How to analyze the situation where you need an out of box solution? How to deliver the list of concepts to improve a product or a service? This self-paced course includes the following modules: Introduction, Function Definition, Ideal Final Result, Function-oriented Search, and Contradictions. This course is a brief introduction to creativity and idea generation with elements of theory, everyday life examples, and tests for self-check.		
Intended Intended Learning Outcomes	Upon completion of the course, a student is able to - identify inventive problems in the complex process of product development - apply several tools for systematic idea generation (Function modelling, Ideal final result, Function-oriented search, Contradictions analysis) - act step-by-step when creative and out-of-box ideas are needed		
Assessment methods and criteria	Video lectures and examples, assessment tests, and discussion forums. Homework and class assignments as well as quizzes passed. No exam. Grades: fail/pass. The course is built around practical problems solved individually. The lectures constitute the theoretical support for assignment reports and written quizzes during the semester.		
Recommended readings	Lecture notes and links to supplementary material are given in Moodle. Course videos are available on the CEPHEI platform.		
TU Coordinator	Anastasia Chakir, Anastasia.Chakir@lut.fi, Leonid Chechurin, Leonid.Chechurin@lut.fi,		

Course title	Entrepreneurship and Career Opportunities in Raw Material Sector W06GIG-SM3071		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	Most industrial sectors are facing a new era that requires companies to transform their operations, create new business models, and foster a digital culture. In this context, the industry is facing a changing talent landscape, necessitating new skill sets in their workforce. Companies need to ensure that their staff are properly constituted to support this transformation process. During the course, entrepreneurship skills as well as innovative thinking for engineers will be trained using examples from the raw material sector. Case studies will bring the understanding of skills and competencies of the future workforce and current trends of the industrial revolution.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and recognizes entrepreneurship and career opportunities in the raw material sector, - and understands the primary sector of the raw materials value chain (geology, mining, mineral processing, metallurgy, and the environment). Skills Upon completion of the course, a student is able to - apply design thinking tools to enhance the creativity and innovation capacity of engineers, - develop skills and competencies to improve the mindset of entrepreneurship.		
Assessment methods and criteria	Online lectures, workshops, exercises, design thinking training, assignments, self-study. Homework and class assignments as well as quizzes passed. No exam. Grades: pass/fail. Group work and individual assignments. 25% lectures and quizzes, 25% training, 25% workshop, 25% self-study.		
Recommended readings	Lecture notes, and articles related to the topics.		
TU Coordinator	Maria Mamelkina, Maria.Mamelkina@lut.fi,		

Course title	Sustainable Water Use W06GIG-SM3072		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	Sustainability challenges of water use. Water footprint. Water risk assessment. Water supply, water use in different sectors and loading of water systems. Wastewater treatment in industry and municipalities. Sludge treatment. Production of drinking water. Protection of groundwater deposits. Legislation on water quality and sludge treatment. Economic efficiency of different water treatment methods. Reclaimed water.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and defines the key concepts of water pollution control, - and recognizes the main factors affecting water footprint and sustainability of water use, - and explains the operation of essential process technology and equipment related to the control of water pollution, - and recognizes means to protect groundwater and reduce the environmental load of surface waters, - and understands methods for the environmentally friendly management of side-product flows from water treatment. Skills Upon completion of the course, a student is able to: - apply risk analysis methods related to water issues, - implement different methods for water footprint calculation, - compare and give grounded proposals for water treatment methods and processes applicable to different situations, - analyze the sustainability of water management systems.		
Assessment methods and criteria	Lectures, tutorials and independent exercises. Moodle assignments. Moodle quizzes. Homework and class assignments as well as quizzes passed. Grades: 0-5. Moodle quizzes 50%, assignment 50%. Possibility to get a higher grade by giving a presentation of a scientific article - 5 points.		
Recommended readings	handouts provided by the lecturer, course environment on Moodle, Tchobanoglous: Wastewater Engineering. Treatment and Reuse, 2003		
TU Coordinator	Heli Kasurinen, Heli.Kasurinen@lut.fi, Mariia Zhaurova, Mariia.Zhaurova@lut.fi, Risto Soukka, Risto.Soukka@lut.fi,		

Semester 3
LUT

Lappeenranta-Lahti University of Technology LUT

Course title	Fluid Dynamics in Chemical Engineering W06GIG-SM3065G		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 2h/week (2 ECTS), classes: 1h/week (1 ECTS), project 2 h/week (2 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	Design methods and scale-up of fluid mixers, rheology, and mixing effects in chemical reactors. Theoretical basics of CFD (Computational Fluid Dynamics) in chemical engineering aspects and ability to solve basic mixing problems with CFD. COMSOL software for Multiphysics Simulation (FEM).		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - theoretical basics of CFD (Computational Fluid Dynamics) in chemical engineering, - design methods and scale-up of fluid mixers, rheology, and mixing effects in chemical reactors, - understand the basics of fluid rheology Skills Upon completion of the course, a student is able to - select, size and scale up different mixing devices (stirred tanks, in-line mixers) for blending and multiphase mixing (solid-liquid mixing, liquid and gas dispersions) based on short-cut design methods, - and can adapt the basics of fluid rheology to mixing design, - solve basic fluid mixing problems with CFD programs (COMSOL software), - calculate heat transfer, chemical reactions, laminar and turbulent flow in CFD, - analyze relevant cases in Power-to-X chemicals production technologies.		
Assessment methods and criteria	Homework and class assignments as well as quizzes passed. No exam. Exercise-based lecturing (MS-TEAMS or classroom lecture), home exercises and quizzes 70 h (online in Moodle). 3 homework tasks (Lectures 1-3) will be about hands-on calculations (fluid mixing short-cut methods, engineering maths and calculations). 4 CFD exercises (Lectures 4-7), using COMSOL Multiphysics. Grades: 0-5. 50 % of the grade is from homework (each homework grading 0-100 %, 25 % of the Quizzes (each weekly Quiz 0-100 %), 25 % of Project work. The overall grade for passing the course should be at least 1.0. The course is built around practical calculation work solved individually by the students. The lectures constitute the theoretical support for assignment reports and written quizzes during the semester.		
Recommended readings	Lecture materials in Moodle. Mixing Device Design Perry's Chemical Engineers' Handbook, Perry, R.H., Green, D.W., Maloney J.O. (Eds.), McGraw-Hill, New York; Handbook of Industrial Mixing, Science and Practice, Paul, E.L., Atiemo-Obeng, V.A., Kresta, S.M., (Edits.), John Wiley & Sons, USA, 2004; EKATO-Handbook of Mixing Technology, EKATO Rühr- und Mischtechnik GmbH, Schopfheim; Zlokarnik, M., Stirring: Theory and Practice, Wiley-VCH, Weinheim, 2001; CFD Material Tu, J., Yeoh, G. H. & Liu, C. (2013). Computational fluid dynamics: A practical approach (2nd ed.). Amsterdam; Boston: Elsevier/Butterworth-		

	Heinemann (e-book); An introduction to computational Fluid Dynamics–The finite volume method, 2nd Edition, H. K. Versteeg and W. Malalasekera, 2007; An introduction to computational Fluid Dynamics –The finite volume method, Second Edition, H. K. Versteeg and W. Malalasekera, 2007 (book); Comsol Multiphysics User's Guide (inside Software); www.cfd-online.com; www.bakker.org;
TU Coordinator	Tuomas Koiranen, Tuomas.Koiranen@lut.fi,

Course title	Process Intensification W06GIG-SM3066G		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 2h/week (2 ECTS), classes: 1h/week (2 ECTS), seminar: 1h/week (1 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	The course covers different process intensification methods and their theoretical background. Teaching involves lectures, assignments, meetings and seminars. The main work will be carried out as a process design project assignment where students will work in teams aiming to intensify a process given by the teacher. Each team will write a report and present their results in the seminar. The topics focus mainly on the intensification of different Power-to-X processes, such as the production of E-fuels, carbon-neutral products, energy storage etc.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and explains intensified reactors and separation equipment, combination of reaction and separation, hybrid separation, alternative energy sources, transformation of batch processes to continuous ones, - and explains the principles and goals of process intensification, - and recognizes possibilities to intensify processes and apply novel technology to existing processes (the production of E-fuels, carbon-neutral products, energy storage, etc.), - and understands how product design and process design are related, - and describes the advantages of process intensification and typical intensification methods. Skills Upon completion of the course, a student is able to: - apply intensified reactors and separation equipment, the combination of reaction and separation, hybrid separation, alternative energy sources, the transformation of batch processes to continuous ones, - carry out process design to intensify a process given by the teacher, - write a report and present their results, - work in a team.		
Assessment methods and criteria	Lectures, seminars and exercises passed. Group work, self-studies, preparation for the seminars and the examinations. Grades: 0-5. Written examination 50%, seminar report and exercises 50%. The lecture: the ability to explain different process intensification methods and their theoretical background. The practical classes: the ability to carry out a process design project assignment in teams aiming to intensify a process given by the teacher. The ability to lead the seminar and produce the presentation.		
Recommended readings	Lecture notes. Online material.		
TU Coordinator	Arto Laari, Arto.Laari@lut.fi,		

Course title	Current Issues in Enabling Technologies for Circular Economy W06GIG-SM3067G		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (2 ECTS), classes: 1h/week (2 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	125
Description of content	The course will introduce the most important processing technologies that enable the implementation of a circular economy, such as recycling and recovery as well as separation and purification technologies. The approach of the course is mainly solution-based and thus aims to show practical examples of the utilization of different technologies in solving different kinds of challenges in the circular economy. A special emphasis is laid on topical themes, such as recycling and upgrading of plastic, electric, packaging and textile waste as well as on the production of biofuels. The course will also introduce the concept of ecodesign as a tool to manage the complex value chains in the circular economy.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and understands basic concepts of circular economy (raw materials, processing, manufacturing until end-of-life recycling and reuse) and the drivers for change from linear to circular economy, - and understands the processing technologies of materials in the context of the circular economy. Skills Upon completion of the course, a student is able to: - evaluate the processing technologies of materials in the context of circular economy, - recognize and compare impacts (environmental, economic and social) of processing technologies when assessing the current (linear) practice of material processing vs circular value chains, - apply the transferable skills of life cycle thinking (ecodesign) to evaluate processing technologies in circular value chains.		
Assessment methods and criteria	The students will prepare a team portfolio on one specific subject during this course that will be assessed. In the preparation and assessment of the portfolios peer and self-evaluation will be utilized. In addition, students will answer individually two compulsory questions (at the beginning and the end of the course). Grades: 0-5. There is no exam. The students will prepare in teams a short pitching video and a report on one specific subject during this course that will be assessed. In the assessment peer and self-evaluation will be utilized. In addition, the course material includes compulsory or voluntary quizzes or questions related to the topic at hand.		
Recommended readings	Course material is available in Moodle and consists of video lectures and scientific and topical articles. The course material and the guidance to supplementary material are provided in connection with the different topics.		
TU Coordinator	Miia John, Miia.John@lut.fi,		

<table>
<tr><td>Course title</td><td colspan="3">Start-ups and Venture Formation W06GIG-SM3068G</td></tr>
<tr><td>European Credits (ECTS)</td><td>6</td><td>Time (hours) given to the students</td><td>75</td></tr>
<tr><td>Type (lecture, classes, laboratory, project, seminar)</td><td>lecture: 1h/week (1 ECTS), project: 2h/week (3 ECTS), seminar: 2h/week (2 ECTS), blended learning</td><td>Student whole working time (hours)</td><td>150</td></tr>
<tr><td>Description of content</td><td colspan="3">Entrepreneurship theory and process, business ideas and opportunities, business models, entrepreneurial teams, start-ups and spin-offs, start-up process and development stages, start-up strategies and sequencing activities, start-up financing, testing of business ideas, business plans, and cases.</td></tr>
<tr><td>Intended Learning Outcomes</td><td colspan="3">Upon completion of the course, a student knows
- business start-up theories and processes.
Skills
Upon completion of the course, a student is able to:
- critically analyse different business ventures and is skilled in testing business ideas and models,
- analyze business cases and prepare a business plan with its calculations as well as pitch the plan successfully,
- work as a team member in a development project.</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3">Individual assignments and preparing for Moodle exam, independent work. Group work. Grades 0-5. Evaluation 0-100 points. Individual assignments 60%, group work 30% (written business plan 20%, oral pitching 10%), Moodle exam 10%.</td></tr>
<tr><td>Recommended readings</td><td colspan="3">Barringer, B.R. & Ireland, R.D. (2006 or later edition). Entrepreneurship: successfully launching new ventures. Pearson Prentice Hall.
Other materials will be distributed during the course.</td></tr>
<tr><td>TU Coordinator</td><td colspan="3">Noora Heino, Noora.Heino@lut.fi,</td></tr>
</table>

Course title	Academic Entrepreneurship W06GIG-SM3069G		
European Credits (ECTS)	6	**Time (hours) given to the students**	75
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (3 ECTS), seminar: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	150
Description of content	- The central concepts of entrepreneurship, - The entrepreneurial mindset, motivations, resources and opportunity recognition, - The anatomy of the venturing process, - Commercializing academic skills and research activities, - Communicating entrepreneurial ventures		
Intended Learning Outcomes	The course aims to develop the student's awareness of their entrepreneurial mindset. The aims also include enhancing the students' understanding of entrepreneurial opportunities and routes for grasping them. Furthermore, the students learn new ways to commercialize their knowledge, skills and research activities.		
Assessment methods and criteria	Lectures and teamwork, tests and exercises, homework exercises, practising presentations of business cases, study visits or visitor lecturers. Grades: 0-5. 1-5 course assignments and an exam. Moodle assignments, individual and group assignments.		
Recommended readings	Shane, Scott (2003) A general theory of entrepreneurship. The individual-opportunity nexus. Edward Elgar. Other literature is to be announced during the course (including e-learning material). Online material.		
TU Coordinator	Tuuli Ikäheimonen, Tuuli.Ikaheimonen@lut.fi,		

ELECTIVE SUBJECTS
BLOCK II

Lappeenranta-Lahti University of Technology LUT

Course title	Intelligent Product-Service Systems W06GIG-SM3073		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	Product-Service Systems (PSS) and Product Lifecycle Management (PLM) trends and digital transformation. Different views on a product/service: structures – processes – lifecycles – data/information, challenges with lifecycle management, requirements management, and systems engineering. Product information modeling, change management, and configuration management through lifecycle (CLM). IoT-based data services for sustainability, features, and functionalities of PSS/PLM systems. PLM project and demos of systems utilization. Future of PSS in various industries.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and understands trends of product-service systems and digital transformation affecting manufacturing business, - and defines, and explains the concepts related to product data management and product life cycle management, - and recognizes the company's product and service processes and understands their interaction with the company's overall operations Skills Upon completion of the course, a student is able to - compare PLM and ERP systems' characteristics, technical features, and managerial functions and is able to see their role in product development and business management.		
Assessment methods and criteria	Lectures, project meetings, and intensive studies. Course assignments and quizzes. Grades 0-5. Quizzes 60 %, project assignment and participation 40 %.		
Recommended readings	Journal articles and lecture material. Sääksvuori-Immonen: Product Lifecycle Management, Springer 2008.		
TU Coordinator	Ilkka Donoghue, Ilkka.Donoghue@lut.fi, Lea Hannola, Lea.Hannola@lut.fi,		

Course title	Inventive Product Design and Advanced TRIZ W06GIG-SM3074		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	It is a course for all interested in creativity, in systematic tools of ideation. The modules contain basic and modern TRIZ (Theory for Inventive Problem Solving) tools for idea generation and other analytical tools that have proven their efficiency in the industry. Have you ever thought about why it is hard to find an idea that can save a product, project, or business? How to analyze the situation where you need an out of box solution? How to deliver systematically the list of patentable concepts to improve a product or a service? How to circumvent the patents of competitors and develop an IP strategy? The course includes the following modules: Introduction, Basics of Patenting, Function Definition, Function-oriented Search and Biomimetics, Contradictions, Function Modelling and Ttrimming, Cause-Effect Chain Analysis, Trends of Engineering System Evolution, Axiomatic Design, Design for Manufacturing and Assembly, Conclusion. There are about 20 case studies and 100+ examples of smart new product design, technology troubleshooting, and inventive solutions, many of which are coming from success and failure stories of technological giants. Most cases originate from the engineering domain, although basic knowledge like how car brakes work and what is inside a refrigerator...except food plus curiosity is enough to follow most.		
Intended Learning Outcomes	The aim of the course is to introduce the students to a wide range of existing design methods with a focus on design creativity and innovation. The participants will gain both theoretical competencies and practical skills, from the descriptive models for analyzing design processes and behaviours to the prescriptive tools that provide a structured and multi-disciplinary approach to design. Knowledge Upon completion of the course, a student knows - and distinguishes the conceptual design phase and its instruments, - and identifies the voice of the product and forecast technology evolution). Skills Upon completion of the course, a student is able to - search and analyze patent landscape, - modulate ideation algorithms, - design a new product and concept of the service on demand, - evaluate design concepts from managerial and production perspectives.		
Assessment methods and criteria	Lectures and project meetings, group work, individual work, and studies. Online lectures, exercises, assignments, self-study. Homework and class assignments passed. No exam. Grades: 0-5. Project work is 50% and individual work is 50%.		
Recommended readings	Study materials will be provided during the course, and open-access Internet resources are actively used.		
TU Coordinator	Anastasia Chakir, Anastasia.Chakir@lut.fi, Leonid Chechurin, Leonid.Chechurin@lut.fi,		

Course title	Knowledge Discovery and Process Data Analysis W06GIG-SM3075		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	Knowledge discovery refers to the overall process of discovering useful knowledge from data. The knowledge discovery process is interactive and iterative and involves several steps starting from studying the application domain and ending with to use of the information discovered. Process data analysis can be part of this process. Fundamental concepts - such as reliability of data, preprocessing (e.g., de-noising, handling missing data, and scaling strategy), data reduction, choosing a methodology, validation, modelling, etc - will be addressed in lectures, Moodle assignments, and discussions. Project work will be carried out in small groups that will define their working methodology. The course is suitable for distance learning.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - have acquired basic information on the main concept of the knowledge discovery process concerning industrial data. Skills Upon completion of the course, a student is able to: - be aware of the effect of digitalization and automation on the amount, nature, and quality of data from the chemical engineering point of view, - apply specified methods and methodology to data, - apply management and collaboration skills in the implementation of project work.		
Assessment methods and criteria	Online lectures, tutorials, online discussions, peer feedback, Moodle quizzes, and weekly assignments. Project work. Grades: 0-5. Project work 39 %, assignments 37 %, discussions in Moodle forum 24 %. Homework and class assignments as well as quizzes passed.		
Recommended readings	Tutorial videos, and online material distributed or announced in Moodle.		
TU Coordinator	Satu-Pia Reinikainen, Satu-Pia.Reinikainen@lut.fi, Tuomas Sihvone, Tuomas.Sihvonen@lut.fi,		

Course title	Development of New Sustainable Products and Solutions W06GIG-SM3076		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar)	lecture: 1h/week (1 ECTS), project: 2h/week (2 ECTS), blended learning	**Student whole working time (hours)**	75
Description of content	The course contains an introduction with an overview of sustainable biobased products, bio-based barrier technologies for packaging applications, Biobased Hygenic Products and Solutions, Biomaterials for Printing, and Biobased tall oil products. and Biomaterials in food application. Fundamentals about biomaterial design, modification, synthesis, and use of fibers, cellulose (derivatives), and lignin in various products. Chemical and mechanical modification, separation methods, mixing and drying methods. Product specification requirements and characterization methods. In addition, the course contains an interesting topic of group and individual assignments related to modern trends of sustainable biobased products and solutions.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - various types of new sustainable product development and solutions, - tailoring of functionalities of biobased polymers to meet functionality needed for specific applications, - various renewable resources (biomaterials, biochemicals, cellulose, lignin, starch, carbohydrates, etc) based on sustainable product development and their applications, - material and molecular design and its role in product performance. Upon completion of the course, a student is able to: - use of forest resources and forest-derived biomaterials for food, pharmaceuticals, composites, industry, and other applications.		
Assessment methods and criteria	Mostly self-study and topic-based exercises, topic-based group, and individual assignments. Online lectures, tutorials, online discussions, peer feedback, Moodle quizzes, and weekly assignments. Project work. Grades: 0-5. Exercises (20%), group assignment (30%), video presentation of group assignment (20%) and individual assignment (30%).		
Recommended readings	Lecture material will be distributed via Moodle.		
TU Coordinator	Rama Layek, Rama.Layek@lut.fi,		

Semester 4
WUST

Wroclaw University of Science and Technology WUST

Course title	Field Academy Student Project W06GIG-SM3064P		
European Credits (ECTS)	2	**Time (hours) given to the students**	45
Type (lecture, classes, laboratory, project, seminar	Project-Practical classes, fieldwork: 3h/week (2 ECTS)	**Student whole working time (hours)**	50
Description of content	The goal of the course is that students should acquire a hands-on understanding of different field research methodologies, and how they can be integrated with innovation and technology in mining. Innovative techniques such as UAV (drones), UGV (robots), VR, GIS-based data analyses, lidar imaging, hyperspectral method as well as InSAR methods and digitalization trends will be explored by students. The students will investigate companies (raw materials, geological, geodesy, mining, processing plants, municipal objects, IT companies) in view of innovative management and techniques implementation.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and understands trends of product-service systems and digital transformation affecting manufacturing business, - and defines, and explains the concepts related to product data management and product life cycle management, - and recognizes the company's product and service processes and understands their interaction with the company's overall operations, - and understands the primary sector of the raw materials value chain (geology, mining, mineral processing, and the environment), - innovative techniques, digitalization trends, and the concept of innovation and technology integration in the raw material sector. Skills Upon completion of the course, a student is able to - compare systems' characteristics, technical features, and managerial functions, - see their role in product development and business management, - create new business models, and foster a digital culture, - implement innovative techniques in the raw materials chain.		
Assessment methods and criteria	The course is mainly connected with practice work in the field, but also with complementary short lectures and exercises. The investigation results will be assessed together with the report and project.		
Recommended readings	The complementary/introductory material will be provided on Moodle. The students will be responsible for the content of the material.		
TU Coordinator	Anna Gogolewska, anna.gogolewska@pwr.edu.pl		

Wroclaw University of Science and Technology WUST

Course title	Industrial Research Internship Project W06GIG-SM3062P		
European Credits (ECTS)	2	**Time (hours) given to the students**	30
Type (lecture, classes, laboratory, project, seminar, internship)	Project classes: 2h/week (2 ECTS), (Practice)	**Student whole working time (hours)**	50
Description of content	The aim of the course is to enable students to work in responsible workplaces and apply their skills and knowledge to promote entrepreneurship, innovation, and technology integration in the raw material sector. The students are to become work-ready professionals, who can implement innovative technologies and efficient managerial issues. They will learn how to actively participate in the affairs of the community and promote public interest, equality, and solidarity. The students will face environmental and technological problems such as the degradation of land, air, and water quality as a result of industrial activities. Therefore the students will be familiarized with the necessity of transparency and accountability standards in the raw materials sector and the strategy to meet them. Moreover, they will be exposed to the lack of effective information flow between the companies and society. In industrial or R&D companies the students will develop and implement innovative solutions to technological or managerial problems observed.		
Intended Learning Outcomes	Knowledge Upon completion of the course, a student knows - and understands trends of product-service systems and digital transformation affecting manufacturing business, - and defines, and explains the concepts related to product data management and product life cycle management, - and recognizes the company's product and service processes and understands their interaction with the company's overall operations, - and understands the primary sector of the raw materials value chain (geology, mining, mineral processing, and the environment), - innovative techniques, digitalization trends, and the concept of innovation and technology integration in the raw material sector. Skills Upon completion of the course, a student is able to - compare systems' characteristics, technical features, and managerial functions, - see their role in product development and business management, - create new business models, and foster a digital culture, - engage in an informal professional discussion and business communication, - implement innovative techniques in the raw materials chain.		
Assessment methods and criteria	Submission and defense of a project report		
Recommended readings			
TU Coordinator	Supervisors of the student’s Master thesis		

Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish: Zintegrowana analiza deformacji w geomechanice
Name of subject in English: Integrated Analysis of Deformations in Geomechanical Engineering
Main field of study: Mining and Geology
Specialization: Mining Engineering
Geomatics for Mineral Resources Management
Entrepreneurship, Innovation and Technology Integration in Mining
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3063G
Group of courses: Yes

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		30		
Number of hours of total student workload (CNPS)	75		50		
Form of crediting (Examination/crediting with grade)	Examination				
For group of courses mark (X) final course	X				
Number of ECTS points	5				
including number of ECTS points for practical classes (P)	2				
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	2,9				

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCIES

1. Introduction to Rock Mechanics
2. Basic knowledge about mining technologies
3. Fundamentals of monitoring of rock mass deformations

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SUBJECT OBJECTIVES

C1 Fundamental understanding of integrated analysis of deformations using the combination of monitoring and numerical modelling of deformations, which is essential for studying the processes occurring in engineering structures and in rock mass at the construction and post-construction stages.
C2 To understand the fully automated monitoring principles, data collection, and processing.
C3 Fundamental understanding of analysis of deformations, which is essential for studying the processes occurring in engineering structures and in rock mass at the construction and post-construction stages.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 Is able to distinguish and describe the applications of deformation monitoring techniques in the spectrum of engineering disciplines such as mining and construction engineering

PEU_W02 Is able to characterize the rock mass and mining methods

PEU_W03 Has knowledge of empirical and deterministic analyzes of rock mass deformations using FEM

PEU_W04 Has knowledge of the basics and applications of the analysis of the integrated deterministic method with the results of geodetic measurements

relating to skills:

PEU_U01 Is able to determine the main assumptions for geodetic measurement of deformations caused by mining exploitation

PEU_U02 Is able to create a FEM model

PEU_U03 Is able to perform integrated analysis using deterministic modelling by means of the FEM method and using the results of geodetic and geotechnical measurements

…

relating to social competencies:

PEU_K01 Is able to assess the role of monitoring and prediction in sustainable mining throughout its entire cycle

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Introduction: course syllabus, methods of evaluation of the learning outcomes, literature	2
Lec 2	Introduction to integrated analysis of deformations. Rock mass and earth mass material characteristics; determination of in-situ rock mass parameters;	2
Lec 3	The role of monitoring in sustainable mining.	2
Lec 4	Description of physical phenomena: statics - dynamics, heat propagation, fluid flow, changes in gravitational force, applications	2
Lec 5	Geodetic and geotechnical monitoring of deformations; deterministic modelling	2
Lec 6	Deformation Monitoring Surveys, design and implementation of geodetic deformation monitoring system. Short review of monitoring requirements and available monitoring techniques.	2
Lec 7	Advantages and disadvantages of geodetic and geotechnical methods. The concept of integrated analysis.	2
Lec 8	Solid mechanics, boundary conditions problem	2
Lec 9	Principles of integrated analysis of deformations; analysis based on system theory; analysis based on continuum mechanics; approximate methods for solving continuum problems; Finite Element Method (FEM);	2
Lec. 10	Solving truss systems in FEM	2
Lec. 11	Large scale problems in rock mechanics. Empirical and deterministic methods of surface deformations modelling in underground and open pit mining. Utilization of the Finite Element Method	2
Lec 12	Examples of utilization of integrated analysis for slope stability problems in open pit mines in Chile and USA	2
Lec 13	Examples of integrated analysis used to control surface deformations caused by underground salt mining in Canada	2

Lec. 14	Problems of oil and gas mining (Venezuela, Canada)	2
Lec 15	Wrap up: conclusions, final remarks	2
	Total hours	30
	Classes	**Number of hours**
Cl 1		
Cl 2		
	Total hours	
	Laboratory	**Number of hours**
Lab 1	Presentation of the course scope, literature and assessment methods	2
Lab 2	Analysis of the impact of load on the rock mass – application of the GeoStudio software	2
Lab 3	In-situ stress analysis of rock mass and loaded rock mass	2
Lab 4	Designing a geodetic measurement in a mining area for underground mining based on FEM results. Discussion of the measurement project.	2
Lab 5	Determination of the mining area category. Discussion of the project results	2
Lab 6	Designing a geodetic measurement in an open-pit mine based on the FEM model. Discussion of the measurement project.	2
Lab 7	Designing a geodetic measurement of an earth dam based on an FEM model. Analysis, discussion	2
Lab 8-11	Task 1: Determining the FEM of rock mass deformations caused by underground mining, determining the terrain category. Elastic and nonlinear analysis. Monitoring overview. Summary	8
Lab 12-15	Task 2: Determination of the FEM of the deformation of the earth mound/dam in conditions of variable water level. Determination of the safety factor using Geostudio software. Monitoring overview. Summary	8
	Total hours	30
	Project	**Number of hours**
Proj 1		
	Total hours	
	Seminar	**Number of hours**
Semin 1		
Semin 2		
	Total hours	

TEACHING TOOLS USED
N1. Lecture, film N2. Individual problem solving with the use of software, teacher’s support N3. Group discussion

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEK_W01- PEK_W03	Marks for laboratory assignments and tasks
P	PEU_W01 – PEU_W04, PEU_U01 – PEU_U03	Examination - final mark for Lecture Final mark for laboratory classes – average from assignments and tasks

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Szostak-Chrzanowski, A., A. Chrzanowski,(2010), „INTEGETED ANALYSIS OF DEFORMATIONS IN GEOMECHANICS “, UNB, Fredericton, N.B., 220p.

SECONDARY LITERATURE:

[1] Szostak-Chrzanowski, A., A. Chrzanowski, M. Massiera (2005) “Use of deformation monitoring results in solving geomechanical problems – case studies “, Engineering Geology, vol. 79, Issues 1-2, pp. 3-12.

[2] Chrzanowski,A. (1993):"Modern Surveying Techniques for Mining and Civil Engineering" Chapter 33 in: Comprehensive Rock Engineering, Pergamon Press,Vol.3.Chapter 33, pp.773-809.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Prof. dr hab. inż. Anna Chrzanowska anna.chrzanowska@pwr.edu.pl

COURSE DESCRIPTIONS/
KARTY PRZEDMIOTÓW

second-level studies/ studia II stopnia
main field of study/ kierunek studiów:
Mining and Geology/ Górnictwo I Geologia

specjalność/specialisation:
Mineral Resources Exploration
- Track WUST - UNI MISKOLC

Semester 1
WUST

Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish … Geofizyka inżynierska
Name of subject in English Engineering Geophysics
Main field of study: Mining and geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
………………………. Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code ………… W06GIG-SM3004….
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			50	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	1			2	
including number of ECTS points for practical classes (P)				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,8			0,9	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. has knowledge of fundamentals of applied geophysics, physics and geology.
2. knows fundamentals of soil and rock mechanics.
3. is able to use MS Office software.
4. is able to work in a team.

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SUBJECT OBJECTIVES

C1 familiarize with physical phenomena in geosphere of the Earth
C2 familiarize with engineering problems solved by means of geophysical surveying
C3 familiarize with various geophysical surveys.
C4 acquisition of skills to plan geophysical field surveying and to interpret its results.
C5 development of skills to work in a group.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 recognizes, names and explains engineering problems in different fields.
PEU_W02 identifies, describes and chooses geophysical surveying methods.
PEU_W03 analyses and assesses case studies from solving the engineering problems.

relating to skills:
PEU_U01 is able to coordinate team work, create field research plans and manage the work progress.
PEU_U02 is able to independently create solutions for complex practical problems in engineering and geoengineering applying knowledge about geophysical surveying, mining geophysics, utilizing modern methods in geophysical data acquisition and interpretation.
PEU_U03 is able to critically assess, process and interpreted results of the geophysical surveying and provide recommendations related to engineering problems in mining, civil engineering, engineering geology, municipal waste site, archeology, engineering properties of soil and rocks, hydrogeology, monitoring seepage in river dykes or dams.
PEU_U04 is able to solve geophysical problems.
PEU_U05 is able to conduct auto-didactical education related to detailed handling of typical software.
relating to social competences:
PEU_K01 understands the need to create and transfer to the society – among others by mass media- information and opinions related to mining engineering achievements and other activities of mining engineer; tries to transfer the information in commonly understood way, presenting different points of view; is aware of the quality and need to shape the work safety culture in mining and the responsibility for the health and life of other employees.

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Physical properties of rocks. Inter-relationships between the various subdisciplines of applied geophysics. Overview of geophysical methods, their physical principles and applications. Methodology of geophysical surveying.	1
Lec 2	Engineering problems solved with geophysical surveying. Case studies.	2
Lec 3	Electrical resistivity methods. Tomography and VSE. IP method. Physical principles. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
Lec 4	Electromagnetic methods. FDEM and TDEM methods. Magnetotelluric methods. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Lec 5	GPR surveying. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Lec 6	Seismic tomography. Seismic interferometry. Physical principles. Applications. Case studies.	2
Lec 7	Mine geophysics. Seismology. Seismic methods. Active and passive seismic tomography. Microgravimetry. Case studies.	2
Lec 8	Gravity and magnetic surveying. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
	Total hours	15

Project	Number of hours

Proj 1	One selected geophysical technique. Fundamentals and equipment. Field surveying	4
Proj 2	Processing and interpretation of field data.	3
Proj 3	Solving the geophysical problems.	8
	Total hours	15

TEACHING TOOLS USED

N1. N1.Lecture aided by presentation.
N2.Demonstration.
N3.Discussion and consultations
N3Calculations
N5Practical field surveying

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
P1	W01-W03	Test related to lecture content. Final grade.
F1	U01-U02, U05	Test. Project 1. Report on Project 1
F2	U03, U05	Test. Project 2. Report on Project 2
F3	U04, U05	Test. Solving geophysical problems
F1-F3, P2	U01-U05 K02	Grades are given for each of three project tasks including tests and reports. The final grade P2 for the project course is the weighted average grade of F1-F3.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Aki, K., Richards P.G., 1980. Quantitative Seismology: Theory and Methods. W.H. Freeman Co.. San Francisco.
[2] Burger, H.R., Sheehan, A.F., Jones, C.H., 2006. Introduction to Applied Geophysics: Exploring the Shallow Subsurface. W.W. Norton & Company, Inc.
[3] Mendecki, A.J. (ed.), 1997. Seismic Monitoring in Mines. Chapman & Hall.
[4] Reynolds, J.M., 2011. An Introduction to Applied and Environmental Geophysics. Wiley – Blackwell. John Wiley & Sons.
[5] Sharma, Prem V., 2002. Environmental and engineering geophysics. Cambridge University Press.
[6] Torge, W., 1989. Gravimetry. Water de Gruyter. Berlin. New York.
[7] Selected Journal Publications (for example journals: Progress in Geophysics, Engineering Geophysics Journal, Environmental and Engineering Geophysics, Journal of Geophysics and Engineering, Pure and Applied Geophysics).

SECONDARY LITERATURE:

[1] Lowrie, W., 2007. Fundamentals of Geophysics. Cambridge University Press.
[2] Milsom, J., 2003. Field Geophysics. John Wiley & Sons Ltd.
[3] Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990. Applied Geophysics. Cambridge University Press.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

ANNA BARBARA GOGOLEWSKA, anna.gogolewska@pwr.edu.pl

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish Wspomagane komputerowo modelowanie geologiczne i geostatystyka.)
Name of subject in English: Computer Aided Geological Modelling and Geostatistics
Main field of study (if applicable): Górnictwo i geologia.
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Mineral Resource Exploration
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W06GIG-SM3002
Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	crediting with grade	Examination / crediting with grade*	crediting with grade	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,8		1,9		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Mathematical Statistics,
2. Fundamentals of Geology and Mineral Deposits

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SUBJECT OBJECTIVES

C1 Developing basic skills in computer modelling of 3-D objects.
C2 Introduction of the principles of digital modelling of typical geological structures.
C3 Introduction to the methods of deposit parameters estimation and resources evaluation.

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 Estimation methods, principles of geostatistics, kriging estimators PEU_W02 Geostatistical modelling of the selected deposit parameters (domain analysis, variogram modelling, PEU_W03 Creating and validating 3-D models of various geological structures in the comprehensive dedicated software environment. relating to skills: PEU_U01 Application of relevant estimation methods for quality modelling of a deposit PEU_U02 Evaluating 3-D objects against structural and quality block models (volumes, tonnages, grades) PEU_U03 Describing the interpretation and applied approach, creating models, evaluation results, recommendations for possible enhancements relating to social competences: PEK_K01 The student can think and act in a creative and enterprising way

PROGRAMME CONTENT		
Lecture		Number of hours
Lec 1	Introduction to the course. Geological database and validation of the geological data.	2
Lec 2	Geology of the seam.	2
Lec 3	Structural model of the stratified deposit. Methods of the prediction of the surface layer parameters.	2
Lec 4	Spatial distribution of samples values. Regionalized variable.	2
Lec 5	BLUE Estimator of the mean value: Kriging.	2
Lec 6	Quality model of the deposit – block model of the parameter layers. Estimation and evaluation of the block model.	2
Lec 7	Reserves modelling and evaluation.	2
Lec 8	Mineral resources. International reporting. The JORC Code	1
	Total hours	**15**

Laboratory		Number of hours
La1	Determining the rules of work at the laboratory.	3
La2	Assignment of the individual dataset for the exercises and creating initial data files.	3
La3	Data validation and creating initial geological database.	3
La4	Construction of the structural wireframe model of stratigraphy layers.	3
La5	Construction of the block model of the deposit and overburden layers. Thickness and stripping ratio analysis.	3
La6	Data preparation to geostatistical analysis. Compositing of the samples.	3
La7	Domain analysis with the use of the statistical methods.	3
La8	Determination of the empirical variogram. Anisotropy analysis.	3
La9	Variogram modelling.	3
La10	Kriging Neighborhood Analysis - defining optimal parameters of the	3

	estimation procedure.	
La11	Estimation of quality parameters in block model of the deposit layers. Validation of the estimation quality.	3
La12	Validation of the quality model and classification of the resources. Balance resources evaluation.	3
La13	Preparation of data for continuous surface mining ultimate pit design. Ultimate pit outlines generation	3
La14	Wireframe and block modelling of the ultimate pit	3
La15	Reserves evaluation, visualization and interrogation of created models	3
	Total hours	45

TEACHING TOOLS USED
N1. Form of lectures - traditional, multimedia presentations using specialized software and demonstrations of its application "live", individual development of specialist topics covered during the lecture, N2. individual development of project tasks within the laboratories frames, individual development of electronic reports concerning project tasks within the laboratories frames, N3. evaluation of laboratory tasks reports with multipoint grade of student's work, group analysis of the results obtained during laboratory tasks; preparation of conclusions concerning data dependencies and constraints of mining projects, skill control tests, duty hours in laboratory.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01, PEU_W02	Lecture grade on the basis of the written examination
F2	PEU_W03,	Laboratory task assessment: "structural modelling assessment
F3	PEU_U01	Laboratory task assessment: "geostatistical modelling"
F4	PEU_U02, PEU_U03	Laboratory task assessment: "reserves evaluation".
P average of F1, F2, F3, F4		

PRIMARY AND SECONDARY LITERATURE
<u>PRIMARY LITERATURE:</u> [1] M. Armstrong, Basic Linear Geostatistics, Springer Verlag, 1998. [2] P. Goovaerts: "Geostatistics for Natural Resource Evaluation", Oxford University Press, 1997. [3] R. H. Grishong, Jr., 3-D Structural Geology, Springer Verlag, 2008 [4] K. Hefferan, J. O'Brien, Earth materials, Willey-Blacwell, Chichester U.K., 2010 [5] W. Hustrulid, M. Kuchta, Open pit mine planning and design. Chapter 3. Orebody description, Taylor&Francis, 2013. [6] A. G. Journel, and C.J. Huijbregts, Mining Geostatistics, Academic Press, 1978. [7] Ch.C. Plummer, D.H. Carlson, L. Hammersley, Physical geology, McGraw-Hill I.E. N.Y. 2010 [8] D.R. Prothero, R.H. Dott Jr., Evolution of the Earth, McGraw-Hill I.E. N.Y., 2010 [9] M.W. Rossi, C.V. Deutsch, Mineral Resources Estimation, Springer Verlag 2014. **<u>SECONDARY LITERATURE:</u>** [10] Handouts, tutorials.
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr inż. Krzysztof Hołodnik **Dr inż. Witold Kawalec**

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Cyfrowa kopalnia
Name in English: Digital Mine……………………..
Main field of study: Mining and geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
………………………. Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3006
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		15		
Number of hours of total student workload (CNPS)	25		25		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**1**		1		
including number of ECTS points for practical (P) classes			1		
Including number of ECTS points for direct teacher-student contact (BK) classes	0,8		0,8		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Computer literacy skills
2. Basic knowledge related to Mining Engineering and Mineral Processing
3. Programming

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SUBJECT OBJECTIVES

C1. Acquisition of the ability to create utility applications in the C / C ++ and LabVIEW environment
C2. Providing students with knowledge about embedded systems, their construction, selection of components, designing, programming and their exploitation.
C3. Familiarizing with the advances of technology & methods of future mining operations.
C4. Acquisition and consolidation of social competencies including emotional intelligence skills involving the cooperation in the group of students aiming to effectively solve problems. Responsibility, honesty and fairness in the proceedings; observance force in academia and society

SUBJECT EDUCATIONAL EFFECTS **relating to knowledge:** PEU_W01 A student has knowledge related to automation systems, control systems and measurement systems in various aspects of the mining industry. PEU_W02 The student has knowledge of the importance of automation and robotics systems in modern mining. **relating to skills:** PEU_U01 A student is able to select and integrate elements of a specialized measuring and control system including: control unit, executive system, measuring system as well as peripheral and communication modules PEU_U02 A student can design improvements in the existing design solutions for automation and robotics components and systems **relating to social competences:** PEU_K01 A student is aware of the need for a professional approach to technical issues, meticulous reading of documentation and knows environmental conditions in which devices and their components can function PEU_K02 The student has knowledge concerning the benefits of creation and implementation new solutions&technologies into mining industry

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	Terminology (process, automation, robots, measurement devices, control systems). Definition of digital mine	2
Lec 2	Aims, benefits, drawbacks of automation. Industrial revolutions. Definition of industry 4.0. Overview of components of the 4th industrial revolution. Industry 4.0 and mining	2
Lec 3	Elements of technological process in mining. Automation of cyclic processes Measuring technologies in industry 4.0. Sensors systems. Data transmission and data storage technologies. Analytics in industry 4.0. Industrial BigData, Cloud Computing	2
Lec 4	Industrial Internet of Things. M2M communication, anti-collision systems, location of people underground	2
Lec 5	Virtual and augmented realities for industry. Simulators. Digital Twin. Digital models of processes and objects. Management information creation systems, reporting	2
Lec 6	Case study: Automation in open pit lignite mining (KTZ, Autonomous haulage (use case from Australia))	1
Lec 7	Case study: underground mine (Rock Vader – Sandvik project, other use cases from Sandvik, Epiroc, MineMaster, Zanam, AOT from ZGPS KGHM, KIC project on shaft inspection, …etc)	2
Lec 8	Case study: mineral processing (ConVis, FlowVis) in KGHM, OPMO project	2
	Total hours	**15**

Form of classes - laboratory		Number of hours
Lab1	Scope of the course, teaching purpose, crediting conditions, literature, data. Introduction to ARDUINO	3
Lab2	Basic sensors for physical parameters measurements	3
Lab3	Measurements in Labview	3
Lab4	Analysis and Visualization in Labview	3
Lab5	Control in labview	3
	Total hours	**15**

TEACHING TOOLS USED
N1. Type of lectures - traditional, illustrated with multimedia presentations with the usage of audio- visual equipment. N2. Discussion concerning lectures and laboratory. N3 Configuration on laboratory classes measuring systems (hardware and software), performing of measurements, teamwork N4. Projects defence - oral and written form. N5. Duty hours.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at the end of semester)	Educational effect number	Way of evaluating educational effect achievement
F1, P1	PEK_U02- PEK_U04	F1.1 Grade from laboratory work's performance and its merits F.1.2 Grade from laboratory work's oral or written defence P1.Final grade (weighted average of F1.1 - 60% and F1.2 - 40%).
F2, P2	PEK_U02- PEK_U04	F2.1 Grade from activity during the lecture (questions, discussions etc) F.2.2 Grade from written exam P2.Final grade (weighted average of F2.1 - 20% and F2.2 - 80%).

LITERATURE
PRIMARY LITERATURE: [1] LabVIEWTM Getting Started with LabVIEW http://www.ni.com/pdf/manuals/373427j.pdf [2] Monk Simon: Arduino dla początkujących. Podstawy i szkice, Anderson R., Cervo D., Helion, 2018 [3] Monk Simon: Arduino dla początkujących. Kolejny krok, Anderson R., Cervo D., Helion, 2015 **ONLINE LITERATURE:** [1] LabVIEW Tutorial [2] ARDUINO Tutorial [3] Materials prepared by Tutor [4] Internet websites
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Prof. dr hab. inż. Radosław Zimroz, radoslaw.zimroz@pwr.edu.pl **dr inż. Anna.Nowak-Szpak**

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Zarządzanie Środowiskiem
Name in English: Environmental Management
Faculty of studies (if applicable): Mining and Geology
Specialisation (if applicable): Mining Engineering
Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Subject Type: Obligatory
Subject code: W06GIG-SM3001
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in the University (ZZU)	**30**				**15**
Number of hours of total student workload (CNPS)	**50**				**25**
Form of crediting	**Crediting with grade**				**Crediting with grade**
For a group of courses mark (X) for the final course					
Number of ECTS points	**2**				**1**
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BU) classes	**1,3**				**0,8**

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of issues related to ecology and environmental protection.

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SUBJECT OBJECTIVES

C1. To get students acquainted with systems of environmental management both in Poland and other EU countries.
C2. To prepare students for rational and sustainable management of environmental components.
C3. To get students acquainted with the genesis of environmental management systems in Poland, review and standardization of environmental management systems.
C4. To get students acquainted with benefits and obligations arising from the implementation of an environmental management system.
C5. To present the relationship between an environmental management system and a quality

management system.
C6. To provide an overview of informative methods of supporting the implementation of environmental management systems (possibilities and practical usage of computerised systems of environmental information management, decision support in the area of environmental protection and choice of methods and tools used to support the implementation of an environmental management system).

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 – Possesses systematic knowledge of the origins of environmental management systems, review and standardization of environmental management systems.
PEU_W02 - Possesses knowledge of the possibilities and practical applications of tools supporting the implementation of the environmental management system.
PEU_W03 - knows basic formal and legal regulations regarding the implementation and functioning of management systems, tools and instruments of environmental management.
PEU_W04 - Possesses knowledge for rational and sustainable management of environmental components.

relating to skills:
PEU_U01 – Possesses linguistic resources appropriate for specialised language and is able to use it in linguistic activities in order to communicate in the professional environment regarding the field of studies; is able to obtain necessary information and interpret and critically evaluate it, reads and understands professional literature, is able to formulate and comprehensively justify opinions, provide presentations of problems related to a studied discipline and also participate in scientific and professional discussions.
PEU_U02 – Is able to use methods and appropriate IT tools in system management of environmental components.

relating to social competencies:
PEU_K01 - Is able to think and act in a creative and enterprising way.

PROGRAMME CONTENT		
	Form of classes - lecture	**Number of hours**
Lec.1	Basic concepts: - Environment, characteristics of individual elements of the environment - Characteristics of hazards for the natural environment which are a result of human activities - Environmental Management - The Environmental Management System	2
Lec.2	Legal aspects of environmental management	2
Lec.3	History and development of environmental management systems	2
Lec.4 Lec.5 Lec.6	Environmental management systems: - Business Charter for Sustainable Development of the International Chamber of Commerce - ICC Business Charter for Sustainable	6

	Development - EMAS – Directive of the European Community Commission regarding the approval for voluntary participation by organisations in a community eco-management and eco-audit scheme - CP - Clean Production - BS 7750 - Specification for Environmental Management Systems - ISO 9000 - ISO 14000 - ISO 14001 Characteristics of selected Environmental Management Systems. The benefits of the implementation of the EMS for a company. Experiences of Polish enterprises from the implementation of EMS. Process of implementation of the selected EMS in a company with an example of EMAS.	
Lec.7 Lec.8	Basic tools of environmental management: - Legal and administrative instruments (laws, standards, licenses and permits) - Economic instruments (fees, taxes, deposit and refund systems, transferable rights, subsidies, liens, fines) - Instruments (techniques) social impact (ecological education, ecological propaganda) Examples of basic tools of environmental management: - Procedure for an assessment of environmental impact - Integrated permits - Audits - Safety Reports - Monitoring of the Environment	4
Lec.9 Lec.10	Design of an environmental management system	4
Lec.11 Lec.12	IT systems supporting environmental management: - Decision Support Systems - Expert systems - Simulation Models - Geographical Information Systems Selected types of information systems which support environmental management, their characteristics, examples of implementation both in Poland and in the world	4
Lec.13	The benefits of an implemented and functioning environmental management system	2
Lec.14	Costs of implementation and functioning of an environmental management system	1
Lec.14 Lec.15	Environmental management systems in practice	3
	Total hours	**30**

Form of classes - seminar		**Number of hours**
Se1	The scope and form of an essay and presentation, terms of crediting and literature.	2

	Assignment of seminar topics for individual students.	
Se2 Se3 Se4 Se5 Se6 Se7 Se8	Student speeches with the use of multimedia presentations on the following issues: environmental management systems - specified examples, formal and legal conditions of administrative procedures (eg. receiving a decision on the environmental conditions of a project, an integrated decision etc.), life-cycle analysis of a selected company; fees, taxes, surcharges and environmental deposits; litter management systems, mineral resource management, renewable energy sources, selected monitoring systems, the institution of environmental protection in Poland and in the world and also alternative energy sources, etc. Group discussion on the content and form of speeches.	13
	Total hours	**15**

TEACHING TOOLS USED
N1. Informative lecture with elements of problematic lectures. N2. Multimedia presentations N3. Didactic discussion during lectures and seminars N4. Preparation of an essay in the form of a report N5. Presentation of the essay N6. Consultations

EVALUATION OF SUBJECT EDUCATIONAL OUTCOME ACHIEVEMENTS

Evaluation F – forming (during semester), P – concluding (at semester end)	Educational outcome number	Method of evaluating educational outcome achievement
F1- Grade from content value of an essay	PEU_U01 PEU_U02 PEU_K01	Text and graphical form of essay
F2 – Grade from presentation and issues included in an essay	PEU_U01 PEU_U02 PEU_K01	Presentation of essay
F3 – Grade from a written or oral test	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Positive grade
final grade from the subject (the weighted average, respectively: 35% for the substantive content of the essay, 25% for the presentation, 40% for the lecture)		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Ejdys J.,1998, Zarządzanie środowiskowe w przedsiębiorstwie – koszty i korzyści, Sterowanie ekorozwojem, t.2, Wyd. Politechniki Białostockiej, Bialystok, [2] Lukasheh A. F., Droste R. L., Warith M. A., 2001, Review of Expert System (ES), Geographic Information System (GIS), Decision Support System (DSS), and their applications in landfill design and management. W: Waste Management & Research nr 19, [3] Łunarski J. (red.), 2002, Zarządzanie środowiskiem", Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszow [4] Nowak Z., 2001, Zarządzanie środowiskiem, Wyd. Politechniki Śląskiej, Gliwice, [5] Matuszak-Flejszman A., 2001: Jak skutecznie wdrożyć system zarządzania środowiskowego wg normy ISO 14001. PZIiTS, Poznan [6] Pochyluk R. i inni, 1999, Zasady wdrażania systemu zarządzania środowiskowego zgodnego z wymaganiami normy ISO 14001, Eco-Konsult, Gdansk, [7] Poskrobko B., Poskrobko T., 2012, Zarządzanie środowiskiem w Polsce, Polskie Wydawnictwo Ekonomiczne, Warsaw [8] Poskrobko B., 1998: Zarządzanie środowiskiem. Polskie Wydawnictwo Ekonomiczne, Warsaw [9] Przybyłowski P. (red.), 2005, Podstawy zarządzania środowiskowego, Wyd. Akademii Morskiej, Gdynia. **SECONDARY LITERATURE** [1] Jeżowski P. (red.), 2007: Ekonomiczne problemy ochrony środowiska i rozwoju zrównoważonego w XXI wieku. Szkoła Główna Handlowa, Warsaw [2] Lemański J. F., Matuszak-Flejszman A., Zabawa S. (red.), 2000: Efektywność funkcjonowania wdrożonego systemu zarządzania środowiskowego wg normy ISO 14001. PZIiTS, AE, Poznan – Pila [3] Websites given during lectures and seminars
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr hab. inż. Justyna Woźniak **Dr hab. Inz. Katarzyna Pactwa,** **Dr inż. Danuta Szyszka**

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish Bezpieczeństwo i higiena pracy
Name of subject in English: Occupational Health and Safety
Main field of study (if applicable): Górnictwo i geologia.
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Mineral Resource Exploration
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W06GIG-SM3005
Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			25	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	**1**			1	
including number of ECTS points for practical classes (P)				1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,7			0,8	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Possesses basic knowledge of technologies used in open-pit mines and underground mines.
2. Is able to use Microsoft Office environment to prepare documents in Word, multimedia presentations in Power Point and work with Excel spreadsheets.
3. Is able to identify harmful, dangerous and nuisance factors in the workplace environment.

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SUBJECT OBJECTIVES

C1. To introduce the principles of occupational risk assessment in accordance with relevant standards
C2 To present the principles of occupational risk assessment and the determination of admissibility with the use of STER software and the RISC SCORE method.

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 Possesses general knowledge of rules of occupational risk assessment formulation PEU_W02 – Possesses knowledge of evaluating and determining the admissibility of occupational risk. PEU _W0 3 – Possesses general knowledge of corrective and preventive actions regarding hazards of typical work posts in the mining industry.… relating to skills: PEU_U01 Is able to identify hazards of harmful, dangerous and nuisance factors of typical work posts in the mining industry PEU_U02 Is able to estimate and determine risk acceptability with methods according to STER software and the RISC SCORE method. PEU_U03 - Is able to plan corrective and preventive actions for hazards of typical work posts in the mining industry.… relating to social competences: PEU_K01 - Is able to work in a team and together complete occupational risk assessment and develop its results and the required documentation in the form of a team report

PROGRAMME CONTENT		
	Lecture	**Number of hours**
Lec 1	Definition of occupational risk. Legal basics of occupational risk assessment. Risk assessment methods. Course of occupational risk assessment. Information necessary for occupational risk assessment. Identification of harmful, dangerous and nuisance factors in the work environment.	3
Lec 2	Estimation of occupational risk assessment and determination of admissibility. Corrective and preventive actions. Familiarising employees with the results of occupational risk assessment. Implementation of agreed corrective and preventive actions. Monitoring the effectiveness of implemented actions. Periodic occupational risk assessment. Harmful factors – identification and assessment of risks.	3
Lec 3	Dangerous factors - identification and assessment of risks.	3
Lec 4	Nuisance factors in occupational risk assessment: psychological burden, static burden, monotype.	3
Lec 5	Methods of occupational risk assessment: STER software, the RISC SCORE method, written test	3
	Total hours	**15**

	Project	Number of hours
Pr1	Occupational risk assessment with the use of STER software for two work posts – description of work post, identification of hazards. Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of harmful factors (dust, noise)	3
Pr2	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of	3

	harmful factors (vibration, chemical agents)	
Pr3	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of dangerous factors (slippery or uneven surfaces, falling elements, moving parts, moving machinery and transported bimi items)	3
Pr4	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility for nuisance factors (psychological burden, static burden, monotype)	3
Pr 5	Occupational risk assessment for a selected work post with the use of the RISC SCORE method, presentation of executed exercises, test	3
	Suma godzin	**15**

TEACHING TOOLS USED
N1. Informative lecture with elements of problematic lectures. N2 Multimedia presentations. N3 Didactic discussions during lectures. N4 Didactic discussions during laboratory classes. N5Computer presentation of executed occupational risk assessments. N6Consultation.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01-W03	grade from a test
F2	PEU_W01-W03 PEU_U01- U03	grade from a presentation
P2	PEU_W01-W03 PEU_U01- U03	final grade from project classes (arithmetic average of F1 and F2)

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Occupational Safety and Health in Mining. Anthology on the situation in 16 mining countries. Ed.: Kaj Elgstrand and Eva Vingård. University of Gothenburg nr 2013;47(2) (gupea.ub.gu.se › bitstream › gupea_2077_32882_1)

[2] Boyle, Tony: Health and safety: Risk management. IOSH, 2001. (http://www.iosh.co.uk/index.cfm?go=publications.main)

[3] Encyclopaedia of occupational health and safety. Fourth edition Stellman, Jeanne M. (ed.). International Labour Organization, 1998 (http://www.ilo.org/public/english/support/publ/xtextre.htm#b103) http://www.ilo.org/public/english/support/publ/encyc/)

[4] McKeown, Céline; Twiss, Michael: Workplace ergonomics: A practical guide, IOSH, 2001, 160 p. http://www.iosh.co.uk/index.cfm?go=publications.main

SECONDARY LITERATURE: Handouts, articles
OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)
Dr inż. Żaklina Konopacka

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOIENGINEERING, MINING AND GEAOLOGY

SUBJECT CARD

Name in Polish: Modele Decyzyjne w Zarządzaniu
Name in English: Operations Research
Main field of study (if applicable): Mining and Geology
Specialization (if applicable): Mining Engineering,
Mineral Resource Exploration
Level and form of studies: 2nd, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3000
Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**15**		**15**		
Number of hours of total student workload (CNPS)	**25**		**50**		
Form of crediting	**crediting with grade**		**Crediting with grade**		
For group of courses mark (X) final course					
Number of ECTS points	1		**2**		
including number of ECTS points for practical (P) classes of practical character (P)			**2**		
including number of ECTS points for direct teacher-student contact (BU) classes	**0,8**		**0,7**		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The student has basic knowledge of mining systems, technological and organizational systems in mining
2. The student has basic knowledge concerning economics in mining
3. The student has basic knowledge concerning mathematical analysis necessary to understand mathematical issues in science having engineering and economic character.
4. The student has basic knowledge and skills of using probability theory models and mathematical statistics
5. The student can use Excel spreadsheet
6. The student understands the need and knows the possibilities of lifelong learning, improving professional, personal and social skills

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SUBJECT OBJECTIVES

C1 Acquiring basic knowledge, taking into consideration its applicational aspects concerning mathematical decision models used in management:

C1.1 Linear programming models

C1.2 Models of planning, deposits and costs of projects
C1.3 Queuing system models
C1.4 Digital simulation models

C2. Learning of qualitative understanding, interpretation and quantitative analysis with applications of selected issues concerning optimization
C2.1. Production systems:
C2.2. Transport issues
C2.3. Flows in networks.
C2.4. Project schedules
C2.5. Queuing system models

C3. Acquiring and consolidating the competencies of thinking and acting in a system way.

SUBJECT LEARNING OUTCOMES

Subject educational effect (knowledge)

PEU_W01 The student has knowledge concerning basic decision models in management
PEU_W02 The student has knowledge concerning line programming models.
PEU_W03 The student has knowledge concerning models for planning and monitoring of activities, deposits, and costs of projects
PEU_W04 The student has knowledge concerning queuing system models
PEU_W05 The student has knowledge concerning simulation models.

Subject educational effect (skills)

PEU_U01 The student has the ability to apply and interpret models using linear programming applications
PEU_U02 The student has the ability to apply and interpret models of planning and monitoring of activities, deposits, and costs of projects with the use of programming applications
PEU_U03 The student has the ability to apply and interpret queuing system models using programming applications
PEU_U04 The student has the ability to apply and interpret simulation models using programming applications

Subject educational effect (social)

PEU_K01 The student can think and act in a system, creative and enterprising way
PEU_K02 The student is able to identify and solve problems with the use of decision models and applications

PROGRAMME CONTENT

	Form of classes - lecture	Number of hours
Le1	Introduction to modelling systems	2
Le2	Linear programming issues - optimization of production	2
Le3	Linear programming issues - flow in networks optimization (optimal allocation issues, the issue of transportation, maximum flow, minimizing costs)	2
Le4	Projects scheduling using critical path	2
Le5	Planning and balancing of deposits in projects	2
Le6	Optimization issues of queuing systems	2
Le7	Monte Carlo methods and digital simulation	3
	Total hours	**15**

Form of classes - laboratory		Number of hours
La1	Defining and solving linear programming issues (Microsoft Excel-Solver)	2
La2	Production optimization (Microsoft Excel - Solver)	2
La3	Flows in networks optimization (Microsoft Excel - Solver)	2
La4	Projects scheduling (Microsoft Project)	2
La5	Planning and balancing of deposits in projects (Microsoft Project)	2
La6	Optimization issues of queuing systems (Microsoft Excel)	2
La7	Elements of Monte Carlo methods and digital simulation (Microsoft Excel)	3
	Total hours	**15**

TEACHING TOOLS USED

N1. Interactive lecture with slides and discussion
N2. Laboratory exercises with the use of IT applications - discussion concerning solutions
N3. Laboratory exercises - short written tests (calculating tasks, tests of knowledge)
N4. Duty hours
N5. Own work - preparation for laboratory classes, solving additional tasks
N6. Own work - own literature studies.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at the end of semester)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_U01-04	short written test.
PEU_U01-04 written test (counting exercise)		
PEU_W01-05; PEU_K01-02 Written test (knowledge test)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE

[1] Ignasiak E., Borucki W., Badania operacyjne, PWE, 2001
[2] Krawczyk S., Badania operacyjne dla menedżerów, PWE
[3] Baranowska B, Badania operacyjne w zarządzaniu, PWSBIA, 1996

SECONDARY LITERATURE

[1] Szapiro T., Decyzje menedżerskie z Excelem, PWE 2000
[2] Trzaskalik T., Modelowanie optymalizacyjne, Absolwent
[3] Trzaskalik T., Badania operacyjne z komputerem, PWE

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. Witold Kawalec
Dr hab. inż. Leszek Jurdziak
Dr inż. Zbigniew Krysa

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish … Zarządzanie projektami, ocena ich opłacalności i ryzyka..
Name of subject in English: Project Management, Appraisal and Risk Evaluation.
Main field of study (if applicable): Mining and Geology
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
…………………….. Mineral Resource Exploration
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code … W06GIG-SM3003G …………
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30	15	
Number of hours of total student workload (CNPS)	25		50	25	
Form of crediting	Examination				
For group of courses mark (X) final course	X				
Number of ECTS points	4				
including number of ECTS points for practical classes (P)	3				
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	3,1				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of basic mathematical analysis, probability and statistical models
2. Skills in using Excel spreadsheets
3. Understanding of the need of lifelong learning and the importance of application of Economics, Management and Social Sciences in engineering.

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SUBJECT OBJECTIVES

The course combines two groups of topics: basics of mineral economics and financial management and introduction to project management.
Part A: The purpose of the course is
C1 to introduce basic concepts of Microeconomics and financial management
C2 to introduce the concept of time value of money and present the methods used to evaluate investment projects. Different techniques are illustrated by examples and case studies. The range of application as well as the advantages and disadvantages of each method are discussed. The issues of inflation and risk analysis are included.

Part B:
C3 Introduction to project management basic concepts, methods and tools.
C4 Presentation of given project management areas: Project scope management, Project time management, Project cost management, Project risk management. Project planning, scheduling and control using Microsoft Project.
C5 Presentation of the issues of effective communication in project teams, group behaviour and leadership.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows the concepts of demand, supply and price elasticities, understands how they affect markets
PEU_W02 knows the concepts of costs in economics and accounting, understands how they differ
PEU_W03 knows the main cost categories and cost accounting methods
PEU_W04 has basic knowledge about the contents of financial statements
PEU_W05 has basic knowledge about the method of ratio analysis of financial statements
PEU_W06 knows and understands the concepts of Present Value and Future Value for simple cash flows and annuities.
PEU_W07 knows the capital budgeting methods (NPV, IRR, PBP) and understand how to interpret the results
PEU_W08 has basic knowledge about the project risk evaluation methods

relating to skills:

PEU_U01 is able to analyze the causes and effects of demand and supply changes
PEU_U02 is able to interpret and use information presented in financial statements also by means of ratio analysis
PEU_U03 is able to use different cost analysis methods and make decisions based on the rsults
PEU_U03 can calculate Future and Present value, also for annuities and solve simple calculation problems
PEU_U04 is able to perform discounted cash flow analysis and draw conclusions based on the results
PEU_U05 is able to carry out sensitivity analysis and scenario analysis using a financial model of an investment
PEU_U06 is able to work out basic project documentation and initiate a project
PEU_U07 is able to use basic methods of project management, monitoring and project risk management
PEU_U08 is able to implement basic conflict management methods in a project group
PEU_U09 is able to use basic group management methods, can undertake and shape the leadership position

relating to social competences:

PEU_K01 is able to think and act in a systematic, creative and entrepreneurial way
PEU_K02 has an established attitude of economic operation and decision-making based on available financial information and forecasts

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec.1	Supply and demand, equilibrium price, changes in demand and supply. Stock and commodity markets used by mineral industries	2
Lec.2	Costs in economics and in accounting. Cost and money outflow. Relevant cost, incremental cost, marginal cost, alternative cost. Short-term decision making.	2
Lec.3	Costs as the subject of cost accounting, different systems of cost accounting Different methods of cost data presentation (by types, divided into direct and indirect costs). Cost allocation	2
Lec.4	Variable and fixed costs. Break even point. Cost-volume –profit analysis.	1
Lec.5	Basics of financial accounting. Income statement and cash flow statement. Balance sheet. Working capital. Examples of financial statements of mining companies	2
Lec.6	Financial ratio analysis. Liquidity, profitability, activity and debt ratios. Financial and operating leverage.	2
Lec.7	The concept of time value of money. Computation of future and present value of money by means of spreadsheet functions. Basics of capital budgeting. Evaluation of different methods.	2
Lec.8	The concept of risk and return. Quantification of risk. Risk analysis in project evaluation: sensitivity analysis, scenario analysis, other methods.	2
	Total hours	15

Project		**Number of hours**
Pr 1	Issues of understanding communication: Definitions Models (Schramm model, Berlo's SMCR (source, message, channel, receiver) model, McCroskey model, Reusch and Bateson model, Westley-MacLean model)	3
Pr 2	Conflict Sources of conflicts Kilmann and Thomas classification of conflict Kilmann and Thomas test Different styles of conflict solving Roles of conflict in group development.	3
Pr3	Team roles Team roles Belbin perspective Discussion group roles Effective managerial behaviour in the context of team roles	3
Pr4	Leadership Hersey and Blanchard theory Black and Mouton approach to leadership Fiedler theory and his Least Preferred Coworker Scale Situational leadership self-assessment	3
Pr5	Summary;	3

	Effective managerial behaviour from the different contexts.	
	Total hours	15

Laboratory		Number of hours
Part A		
La1	Supply and Demand curves. Elasticity of demand.	2
La2	Economic costs. Cost curves. Profit maximization cases.	2
La3	Managerial cost accounting. Decision making cases.	2
La4	Basic financial accounting. Creation of simple Balance Sheet, Profit and Loss Statement and Cash Flow Statement	2
La5	Ratio analysis based on financial statements of companies	2
La6	Time value of money and capital budgeting – calculation by means of Excel functions	2
La7	Financial model of an investment. Sensitivity and Scenario analysis.	3
Part B		
La8	Basic concepts (process, project, project management, management by projects, critical factors for project success, competences). Preparing and initiation of the project. Project analysis (project environment, stakeholders, project objectives).	3
La9	Planning and estimating of the project. Project phases and life cycle	3
La10	Project organization. Project scope management. Planning of activities, resources and costs.	3
La11	Project risk management. Project monitoring. Project management methodologies.	3
La12	Quality management. Change control. Project closing.	3
	Suma godzin	**30**

TEACHING TOOLS USED
N1. Interactive lecture with the use of multimedia and discussion
N2. Laboratory classes: individual problem solving with the use of Excel spreadsheet
N3. Laboratory classes part B and project classes: case studies solving in groups and individually. Project presentations, discussion
N4. Consultation
N5. Self-study: solving assigned problems, literature studies

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01-W08 PEU_K01-K02	Assesment of student class activity
F2	PEU_U01-U10 PEU_K01-K02	Evaluation of student's assignements
P1	PEU_W01-W08 PEU_U01-U10 PEU_K01-K02	Written test

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: 1. Erhardt M., Brigham E.: Financial Management Theory and Practice. South-Western Cengage Learning, USA 2. Brigham E., Glapenski L.: Financial Management, 1997 3. Johnson H.: Making Capital Budgeting Decisions – Maximising the Value of the Firm. Financial Times/Prentice Hall (April 15, 1999) 4. Jonson H.: Strategic Capital Budgeting: Developing and Implementing the Corporate Capital Allocation Program, January 1994. 5. Lock Dennis, Project Management, Published April 11, 2013 by Routledge **SECONDARY LITERATURE:** 1. Jonson H.: Determining Cost of Capital: The Key to Firm Value. Apr 1999. 2. A Guide to Project Management Body of Knowledge (PMBOK®Guide Fourth Edition), Project Management Institute, 2008 (2004). wydanie polskie, MT&DC Warszawa, 2009 (2006) 3. Johnson H.: Global Financial Institutions and Markets. December 1999
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr inż. Gabriela Paszkowska, Gabriela.paszkowska@pwr.wroc.pl

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: ***Zasady i zastosowania InSAR oraz GIS w górnictwie***
Name in English: ***Principles and Application of InSAR and GIS in mining***
Main field of study: Mining and geology
Specialization: Geomatics for Mineral Resources Management
……………………….Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3007
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	Examination		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		
including number of ECTS points for practical (P) classes			3		
Including number of ECTS points for direct teacher-student contact (BU) classes	1,4		2,0		

*niepotrzebne skreślić

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of C ++ and Python programming language.
2. Basic knowledge of GIS functions and spatial data acquisition techniques
3. Ability to use GIS software package
4. Basic knowledge of databases

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SUBJECT OBJECTIVES

C1 Presentation of knowledge of satellite radar interferometry, as well as the possibility of using it in the ground deformation measurements.
C2 Acquiring the ability to determine surface displacements based on satellite radar data.
C3 Presentation of information on the use of GIS in advanced analysis of objects, phenomena and processes occurring in space.
C4 Acquiring the ability to formulate and solve tasks using GIS analytical functions.
C5 Acquiring skills to use spatial data and services in accordance with the INSPIRE Directive

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEK_W01 Has expanded knowledge in the field of using geoinformation systems to collect and process data used in modeling of both natural and anthropogenic phenomena and processes PEK_W02 Knows the principles of construction and functioning of geoinformation systems in the mining industry and public administration relating to skills: PEK_U01 has the ability to use advanced GIS tools in mining, studies of natural phenomena, the impact of mining on the environment and space development, PEK_U02 has the ability to formulate and solve spatial tasks in the GIS environment PEK_U03 has the ability to interpret the results obtained and draw conclusions relating to social competences: PEU_K01 has the ability to formulate and transfer knowledge on the use of geoinformation systems in spatial analysis and presentation of their results

PROGRAMME CONTENT		
	Lecture	**Number of hours**
Lec 1	Discussion of syllabus, requirements for passing the course, literature	2
Lec 2	Introduction to Microwave Signals for Earth Observation	2
Lec 3	Principles and Applications of Passive and Active Microwave Remote Sensing	2
Lec 4	Acquisition and processing of SAR data	2
Lec 5	SAR image theory (geometric properties, polarization)	2
Lec 6	Basics of SAR data calculation using the DInSAR and SBAS methods	2
Lec 7	Principlesand Applicationsof Interferometric SAR (monitoring surface activity, natural and anthropogenic phenomena)	2
Lec 8	Fundamental concepts of geographical information systems	2
Lec 9	Data modelling in GIS. Representation of spatial data. Spatial databases. Current status and development trends	2
Lec 10	Methods of spatial analysis in GIS	2
Lec 11	Spatial data interpolation	2
Lec 12	Map algebra. Surface analysis, local and zonal functions	2
Lec 13	Basics of spatial statistics	2
Lec 14	Spatial Information Infrastructure. Inspire Directive. Open Data	2
Lec 15	Examples of applications of geoinformation systems in mining and environmental protection	2
	Total hours	**30**

	Laboratory	Number of hours
La1	Configuration of the environment for SAR calculations	3
La2-3	Introduction to radar data calculations - calculation tasks	6
La4	Acquiring radar data and calculating the interferogram - DInSAR method	3
La5	Unwrapping of the interferometric phase - calculations	3
La6-7	Presentation of results in the GMT environment	6
La8	Discrete data interpolation. Preparation of input data for analysis (e.g. deformation measurements in the mining area)	3
La9	Discrete data interpolation. Development mining area terrain deformation maps with various interpolation methods.	3
La10	Discrete data interpolation. Analysis and assessment of the quality and uncertainty of interpolation. Prediction map. Development of maps of changes between two periods using a raster calculator.	3
La11	Spatial analysis - assessment of the suitability of the area for the location	3
La12	of mining operation. Construction of a database of spatial location criteria	3
La13	Spatial analysis - assessment of the suitability of the area for the location	3
La14	of mining operation. Selection of analytical procedures and conducting analytical operations.	3
La15	Spatial analysis - assessment of the suitability of the area for the location	3
	Total hours	**45**

TEACHING TOOLS USED
N1. Lectures N2. Multimedia presentations N3. Preparation of individual written term paper on a given topic N4. Multimedia materials (MOOC) N5. Laboratory instructions N6. Reports from laboratory exercises N7. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F1 Final mark for the written examination F2 Mark for the written report, P Final mark for the lecture (weighted average of F1 and F2, where F1 – 80% and F2 - 20%)
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F3 Mark for the written assignment reports F4 Mark from written tests, P2 Final mark for the laboratory (weighted average of F3 and F4, where F3 – 80% and F4 - 20%)

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. 2015: Geographic Information Science and Systems, 4th Edition, John Wiley & Sons; [2] Maguire D., Batty M., Goodchild M., 2005. GIS Spatial Analysis and Modelling. ESRI Press [3] Berry J., 2007-2013. Beyond Mapping IV — GIS Modelling [4] Satellite InSAR Data: Reservoir Monitoring from Space, A. Ferretti, EAGE; 1st edition, 2014 [5] GMTSAR: An InSAR Processing System Based on Generic Mapping Tools (Second Edition), D. Sandwell i in., Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, 2016 [6] InSAR Principles - Guidelines for SAR Interferometry Processing and Interpretation, ESA Publications, 2008 **SECONDARY LITERATURE:** [1] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) [2] Kennedy M., 2009: Introducing Geographic Information Systems with ArcGIS: A Workbook Approach to Learning GIS, Second Edition, John Wiley and Sons; [3] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. W., 2006. GIS. Teoria i praktyka. Wydawnictwo Naukowe PWN, Warszawa [4] Urbański J., 2010. GIS w badaniach przyrodniczych, Wydawnictwo Uniwersytetu Gdańskiego [5] Dokumentacja środowiska GMT (Generic Mapping Tools) - http://gmt.soest.hawaii.edu/projects/gmt/wiki/Documentation
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Wojciech Milczarek, wojciech.milczarek@pwr.edu.pl Jan Blachowski, jan.blachowski@pwr.edu.pl

Semester 2 and 3
UNI MISKOLC

Course descriptions – Earth Science Engineering MSc

Contents

Physical geology

Course Title: Physical geology	**ECTS: 4**
Type of course (C/E):	Course code: **MFFTT710001**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** During the semester the following tasks should be completed: students have to complete two field programmes: 1) studying sedimentary rocks, reporting in ppt presentations (15%), 2) studying magmatic rocks, Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **1**.	Pre-requisites *(if any)*: -
Course Description:	

Objectives of the course:
The main objectives of the course are deepening the students' abilities for geological interpretation, making them familiar with the reconstruction of rock-forming processes, introducing them to facial analysis and the stratigraphic methods.

Course content:
Fieldtrip, analysis of sedimentary formations
The formation and the inner structure of the Earth
Plate tectonic background of the geological processes
The role of physical geology in the geological exploration. Magmatic processes, their interpretation on field
Sedimentary processes, their interpretation on field
Fieldtrip, studying magmatic rocks
Metamorphic processes, their interpretation on field
Principles of stratigraphy, stratigraphic nomenclature
Stratotype, lito-, bio- and chronostratigraphy
Magneto-, chemo-, seismic, sequence, and cycle stratigraphy
Reconstruction of continental sedimentary environments
Reconstruction of marine sedimentary environments
Defining the succession of rock-forming processes and tectonic events

Teaching methodologies:
During the semester the following tasks should be completed: students have to complete two field programmes: 1) studying sedimentary rocks, reporting in ppt presentations (15%), 2) studying magmatic rocks,

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Sam J. Boggs: Principles of Sedimentology and Stratigraphy, Prentice Hall Publishing, 2011
Angela L. Coe: Field techniques. Wiley-Blackwell 2010
Gary Nichols: Sedimentology and Stratigraphy. Wiley-Blackwell, 2009

Competencies to evolve (relevant Learning outcomes, Appendix 1):

Knowledge: T1, T2, T3, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K9, K11, K12, K13
Attitudes:
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course gives the fundamentals to later specific geological courses. It introduces the basic concepts and skills necessary for interpreation of different geological processes.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by classworks as well as field works

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Hartai Éva foldshe@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Mineralogy and geochemistry

Course Title: Mineralogy and geochemistry	**ECTS: 4**
Type of course (C/E):	Course code: **MFFAT710005**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** The final grade will consist of two part. During the semester two midterm tests are written. The average of them will be the 50% of the final grade. The rest 50% is for the final exam. Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)	
Position in Curriculum (which semester): **1.**	Pre-requisites *(if any)*: -

Course Description:

<u>Objectives of the course</u>:
Students will get the knowledge of the principals of the distribution of chemical element in the Earth. They will also know the most important thermodynamic processes concerning solid materials, the geochemical classification of elements, the geochemical aspects of the genesis of the most important minerals and mineral assemblages. The geochemistry of isotopes, which explores the chemical evolution of the Earth will also be introduced, as well as the geochemical characteristics of water, organic matter, magmatic, sedimentary and metamorphic rocks by which we can describe the mineral-and rock-forming processes in the crust and mantle.

<u>Course content</u>:
Introduction; Hydrogen and alkaline metals
Alkaline earth metals
Boron, aluminium, carbon and silicon
Rare earth elements, titanium and zirconium
Uranium, thorium, vanadium, niobium and tantalum
Chromium, molybdenium and tungsten
Midterm test (1st); Manganese, iron, cobalt and nickel
Copper, gold, silver and platina group elements
Zinc, cadmium, mercury, gallium, indium and thallium
Tin, lead, arsenic, antimony and bismuth
Nitrogen, phosphorus and oxygen
Sulphur, selenium, tellurium, haloids and noble gases

<u>Teaching methodologies</u>:
The final grade will consist of two part. During the semester two midterm tests are written. The average of them will be the 50% of the final grade. The rest 50% is for the final exam.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Dill H.G. (2010): The „chessboard" classification schene of mineral deposits. Elsevier, 2010.
White, W. M. (2013): Geochemistry. Wiley-Blackwell.
Nordstrom D.K., Blowes D.W., Ptacek C.J. (2015): Hydrogeochemistry and microbiology of mine drainage: An update. Applied Geochemistry, Elsevier.
Albared, F. (2005): Geochemistry. An introduction. Cambridge Univ. Press.

Sarkar D., Datta R., Hanningan R.(2007): Concepts, and applications in environmental geochemistry, Elsevier.
John W. Anthony, Richard A. Bideaux, Kenneth W. Bladh, and Monte C. Nichols, Eds. (2003): Handbook of Mineralogy. Mineralogical Society of America.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T7
Skills: K1, K2
Attitudes: A1, A2, A9
Autonomy and responsibility: F2, F5

Demonstration of coherence of course content and unit's objectives:
This is a fundamental course, discussing systematic mineralogy and geochemical baskground of mineral formation processes

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by mineralogy laboratory work and geochemical modeling exercises

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Zajzon Norbert askzn@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*): **Móricz Ferenc**

Geophysical exploration methods I.

Course Title: Geophysical exploration methods I.	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT7100021**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** Attendance at lectures is regulated by the university code of education and examination. Three writing tests with satisfactory results, and two assignments during the semester is the requirement of signature. Grading scale: % value Grade 86 -100% 5 (excellent) 70 – 85% 4 (good) 60 - 69% 3 (satisfactory) 46 - 59% 2 (pass) 0 - 45% 1 (failed)	
Position in Curriculum (which semester): **1.**	Pre-requisites *(if any)*: -
Course Description:	

Objectives of the course:
Understanding the surface geophysical methods and the geophysical methods used in boreholes for the purpose that students can design and execute geophysical research and evaluate data.

Course content:
Classification of applied geophysics methods. Gravity methods: measured quantities, basic corrections and data processing methods. Filtering gravity maps.
Evaluation of measurement data for causative bodies with simple geometries. Geological and environmental geological applications. Magnetic methods: measured quantities, basic corrections and data processing methods.
Reducing magnetic data to the pole. Evaluation of measurement data for magnetizable bodies with simple geometries. Geological and environmental geological applications. The specific resistivity of rocks, the concept of apparent resistivity. Direct current geoelectric methods. VES and multi-electrode measurement methods. Introduction of electromagnetic methods.
Induced Polarization (IP) in the time domain (TDIP) and the frequency domain (FDIP). Types of electric polarizations creating the IP signal and their geological background. Frequency domain electromagnetic methods (FDEM): MT and VLF methods, artificial source frequency sounding methods: measurement systems, zones around the transmitter, characteristics of the apparent resistivity and phase curves.
Time-domain electromagnetic methods (TDEM): transient, IP and ground radar methods. The transient EM measurement system and the zones around the transmitter. In the case of electrical and electromagnetic methods, the possibilities of controlling the depth of penetration.
The development of seismic reflected waves. The travel-time curve and its characteristic parameters. Dynamic and static corrections. The common mid-point (CMP) gather. Features of seismic (TWT) sections.
Interpretation of seismic (2D and 3D) sections. Isochronal maps. Seismic stratigraphy. Vertical and horizontal resolution. Acoustic impedance, reflection and transmission coefficients. Possibilities of detecting gas reservoirs by seismic method. The bright spot.
The development of seismic refracted waves. The travel-time curve and its characteristic parameters. Processing and evaluation of refraction data. Near-surface applications. The relationship between the petrophysical properties of rocks and parameters measured by well logging methods.
Introduction to petrophysics. Reservoir modeling. The basics of nuclear well logging methods. Determination of lithology and porosity. Presentation of main application areas.

The basics of acoustic well logging methods. Determination of sonic porosity and permeability. Presentation of main application areas.
The basics of electric well logging methods. The relation between resistivity and water saturation. Presentation of main application areas.
Possibilities for joint processing of open-hole well logging data. Crossplot techniques. Statistical and depth-by-depth inversion methods.
Principle of engineering geophysical sounding measurements. Determination of petrophysical and geotechnical properties of soils/rocks.

Teaching methodologies:
Attendance at lectures is regulated by the university code of education and examination. Three writing tests with satisfactory results, and two assignments during the semester is the requirement of signature.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Telford W. M., Geldart L. P., Sheriff R. E., 1990. Applied geophysics. Second edition. Cambridge University Press.
Kearey P., Brooks M., Hill I., 2002. An Introduction to Geophysical Exploration. Third edition. Blackwell Science Ltd.
Serra O. & L., 2004. Well logging data acquisition and application, Editions Technip.
Szabó N. P., 2015. Geophysical exploration methods I. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/education.html
Szabó N. P., 2016. Well-logging methods. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/education.htmlScientific papers selected from geophysical journals, e.g., First Break, Near Surface Geophysics, Geophysics, Journal of Applied Geophysics etc.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K9, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course intruduces the principal theoretical background and practical skills to plan and perform geophysical explorations for different geological environments and deposit types

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the theoretical part, the students are introduced to different geophysical prospecting and exploration methods in practice.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Szabó Norbert Péter gfnmail@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Graduate research seminar

Course Title: Graduate research seminar	ECTS: 2
Type of course (C/E):	Course code: **MFFAT710006**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **0 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **P** During the semester the following tasks should be completed: short presentation of the selected topic, outline and references (20%), elaboration of the concept map of the article (20%), submission of first draft (15%), submission of the final text (20%), Grading scale: % value Grade 80 -100% 5 (excellent) 70 – 79% 4 (good) 60 - 69% 3 (satisfactory) 50 - 59% 2 (pass) 0 - 49% 1 (failed)	
Position in Curriculum (which semester): **1**.	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
To introduce the methods of information gathering and evaluation, formal and ethic requirements of scientific communication, rules for preparation of oral and poster presentations. During the course these general requirements are actualized to the field of earth science and engineering. Examples and excercises will use English publications and text materials.

Course content:
Editorial and formal requirements of scientific publications. Planning of the concept and structure of a scientific publication, making an outline, development of a concept map. Usage of references, reference styles. Etics of scientific writing: how to avoid plagiarism, usage of citations. Information sources provided by the Central Library: hard copy, catalogue search, electronic resources. Usage of electronic information resources: search options, simple and combined search, electronic libraries. Data visualization: graphs, figures, tables. The art of presentation: preparation for an oral contribution. The art of presentation: preparation of a poster.

Teaching methodologies:
During the semester the following tasks should be completed: short presentation of the selected topic, outline and references (20%), elaboration of the concept map of the article (20%), submission of first draft (15%), submission of the final text (20%),

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

L. C. Perelman, J. Paradis, and E. Barrett: The Mayfield Handbook of Technical and Scientific Writing (McGraw-Hill, 2001).
G. J. Alred, C. T. Brusaw, and W. E. Oliu: Handbook of Technical Writing, (St. Martin's, New York, 2003).
Hagan P; Mort P: Report writing guideline for mining entógineers. Mining Education Australia, 2014.
Chun-houh Chen, Wolfgang Härdle, Antony Unwin (eds.) Handbook of Data Visualization (Springer, 2008).
MEA Report writing guide. https://www.engineering.unsw.edu.au/mining-engineering/sites/mine/files/publications/MEA_ReportWritingGuide_eBook_2018ed.pdf
ISO 690-2: Information and documentation - Bibliographic references.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T5, T8, T12
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K10, K11
Attitudes: A2, A3, A4, A5, A6, A7, A8, A9
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
Students are introduced to the information sources available paper-based and electronically. They are also introduced to best practices on scientific writing, referencing and presentation techniques.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Completing a small research article and a presentation the students improve their knowledge in scientific communication. This is a learning by doing course, where one of the most important goals is to learn the proper way of scientific writing and referen

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Mádai Ferenc askmf@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Structural geology

Course Title: Structural geology	**ECTS: 4**
Type of course (C/E):	Course code: **MFFAT720020**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** Attendance at lectures is regulated by the university code of education and examination. Writing a test and constructing a geological profile at least on satisfactory level, respectively during the semester is the requirement of signature. The exam is ora Grading scale: % value Grade 86 -100% 5 (excellent) 70 – 85% 4 (good) 60 - 69% 3 (satisfactory) 46 - 59% 2 (pass) 0 - 45% 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	

Objectives of the course:
The course provides a background in the fundamentals of structural geology. It introduces the methods of interpreting structural observations and determining the 3-D distribution of the lithological units, the physical properties controlling the development of fractures, folds and other structural features. The course also introduces the students to building up, constructing and analysing spatial models.

Course content:
Theoretical backgrounds: basic terms of structural geology and tectonics. Techniques of data acquisition, recording and visualization. Stress and strain, deformation mechanisms, rheological models. Brittle and ductile features, their style and origin. Syngenetic structures and their role in further structural evolution. Plate tectonics and large scale structures. Characteristics of tectonic regimes. Practical exercises: use of tools to measure, demonstrate and analyze the structural data. Basics for constructing maps and cross sections.
Lecture: Basic terms; information on the interior of the Earth.
Practice: Use of geological maps; rules and geometrical basis of construction of cross sections.
Lecture: Structural features of the rocks, deformation, description of movements.
Practice: construction of cross sections.
Lecture: Stresses, mechanics.
Practice: construction of cross sections.
Lecture: Rheology and failure envelopes.
Practice: construction of cross sections.
Lecture: Mechanisms and features of brittle deformation. Practice: construction of cross sections with drill logs
Lecture: Mechanisms and features of ductile deformation
Practice: construction of cross sections with drill logs.
Field exercise: structural orientation measurements on folded and faulted rocks.
(The exercise is organised by exchange with the contact hours of another course, in 6 hours)
Practice: working with orientation data, stereograms.
Practice: working with orientation data, stereograms.
Practice: construction exercises.
Practice: construction exercises.

Teaching methodologies:
Attendance at lectures is regulated by the university code of education and examination. Writing a test and constructing a geological profile at least on satisfactory level, respectively during the semester is the requirement of signature. The exam is oral

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Twiss, R. J. & Moores, E. M: Structural Geology. Freeman & Co., New York, 1992, 532 p.
Ramsay, J. G. & Huber, M. I: The techniques of modern structural geology. Vol. 1: Strain Analysis. Academic Press, London, 1983, 1-308 p.
Ramsay, J. G. & Huber, M. I: The techniques of modern structural geology. Vol. 2: Folds and Fractures. Academic Press, London, 1987, 309-700 p.
Ramsay, J. G. & Lisle, R. J: The techniques of modern structural geology. Vol. 3: Applications of continuum mechanics in structural geology. Academic Press, London, 2000, 701-1062 p.
Twiss, R. J. & Moores, E. M: Tectonics. Freeman & Co., New York, 1995, 415 p.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K9, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
In the limited timeframes of the semester, the thematics includes all topics which belong to the structural geology on introductory level. It also provides a possibility to go deeper in some topics for those who have the appropriate basic knowledge alread

Demonstration of coherence between teaching methodologies and the learning outcomes:
The program is arranged with giving the theoretical and practical basics first and then going to the application of these basics by making field observations, measurements and then working with these data. The students have to be able to interpret the obs

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Németh Norbert foldnn@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Mineral deposits

Course Title: Mineral deposits	ECTS: 4
Type of course (C/E):	Course code: **MFFTT720021**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	

Type of Assessment (exam. / pr. mark. / other): **E**
Test about recognizing the different hand specimens of ores, raw materials (35%); Written test about the classification of ores with examples (65%).

Grading scale:

% value	Grade
80 -100%	5 (excellent)
70 – 79%	4 (good)
60 - 69%	3 (satisfactory)
50 - 59%	2 (pass)
0 - 49%	1 (failed)

Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
The key target of the course is to introduce the geology of raw material deposits, their spatial distribution, their quantity and quality for the different commodities.

Course content:
During the introduction the students get familiar with the different groups of commodities – ores, industrial minerals, solid fossil energy minerals, construction materials and their use and history. In the next period, the students will learn the ore forming geological processes and their appearances, which creates the different deposits. Also they will learn the genetic classification of the deposits with national and international examples. It prepares the students to be able to recognize the geological features of mineralizations, alterations and tectonic preformation. It covers all the important mines and ore districts in Europe and worldwide. During the laboratory classes the students can learn the natural occurrences of the ores, non-ores and industrial minerals. They will learn the physical and chemical properties, and texture of the different raw material types, and how to identify and distinguish them. To the proper use of geological maps and sections in 3D, the students will do exercises to develop their capabilities. During the related field trips the students will examine real deposits in the field.

Teaching methodologies:
Test about recognizing the different hand specimens of ores, raw materials (35%); Written test about the classification of ores with examples (65%).

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Robb, L., (2005): Introduction to Ore-Forming Processes: Blackwell Publishing Co., 373 p. (ISBN 0-632-06378-5).
EVANS, A. M. 1993: Ore Geology and Industrial Minerals – An Introduction. Blackwell Publishing, ISBN 978-0632-02953-2
CRAIG, J. R. & Vaughan, D. J. 1994: Ore Microscopy & Ore Petrography. John Wiley and Sons Inc. ISBN 10158-0012
Dill H.G. (2010): The „chessboard" classification scheme of mineral deposits. Elsevier, 2010.
Cox, D.P. Singer D.E. (1992): Mineral Deposit Models, U.S.G.S. Bulletin 1993.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
Students get familiar with the different groups of commodities – ores, industrial minerals, solid fossil energy minerals, construction materials and their use and history, as well as the ore forming geological processes and their appearances, genetic clas

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by laboratory classes where students analyze specimens from different deposit types. learn the natural occurrences of the ores, non-ores and industrial minerals. They will learn the physical and chemical properties, and te

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Zajzon Norbert askzn@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*): **Leskó Máté**

Engineering geology and hydrogeology

Course Title: Engineering geology and hydrogeology	**ECTS: 4**
Type of course (C/E):	Course code: **MFKHT720020**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** Participation in presentation lectures and practical classes is mandatory. Field trips and classroom calculations. The successful completion of the course is based on the successful completion of the semester test and the successful completion of the exam Grading scale: % value — Grade 85 -100% — 5 (excellent) 75 – 84% — 4 (good) 63 - 74% — 3 (satisfactory) 50 - 62% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2.**	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
It introduces students to the key concepts of engineering geology, modern hydrogeology, and field hydrogeology, soil formation, soil classification methods, laboratory and field soil tests, water-to-rock underwater stress, and groundwater flow patterns.

Course content:
Introduction to the examination of soil characteristics
Determination of shear strength parameters of soils
Soil consolidation
Shallow and deep foundation, the basics of EC7 design
The most important basics, problems and relationships of hydrogeology
Hydrogeological pools, flow systems, sustainability, artificial replenishment
Hydrogeochemistry, transport processes
Water management issues, particularly in cross-border areas
Hydrogeology of the Carpathian Basin
Isotope hydrogeology, use of stable isotopes to understand groundwater
Groundwater recharge and their interpretation
Well hydraulics calculations
Isotope hydrogeology, use of radioactive isotopes to understand groundwater

Teaching methodologies:
Participation in presentation lectures and practical classes is mandatory. Field trips and classroom calculations. The successful completion of the course is based on the successful completion of the semester test and the successful completion of the exam

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
David Daming: Introduction to Hydrogeology, McGraw-Hill Higher Education, 2002.
F. G. Bell: Engineering Geology, Oxford, Blackwell Scientific Publications, 1992
Dr. Juhász József: Hidrogeológia. Akadémiai kiadó, Budapest, 2002. Dr. Juhász József: Mérnökgeológia I-III. Miskolci Egyetemi Kiadó, 1999; 2002; 2003 Dr. Kleb Béla: Mérnökgeológia Budapest, 1980 David Daming: Introduction to Hydrogeology, McGraw-Hill Higher Education,

2002. F. G. Bell: Engineering Geology, Oxford, Blackwell Scientific Publications, 1992 S. E. Ingebritsen, W. E. Sanford: Groundwater in Geologic Processes. Cabridge University Press, 1998. Kruseman G.P. and Ridder N.A: Analysis and Evaluation of Pumping Test Data, ILRI publication, Wageningen, Netherlamds, 1990, pp. 1-377. Neven Kresic: Quantitative Solutions in Hydrogeology and Groundwater Modeling. Lewis Publishers, 1997. Barnes, C. W. (1988): Earth, Time and Life. John Wiley and Sons, New York Brookfield, M. (2006): Principles of Stratigraphy. Blackwell Publishing, New York

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K10, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course provides the theory and practical skills to understand the hydrogeological and engineering geological background for interpretation of different geological and geotechnical processes.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by laboratory classes where students perform calculations and modeling exercises of hydrogeological systems and geotechnical characterization of soils.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Szűcs Péter hgszucs@ui-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Analytical technics in mineralogy and petrology

Course Title: Analytical technics in mineralogy and petrology	**ECTS: 2**
Type of course (C/E):	Course code: **MFFAT720025**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **P** There are two written tests about the theoretical part (50% of the final grade). Both must be written to minimum 50%. Two laboratory report must be written about the individual work (50% of the final grade). Missing, or not passed tests can be completed a Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2.**	Pre-requisites *(if any)*: -
Course Description:	

Objectives of the course:
The key target of the course is to introduce the different analytical methods used in mineralogy and geology for the students. There are laboratory classes with individual work about the learned methods nearby the theoretical classes. Thru these exercises the students learn what is the best available method to answer certain geological questions.

Course content:
Description of the work, formulating analytical pairs, work and lab safety teaching
Physical properties (hardness, magnetic, solubility, density), density measurements
X-ray diffraction lecture I.
X-ray diffraction lecture II.
X-ray diffraction practice
DTA lecture
DTA quantitative calculations
Scanning electron microscopy lecture I.
Scanning electron microscopy lecture II.
Scanning electron microscopy practice
Formula calculations

Teaching methodologies:
There are two written tests about the theoretical part (50% of the final grade). Both must be written to minimum 50%. Two laboratory report must be written about the individual work (50% of the final grade). Missing, or not passed tests can be completed a

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

Reed SJB (2005): Electron Microprobe Analysis and Scanning Electron Microscopy in Geology. Cambridge University Press.
O'Donoghue M (2006): Gems: Their sources, descriptions and identification. Elsevier.
Pracejus B (2008): The ore minerals under the microscope: an optical guide. Elsevier.
Goldstein J et al. (2003): Scanning Electron Microscopy and X-ray Microanalysis. Kluwer Academic/Plenum Publishers.

King M. et al. (1993): Mineral Powder Diffraction File Search- and Databook. ICDD, USA.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
Lectures cover the theoretical fundamentals for different methods of analysis of minerals, which is essential basics for geological exploration tasks.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the introduction of different analytical methods, this is a learning by doing course where students go through the preparation, analysis and interpretation steps for various analytical techniques (XRPD, EPMA, SEM)

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Zajzon Norbert askzn@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geological interpretation and prospecting

Course Title: Geological interpretation and prospecting	**ECTS: 4**
Type of course (C/E):	Course code: **MFFAT730026**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	

Type of Assessment (exam. / pr. mark. / other): **E**
Participation in presentation lectures and practical classes is mandatory. Field trips and classroom exercises. The successful completion of the course is based on the successful completion of the semester test and the successful completion of the exam.

Grading scale:

% value	Grade
80 -100%	5 (excellent)
70 – 79%	4 (good)
60 - 69%	3 (satisfactory)
50 - 59%	2 (pass)
0 - 49%	1 (failed)

Position in Curriculum (which semester): **3.**	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
The main objective of this course is (1) to integrate all the information from the different applied survey methods to allw assessing the economic potential of mineral raw material occurrences, (2) to build capacity to use practical methods in mineral exploration, (3) to develop team working skills, (4) training of different exploration tasks in real field situations

Course content:
Introduction, objectives, team exercise information
Exploration methods, quality control and quality assurance
Project planning and scheduling
Resource estimation terminology and basic methods
Team exercise – Rudabánya and Martonyi geology
Geological models in interpretation
Overview of available statistical tools
Spatial distribution statistics – basic practices
JORC and NI43-101 reporting standards, exploration requirements
Introduction to Rockworks modelling
Team field exercise – Rudabanya sample Preparation, handling and storage
Team exercise –data harmoniztation with geophysics and geochemnistry
Presentation and discussion of team exercise project Rudabánya and Martonyi

Teaching methodologies:
Participation in presentation lectures and practical classes is mandatory. Field trips and classroom exercises. The successful completion of the course is based on the successful completion of the semester test and the successful completion of the exam.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Marjoriebanks R. 2010: Geological Methods in Minerals Exploration and Mining ISBN 978-3-540-74370-5 e-ISBN 978-3-540-74375-0
Sinclair A.J. and Blacwell G.H. 2002: Applied Mineral Inventory Estimation ISBN 0-511-03145-9 eBook Alastair J. Sinclair and Garston H. Blackwell 2004 2002

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T5, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K10, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course goes through the key points of performance and quality assurance of geological prospection and exploration tasks. This is a synthetizing course for the whole master programme.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the theoretical part, the students complete small projects about mineral resource assessment and a complex project where geological, geophysical and geochemical prospecting data should be interpreted.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Földessy János foldfj@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geophysical interpretation and prospecting

Course Title: Geophysical interpretation and prospecting	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT730025**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** During the semester the following tasks should be completed: presentation on a report covering the process from exploration planning to interpretation (60%), exam (40%) Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **3.**	Pre-requisites *(if any)*: -
Course Description:	

Objectives of the course:
In the scope of this subject students acquire knowledge about the closing phase of geological-geophysical exploration and study the linkage and hierarchy of different geophysical methods. They learn how to determine the most probable geological model by using geophysical measurement results and other geoscientific information jointly. They study the points of view of exploration and measurement planning related to the interpretation of data acquited

Course content:
Water exploration by geophysical methods: Some types of water aquifers. Simultaneous application of geoelectrical and IP methods. The use of frequency and time domain EM methods in water exploration. The role of GPR and surface nuclear magnetic resonance methods. The most important well logging methods and their interpretation. Case histories including water base protection. Coal, bauxite, uranium exploration: Coal formation, low-rank and high-rank coals. The physical parameters of different coal types. The use of surface geophysical methods, the adventages of underground exploration. In-seam seismic surveys, in mine geoelectrical methods. Well logging methods for coal qualification. Complex coal exploration case histories. Bauxite formation (carbonate, lateritic bauxite). The role of seismic refraction and VLF method in bauxite exploration. Well logging for quantitative interpretation and neutron activation analysis. The most important types of uranium deposits. The determination of K, U, Th content with (airborne, surface, borehole) NGS method. Rn measurement applied in U exploration. Geophysical methods in geothermal exploration: The types of heat propagation (conduction, convection), Fourier equations, Fourier-Kirchhoff equation, heat transport in porous, isotropic formation. Radioactive heat production. Heat flow maps and their interpretation.The depth dependence of heat flow and temperature for a continental and an oceanic crust. Mantle plumes and hot spots. The role of gravity, magnetic, EM methods in geothermal exploration and the application of passive and active seismic methods. Complex case histories in geothermal energy exploration. HC exploration: HC formation, the basic geological elements of a petroleum system. Different stages of HC exploration (lead, prospect, play). The role of gravity exploration (from the torsion balance invented by R. Eötvös till ROVdog seafloor gravity) measurements in the course of HC exploration including reservoir monitoring. The application of frequency domain EM methods (MT, CSAMT,CSEM, MCSEM). Simultaneous interpretation of marine controlled source electromagnetics and marine seismic reflection. Seismic reflection method for 1D, 2D and 2D situation. Corrections, migration process, VSP, time to depth transformation. The most important seismic attributes. Geological information can be gained based on seismic sequence analysis. Information can be gained from seismic data cube (time slice, horizon slice, etc.).

Interpretation of up-to-date open hole, cased hole logging data systems, the role of production logging. Complex HC exploration case history presented by a MOL expert

Teaching methodologies:
During the semester the following tasks should be completed: presentation on a report covering the process from exploration planning to interpretation (60%), exam (40%)

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Kearey P., Brooks M., Hill I.: An Introduction to Geophysical Exploration, Blackwell Publishing, 2002
Bacon M., Simm R., Redshaw T.: 3-D Seismic Interpretation, 2003
Serra O.: Well Logging and Reservoir Evaluation, 2007
Periodicals: Geophysical Transactions, The Leading Edge, First Break, etc.
Work-help tutorials, geophysical softwares

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T5, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K10, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course goes through the key points of performance and quality assurance of geophysica prospection and exploration tasks. This is a synthetizing course for the whole master programme.

Demonstration of coherence between teaching methodologies and the learning outcomes:
During the semester the students complete a project-based tasks based on geophysical exploration data and prepare presentations on relevant topics.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Takács Ernő**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Global environmental geophysics

Course Title: Global environmental geophysics	**ECTS: 2**
Type of course (C/E):	Course code: **MFGFT730027**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** attendance on the lectures and seminars and the solution of one personal task with presentation. Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	

Objectives of the course:
Training global environmental geophysics to a level that graduated engineers can begin to work in the field of general geophysics and maintain communication with colleagues working as experts in the field of global environmental geophysics.

Course content:
Solar System. Zonal interior of the Sun, radiochemical transformation in it, differential rotation of the Sun, its atmosphere with processes acting on the Earth. Physical and geometrical parameters of the Sun, solar cycles. Activity of geophysical and astronomical observatories. The classification of the planets of the Solar System. The main physical, chemical and geometrical parameters of the planets. The gravitational and magnetic field of the planets. The main features of the magnetosphere of the Earth, characterization of ionosphere. Magnetic field's reversal. Different types of remanent magnetization. Composition of the Earth' interior based on seismic tomography, the most significant boundaries. Visiting Kövesligethy Radó Seismological Observatory. The zonal composition of the Earth, characterization of the zones, putting emphasis on mantle convection, liquid and solid core. Radiometric dating methods, their reliability. Radioactive heat production. Heat flux map of the Earth. Hot spots, mantle plums. Viscosity, temperature, elastic waves velocity and density in the function of depth. Focal depth determination. Magnitude definitions, energy released, intensity. Focal mechanism based on first motion studies using focal spheres. Connection between plate tectonics and earthquake mechanism. Applied monitoring technologies by CTBTO for detecting nuclear explosion. Student's .ppt presentations, questions, evaluation.

Teaching methodologies:
attendance on the lectures and seminars and the solution of one personal task with presentation.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Frank Stacey & Paul Davis: Physics of the Earth. Cambridge Univ. Press, 4. edition 2008. ISBN-10: 0521873622
William Lowrie: Fundamentals of Geophysics 2nd edition, Cambridge Univ. Press. 2007. ISBN- 13 978-0-521-85902-8
http://www.uni-miskolc.hu/~geofiz/PG_GlobenvGeophysics.pdf
https://www.ctbto.org/verification-regime/monitoring-technologies-how-they-work/

Competencies to evolve (relevant Learning outcomes, Appendix 1):

Knowledge: T1, T2, T3, T4, T5, T6, T7, T8, T9
Skills: K1, K2, K3, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course gives detailed theoretical background to understand large-scale, global geophysical processes and their invesitgation.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by individual task which the student should elaborate and present during the semester

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Pethő Gábor , private professor gfpg@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geoelectric lectureship

Course Title: Geoelectric lectureship	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT730031**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** attendance on the seminars and solution of one personal task with presentation. Grading scale: % value — Grade 86 -100% — 5 (excellent) 71 – 85% — 4 (good) 61 - 70% — 3 (satisfactory) 46 - 60% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **3**.	Pre-requisites *(if any)*: -
Course Description:	

Objectives of the course:
System of electrical and electromagnetic geophysical methods. Physical basics of direct current (DC) geoelectric methods. Solution of the Laplace equation in layered homogeneous isotropic half space. The geological information content and calculation of the kernel function. Hankel and the Inverse Hankel transformation. Physical basics of alternating current (AC) electromagnetic methods. Derivation of telegraph and wave equations. Information content of the wave number. Wavelength, penetration depth and propagation speed of electromagnetic waves. Characterization of dielectric, lossy and good conducting media. The zones formed around the electric and magnetic dipoles and the phase surfaces of the electromagnetic fields in the various zones. Electromagnetic field calculation of the horizontal electric dipole source in inhomogeneous anisotropic media. Electromagnetic field calculation of the vertical magnetic dipole source in inhomogeneous anisotropic media. Presentation of reports.

Course content:
System of electrical and electromagnetic geophysical methods.
Physical basics of direct current (DC) geoelectric methods. Solution of the Laplace equation in a layered homogeneous isotropic half space.
The geological information content and calculation of the kernel function.
The Hankel and the Inverse Hankel transformation.
Physical basics of alternating current (AC) electromagnetic methods.
Derivation of telegraph and wave equations.
Information content of the wave number.
Wavelength, penetration depth and propagation speed of electromagnetic waves.
Characterization of dielectric, lossy and good conducting media.
The zones formed around the electric and magnetic dipoles and the phase surfaces of the electromagnetic fields in the various zones.
Electromagnetic field calculation of the horizontal electric dipole source in inhomogeneous anisotropic media.
Electromagnetic field calculation of the vertical magnetic dipole source in inhomogeneous anisotropic media.
Presentation of reports and semester closing.

Teaching methodologies:
attendance on the seminars and solution of one personal task with presentation.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

Kearey, P., Brooks, M., Hill I., 2002: An introduction to geophysical exploration, Blackwell Science Ltd., ISBN 0-632-04929-4
Keller, G. W., Frischknecht F. C.: Electrical Methods in Geophysical Prospecting, Pergamon Press, Oxford, 1966.
Sumner, J. S.: Principles of Induced Polarization for Geophysical Exploration, Elsevier Scientific Publishing Company, Amsterdam, 1976.
Telford W. M., Geldart L. P., Sheriff R. E., 1990: Applied Geophysics. 2nd Edition. Cambridge University Press, ISBN: 0 521 32693 1
Wait, J. R.: Overvoltage Research and Geophysical Applications, Pergamon Press, London, 1959.
Periodicals: Geophysical Transactions, First Break, etc.
Other educational materials and study aids on the web page of Geophysical Department: http://www.uni-miskolc.hu/~geofiz

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge:
Skills:
Attitudes:
Autonomy and responsibility:

Demonstration of coherence of course content and unit's objectives:
Geoelectric lectureship is an elective subject in the geophysical engineering specialization of the Earth Science Engineering Master Program. The main goal of the specialization is to train engineers who, by developing geophysical methods and applying the

Demonstration of coherence between teaching methodologies and the learning outcomes:
The lectures of the course introduce in detail the methods included in the curriculum and their geological and mathematical-physical descriptions. In practice, students become familiar with and apply each method during field measurements. Each student ela

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Turai Endre, gfturai@gold.uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geological mapping

Course Title: Geological mapping	**ECTS: 4**
Type of course (C/E):	Course code: **MFFTT720029**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **practical mark** Criterion for signature: Preparation of two geological cross-sections based on real Carpathian geological maps (from Slovakia and Romania); Preparation of covered and uncovered (without Quaternary deposits) geological map of an about 2 sq. km territory (i Grading scale: % value — Grade 90 -100% — 5 (excellent) 75 – 89% — 4 (good) 60 - 74% — 3 (satisfactory) 45 - 59% — 2 (pass) 0 - 44% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: The subject gives knowledge on the figuration of geological phenomena on topographic maps, on preparing geological maps, cross-sections, their legend and on assembling explanatory report **Course content:** The aim of preparing geological maps. The geological map and its additional parts (geological cross-sections, stratigraphical columns and legend). Geological phenomena figured in the geological maps: lithostratigraphical units, structural chacteristics. Different types of geological boundaries and their recognition on the field. Orientation on the field with topographical map and with GPS. Documentation of field observations in the field booklet and on the topographical map. Preparation of geological cross-sections. Preparation of covered and uncovered (without Quaternary deposits) geological maps with stratigraphical column and legend. Assembly of explanatory reports **Teaching methodologies:** Criterion for signature: Preparation of two geological cross-sections based on real Carpathian geological maps (from Slovakia and Romania); Preparation of covered and uncovered (without Quaternary deposits) geological map of an about 2 sq. km territory (i	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Tearprock, D.J. & Bischke, R.E. (2002): Applied Subsurface Geological Mapping with Structural Methods 2nd Edition, 846 p., Prentice Hall Hamilton, D.E. & Jones, T.A.: Computer modeling of geological surfaces and volumes. – AAPG Computer applications in geology. No.1., 589 p. Tulsa, Oklahoma McClay, K. (1995): The mapping of Geological Structures. Geolog. Soc. of London Handbook. John Wiley Sons, Chichester, New York, Brisbane, Toronto, Singapore. SURFER 8.0 Tutorial and User's Guide. - Golden Software. P512 . Denver	
Competencies to evolve (relevant Learning outcomes, Appendix 1): Knowledge: T1, T2, T3, T4, T5, T7, T8, T9	

Skills: K1, K2, K3, K5, K6, K7, K9, K11, K12, K13 Attitudes: A1, A2, A3, A4, A5, A7 Autonomy and responsibility: F1, F2, F3, F4, F5 **Demonstration of coherence of course content and unit's objectives:** Theoretical part and laboratory exercisis givesan overview to the students about methodology and tools of geological mapping works. **Demonstration of coherence between teaching methodologies and the learning outcomes:** After giving the theoretical basis of mapping methodology, this is a learning by doing course, where the students should compete geological mapping work in the Bükk mountains
Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Less György, full professor foldlgy@uni-miskolc.hu**
Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Sedimentology

Geochemical prospecting methods

Course Title: Geochemical prospecting methods	**ECTS: 4**
Type of course (C/E):	Course code: **MFFAT720031**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **practical mark** completion of three exercises during the semester and participation in a 2-3 days field trip and completion of a sampling plan based on the field trip Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2.**	Pre-requisites *(if any)*: -
Course Description:	

Objectives of the course:
Introduction into a basic area of mineral exploration methods, including the theorethical background of geochemical sampling, the detailed discussion of different sampling and analytical methods, as well as the methods of data processing and interpretation. Completion of a geochemical exploration project, including field sampling, sample preparation, data processing and interpretation is an important part of the course.

Course content:
Geochemical distribution of chemical elements in different rock types,
Periodic table for geochemists
Concept of the geochemical background.
Geochemical delineation of a mineralization, a mineral deposit.
Primary dispersion, methods of its exploration.
Geochemical aspects of weathering.
Geochemistry of the surface environment.
Sorption processes
Secondary dispersion and methods of its exploration.
Sampling methods, sampling standards.
Soil surveys, vegetation and water surveys.
Stream sediment sampling methods, heavy minerals geochemistry.
Major analytical methods.
Data processing and statistical methods.

Teaching methodologies:
completion of three exercises during the semester and participation in a 2-3 days field trip and completion of a sampling plan based on the field trip

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Reedman J.H.: Techniques in mineral exploration (Appl. Sci. Publ. London, 1979)
Kuzvart M. & Böhmer M.: Prospecting and exploration of mineral deposits (Elsevier, 1986)
Wite W.M. (2007): Geochemistry. Online textbook, (John Hopkins University, 2007)

Hawkes H.E.: Principles of geochemical prospecting. (US DOE, Geological survey bulletin 1000-F)
Geboj N.J.; Engle E.A. (2011): Quality Assurance and Quality Control of Geochemical Data: A Primer for the Research Scientist (USGS Open-File Report 2011–1187)
Sarkar D., Datta R., Hannigan R.: Concepts and applications in environmental geochemistry. (Elsevier, 2007)

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T5, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course content introduces the fundamental parameters of the near-surface geochemical system as well as practical skills to plan, organize, perform a geochemical prospecting campaign and interpret the resulting dataset.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Students shall understand the interrelationship between different elements of the near-surface geochemical system. Practical skills are developed by a project-like exercise to compile a geochemical prospecting sampling plan of an ore field.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Mádai Ferenc, associate professor askmf@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Non-metallic industrial minerals

Course Title: Non-metallic industrial minerals	**ECTS: 4**
Type of course (C/E):	Course code: **MFFTT730030**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 2 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Lectures with .ppt presentation, laboratory exercises for sample and specimen preparation, fieldtrips, methods for data validation and documentation. Short written test. Individual data research + presentation (60-40%) in an assay. Oral examination Grading scale: % value — Grade 90 -100% — 5 (excellent) 76 – 89% — 4 (good) 60 - 75% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **3.**	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
The course will allow students to gather knowledge on the non-metallic mineral resources, geological characteristics of the deposits, type and mode of the accumulations, spatial distribution and quality-quantity data of the mineral types, technological requirements, exploration, exploitation and beneficiation techniques

Course content:
The introductory part is a short review on the geological settings and related petrological-geochemical knowledge, related non-metallic resources, industrial mineral groups. The first part dissects the grouping on genetical and industrial-application point of view mineral resources. During the semester detailed knowledge is offered on 1) native element, 2) sulphide, 3) halogenide, 4) oxide/hydroxide, 5) carbonate/nitrate, 6) borate, 7) sulphate, 8) phosphate and 9) silicate types of industrial minerals. Students get familiar with their mineralogy, deposits and formation, extraction and uses based on detailed international data. We also study the rock type industrial minerals, their generating and applications. In the case of silicates emphasis is put on clay minerals, feldspars and zeolites. Separate lecture+laboratory visit discusses the exploitation and beneficiation techniques. During the laboratory exercises and field trips students learn to recognize industrial minerals, to give mineralogical characterization, exploration and quality remarks, their natural types of occurrence.

Teaching methodologies:
Lectures with .ppt presentation, laboratory exercises for sample and specimen preparation, fieldtrips, methods for data validation and documentation. Short written test. Individual data research + presentation (60-40%) in an assay. Oral examination

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

EVANS A.M. (1993) Ore Geology and Industrial Minerals: an Introduction. Blackwell Publishing, 379 p ISBN 978-0-632-02953-2
Ciulo P. A. (1996) Industrial minerals and their uses. Noyes Publication, New Jersey, 607 p
https://minerals.usgs.gov/minerals/pubs/myb.html
https://www.ima-europe.eu/

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T5, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
Students get familiar with their mineralogy, deposits and formation, extraction and uses based on detailed international data. We also study the rock type industrial minerals, their generating and applications. In the case of silicates emphasis is put on

Demonstration of coherence between teaching methodologies and the learning outcomes:
Field trips and individual exercises enhance the skills of the student and to understand the genetic conditions of formation of non-metallic depostis. During the laboratory exercises and field trips students learn to recognize industrial minerals, to give

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Kristály Ferenc, professor emeritus askkf@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

List of competences

a) Knowledge

T1 - Understands the processes described by the general and specific theories required for the practicising of the fields of earth science engineering (geologist-engineering, geophysical-engineering, geoinformatics-engineering), understands the internal connections between geological processes, and knows the planning and interpretation procedures based on the processes.
T2 - Has a solid technical and scientific knowledge required for the high-level progress in earth sciences engineering disciplines, among others in numerical methods, technical physics and their contexts.
T3 - Based on his/her knowledge, understands the structure of the raw material extraction sector, the technologies used for the extraction and preparation of mineral raw materials, as well as the scope of geo-environmental tasks, their external socio-economic environment and regulatory system.
T4 - Has a thorough knowledge and understanding of the best practices applied to earth science engineering tasks and the long-term development directions that can be expected in this field in the medium term.
T5 - Knows the problem-solving (research-planning and management) techniques of best available practices in earth sciences.
T6 - At the application level, knows the GIS methods of computer design and analysis and the geoinformatics systems.
T7 - Knows in detail the geological and geophysical methods suitable for exploring natural resources.
T8 - Has a well-established knowledge of the methods of exploring mineral deposits.
T9 - Has detailed knowledge and sound application practice on the methods of knowledge acquisition and data collection in the technical earth sciences, and on their instrumental measurement and IT data processing procedures.
T10 - Has a well-established knowledge of the legal, economic, administrative, safety, work and fire protection, information technology and environmental protection fields related to the fields of earth science engineering.

b) Skills

K1- Able to apply general and specific basic and applied scientific theories within the technical earth sciences, able to systematize them, to solve independent engineering tasks (mainly complex geological prospecting, final report summarizing exploration results, geological-geophysical parts of environmental impact assessments).
K2 - Able to convey knowledge authentically by preparing presentations and written documents in Hungarian or in a foreign language.
K3 - Able to perform complex planning, construction, inspection and official licensing tasks (geological-geophysical exploration plans of natural resources, acquisition of environmental geology) with the innovative application of theories and terminology describing technical earth science knowledge.
K4 - Able to review legal and economic knowledge and activities related to technical earth science tasks, to optimize connections.
K5 - Able to actively cooperate with, organize, manage, and supervise larger and more complex activities based on or incorporating technical earth science tasks (especially mining, environmental technology investments, operations).
K6 - Uses modern information acquisition and data collection methods.
K7 - Able to solve technical problems requiring innovative skills in theory and practice (especially field, surface, underground data collection, measurements, and their processing and interpretation requiring innovative skills).
K8 - Able to process raw material exploration and production data and organize it into geoinformatics databases (systems).
K9 - Able to prospect and explore geological structures, to plan these research phases.
K10 - Able to take quantitative and qualitative assessment of mineral resources, to evaluate their economics, to compile concession tenders and to give opinions on this type of report.
K11- Able to contribute to the solution of geological-geophysical tasks arising during the extraction of mineral raw materials (planning, investment, operation, closure) and to analyze the solution possibilities.

K12 - Able to review the structure of the raw materials extraction sector, the technologies used for the extraction and processing of mineral raw materials, as well as the scope of geo-environmental tasks, their external socio-economic environment and regulatory system.
K13 - Able to organize cooperation with related disciplines and manage the (working) group within the framework of larger and more complex activities based on or incorporating technical earth science tasks.

c) Competence in terms of attitude

A1 - Open and receptive to the knowledge and acceptance of professional and technological methodological developments in the fields of technical earth sciences, to the acquisition of their management, and to the participation in their development.
A2 - Actively applies innovative skills and knowledge in solving professional problems in the fields of earth science engineering.
A3 - Commits and convincingly demonstrates to knowing and adhering to the professional and ethical values.
A4 - Professionalism and professional solidarity have deepened.
A5 - Respects and follows the ethical principles and written rules of work and professional culture in activities, and is able to follow them even when managing small workgroups.
A6 - In the course of professional work, observes and adheres to the requirements of safety, health, environmental protection and quality assurance and control (SHE and QA / QC).
A7 - Has a sufficient motivation to carry out activities in often changing working, geographical and cultural circumstances.

(d) Competence in terms of autonomy and responsibility

F1 - With the in-depth knowledge of the received strategic guidelines and external environmental requirements, is able to plan the work independently, and is also suitable to lead workgroups.
F2 - Takes responsibility and is accountable for the work processes carried out under his / her control, for the employees working in them.
F3 - Makes decisions carefully, in consultation with representatives of other disciplines (primarily legal, economic, and environmental), independently, takes responsibility for decisions.
F4 - In addition to constructive teamwork, is an autonomous specialist capable of making professional decisions in the field of operation entrusted to him/her.
F5 - Committed to the practice of sustainable natural resource management, occupational health and safety

Semester 4
WUST

<table>
<tr><td>Course title</td><td colspan="6">Applied field exploration</td></tr>
<tr><td>European Credits (ECTS)</td><td colspan="2">3</td><td colspan="2">Time (hours) given to the students</td><td colspan="2">45</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td colspan="2">Lectures: , Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: , Seminar classes: , Fieldwork: 3</td><td colspan="2">Student whole working time (hours)</td><td colspan="2">75</td></tr>
<tr><td>Description of content</td><td colspan="6">The goal of the course is that students should acquire a hands-on understanding of different field exploration methodologies, and how they can be integrated for targeting VMS deposits.
Geological, geophysical and geochemical exploration methods in VMS exploration. Practical field mapping exercises in structural geology, stratigraphy, hydrothermal alteration. Practical geophysical surveying using UAV technology. GIS-based data synthesis for exploration target selection. Drill core logging and assaying.</td></tr>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="6">Knowledge: when passed the student is expected to have:
-knowledge about different field methods and their use during an exploration program.
-knowledge about drilling and sampling methods.
-knowledge about different methods for field mapping.
Skills: when passed the student is expected to have the ability to
- acquire in-depth structural, volcanological and alteration data from outcrops in the field
- contextualize field observations in relation to ore genetic model for VMS deposits.
- synthesize different types of geological and geophysical data for targeting a VMS deposit.
Competences: ,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">Exercises U G# 1.20
Project work G U 3 4 5 1.80
The course is mainly presented via practicals in the field, but also with complementary lectures and excercises, in addition to project work.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">Online compendium in Canvas room</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Nils Jansson, Nils.Jansson@ltu.se</td></tr>
<tr><td rowspan="2">Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Justification for OLO contribution	

Course title	**SOC Internship**		
European Credits (ECTS)	2	**Time (hours) given to the students**	30
Type (Lecture, internship, exercise etc.)	Lectures:, Auditorium classes: , Lab. Classes: , Project classes: 2 , Practical classes:, Seminar classes: , Fieldwork: x	**Student whole working time (hours)**	50
Description of content	The aim of the course is to enable students to work in socially responsible workplaces, and apply their skills and knowledge to promote social good. While this develops them to become work-ready professionals, it also nurtures them to become advocates who help build a better world. EDUCATIONAL GOALS: 1. To actively participate in the affairs of the community and in concrete actions on the ground that aim to promote the public interest, equality and solidarity. 2. To reflect on social license to operate issues 3. To work in direct contact with the beneficiaries of the civic activities undertaken e.g.: reception, facilitation, support, social assistance, etc. EXAMPLES OF SOCIAL AND CIVIC ISSUES IN MINERALS INDUSTRIES: • Depletion of natural capital (degradation of air, land and water quality), land use conflicts, health impacts • Digitalization and automation generate particular challenges for well-being in mining regions. Limited job opportunities for local workforce and skills mismatches. • High and continuous transparency and accountability standards of the industry, effective methods of information sharing and dialogue • A more equitable value-sharing, Corporate Social Responsibility issues • Facilitation of environmental awareness • Preservation and restoring of historic sites,		
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: to understand that social responsibility incorporates an ethical, social and environmentally-friendly perspective to our personal and professional activities Skills: To be able to engage in an informal professional discussion and business communication Competences: To cope with complexity, uncertainty and change in global contexts		

Assessment methods and criteria	Criterion: Submission of a project report					
Recommended readings						
TU Coordinator	Supervisors of the student’s Master thesis					
Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
	Students will be engaged in professional discussion and business communication				Students will be able to understand that social responsibility incorporates an ethical, social and environmentally-friendly perspective to our personal and professional activities	
Justification for OLO contribution						

<table>
<tr><td>Course title</td><td colspan="3">Exploration entrepreneurship</td></tr>
<tr><td>European Credits (ECTS)</td><td>4</td><td>Time (hours) given to the students</td><td>60</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td>Lectures: 1, Auditorium classes: , Lab. Classes: , Project classes: 1, Practical classes: 3, Seminar classes: 2, Fieldwork:</td><td>Student whole working time (hours)</td><td>100</td></tr>
<tr><td>Description of content</td><td colspan="3">To equip students with the professional skills to increase their employability and entrepreneurship skills to meet the current market demands. The EFGeoMentoring scheme aims at improving international networking and supporting the life-long learning and CPD requirements of experienced geology professionals. In addition, it allows students to benefit from insider knowledge about international work perspectives in different sectors of geological profession and countries.
Mentoring within the course is a process during which an experienced professional with and EurGeol title (mentor) accompanies the student in a targeted way. Mentoring contributes to developing personal, entrepreneurial, networking, social and professional skills regarding the mineral prospecting and exploration activity. It allows learning from professional experiences that can only be acquired through practice and can't be found in any textbook. Mentoring improves the opportunities of career beginners by providing career-enhancing contacts and involvement in professional networks.
At the beginning of the mentoring cooperation, students formulate clear goals and communicate them to their mentor. In consultation with the mentor, concrete topics and the respective roles within the mentoring process will be defined. Since the student is at the centre of the process, it is their task to become aware of their own plans and their support needs.
OBJECTIVES OF THE MODULE:
Intensify international networking among geologists all across Europe and beyond
Provide young professionals with contacts helping them to think through, plan and access their short, medium or long-term career development
Contribute on internship positions
Improve gender balance and increase diversity in leadership positions by providing targeted support to women and under-represented minorities
Facilitate life-long learning and Continuing Professional Development (CPD)
The EFG mentors are professionals who have acquired a high level of industrial and/or academic experience and work in industrial practice, business, academia, education or administration.
Coaching: The mentor actively guides and encourages the student to develop essential skills and attitudes for the future ("How do I assert myself? How do I behave in negotiations? What do I do in challenging work contexts?")
Advice: The mentor advises the student in concrete situations, in current questions and difficulties. Mentors support students in solving problems and assist them in making tough decisions.</td></tr>
</table>

	• **Help:** The mentor can help open otherwise locked doors that allow the student to pursue their goals. • **Support:** The mentor supports the student in essential decisions without deciding. Mentors assist in the development of professional strategies, as well as in career planning and review of possible obstacles. • **Inform:** The mentor informs the student about (informal) rules and processes applied in organisations or professional life in general. According to the student's background, mentors can also inform about seminars or conferences that they consider helpful. • **Participation:** Mentors allow students to participate in parts of their professional career, experiences and strategic decisions. They allow students to share their professional life and invite them, for instance, to participate in meetings or appointments. • **Give feedback:** Mentor and student provide each other with constructive feedback about their appearance and public perception. • **Networking:** Mentors give the students hints on maintaining and using contacts. They introduce the students into active networks and provide professional contacts. The mentor provides the student with the chance to create a successful CV and take a chance on social networks such as LinkedIn.
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: to provide background training to support the learning process; make students aware of broad professional issues; provide business and entrepreneurship skills to develop an awareness of business management and commercial practices regarding mineral prospecting and exploration. Skills: Develop relationships with other persons and maintain them. Can talk frankly about his ideas, fears and weaknesses. Identifying investment opportunities in the mineral resources sector. Competences: To define professional targets, wants to succeed and is actively committed to implementing these targets. Not afraid of making mistakes and experimenting with new ideas. Willing to question himself critically, accept external advice, and implement it.
Assessment methods and criteria	Practical mark At the end of the mentoring process, students will a) reflect their mentoring experience on a two-page report highlighting benefits and potential gaps for future implementation b) prepare a small business plan for an identified innovative idea of their own. Slack channel will allow for student-mentor exchange and networking within the whole cohort of participants. Mentoring is a one-to-one relationship between a mentor and a student. • Mentoring takes place beyond a dependent relationship (e.g. supervisor-subordinate or professor-student relationships). • During the mentoring process, learning and experimentation occur in a protected environment. • An integral part of mentoring is the development of professional skills and competencies. Mentoring is a reciprocal process of "give and take". Both sides learn from each

<table>
<tr><td></td><td colspan="6">other because even the mentor will have the opportunity to critically question his professional perspective and discover new perspectives, software and applications, and previously unperceived situations.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">Mentoring Mindset, Skills and Tools 4th Edition: Make it easy for mentors and students, 2020, Synergetic People Development Pty Ltd, 252 pages, ISBN 0980356458
The Mentoring Guide: Helping Mentors and Students Succeed, 2019, Michigan Publishing Services, ISBN: 1607855399.
Wang, J., Shibayama, S., 2022. Mentorship and creativity: Effects of mentor creativity and mentoring style. Research Policy 51, 104451. doi:10.1016/j.respol.2021.104451
Entrepreneurship: A Guide To Success For Entrepreneurs And Aspiring Entrepreneurs, 2018, ISBN 978-1720221654
Entrepreneurship: Successfully Launching New Ventures, Global Edition, 2018, Pearson, ISBN: 9781292255330</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Pavlos Tyrologou, pavlos.tyrologou@gmail.com</td></tr>
<tr><td rowspan="2">Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td>XX</td><td></td><td>X</td><td>XX</td><td>XX</td><td>XX</td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

COURSE DESCRIPTIONS/
KARTY PRZEDMIOTÓW

second-level studies/ studia II stopnia
main field of study/ kierunek studiów:
Mining and Geology/ Górnictwo I Geologia

specjalność/specialisation:
Mineral Resources Exploration
- Track WUST - UNI ZAGREB

Semester 1
WUST

Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish … Geofizyka inżynierska
Name of subject in English Engineering Geophysics
Main field of study: Mining and geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
………………………. Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code ………… W06GIG-SM3004….
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			50	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	1			2	
including number of ECTS points for practical classes (P)				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,8			0,9	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. has knowledge of fundamentals of applied geophysics, physics and geology.
2. knows fundamentals of soil and rock mechanics.
3. is able to use MS Office software.
4. is able to work in a team.

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SUBJECT OBJECTIVES

C1 familiarize with physical phenomena in geosphere of the Earth
C2 familiarize with engineering problems solved by means of geophysical surveying
C3 familiarize with various geophysical surveys.
C4 acquisition of skills to plan geophysical field surveying and to interpret its results.
C5 development of skills to work in a group.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 recognizes, names and explains engineering problems in different fields.
PEU_W02 identifies, describes and chooses geophysical surveying methods.
PEU_W03 analyses and assesses case studies from solving the engineering problems.

relating to skills:
PEU_U01 is able to coordinate team work, create field research plans and manage the work progress.
PEU_U02 is able to independently create solutions for complex practical problems in engineering and geoengineering applying knowledge about geophysical surveying, mining geophysics, utilizing modern methods in geophysical data acquisition and interpretation.
PEU_U03 is able to critically assess, process and interpreted results of the geophysical surveying and provide recommendations related to engineering problems in mining, civil engineering, engineering geology, municipal waste site, archeology, engineering properties of soil and rocks, hydrogeology, monitoring seepage in river dykes or dams.
PEU_U04 is able to solve geophysical problems.
PEU_U05 is able to conduct auto-didactical education related to detailed handling of typical software.
relating to social competences:
PEU_K01 understands the need to create and transfer to the society – among others by mass media- information and opinions related to mining engineering achievements and other activities of mining engineer; tries to transfer the information in commonly understood way, presenting different points of view; is aware of the quality and need to shape the work safety culture in mining and the responsibility for the health and life of other employees.

PROGRAMME CONTENT

	Lecture	**Number of hours**
Lec 1	Physical properties of rocks. Inter-relationships between the various subdisciplines of applied geophysics. Overview of geophysical methods, their physical principles and applications. Methodology of geophysical surveying.	1
Lec 2	Engineering problems solved with geophysical surveying. Case studies.	2
Lec 3	Electrical resistivity methods. Tomography and VSE. IP method. Physical principles. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
Lec 4	Electromagnetic methods. FDEM and TDEM methods. Magnetotelluric methods. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Lec 5	GPR surveying. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Lec 6	Seismic tomography. Seismic interferometry. Physical principles. Applications. Case studies.	2
Lec 7	Mine geophysics. Seismology. Seismic methods. Active and passive seismic tomography. Microgravimetry. Case studies.	2
Lec 8	Gravity and magnetic surveying. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
	Total hours	15

Project	**Number of hours**

Proj 1	One selected geophysical technique. Fundamentals and equipment. Field surveying	4
Proj 2	Processing and interpretation of field data.	3
Proj 3	Solving the geophysical problems.	8
	Total hours	15

TEACHING TOOLS USED

N1. N1.Lecture aided by presentation.
N2.Demonstration.
N3.Discussion and consultations
N3Calculations
N5Practical field surveying

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
P1	W01-W03	Test related to lecture content. Final grade.
F1	U01-U02, U05	Test. Project 1. Report on Project 1
F2	U03, U05	Test. Project 2. Report on Project 2
F3	U04, U05	Test. Solving geophysical problems
F1-F3, P2	U01-U05 K02	Grades are given for each of three project tasks including tests and reports. The final grade P2 for the project course is the weighted average grade of F1-F3.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Aki, K., Richards P.G., 1980. Quantitative Seismology: Theory and Methods. W.H. Freeman Co.. San Francisco.
[2] Burger, H.R., Sheehan, A.F., Jones, C.H., 2006. Introduction to Applied Geophysics: Exploring the Shallow Subsurface. W.W. Norton & Company, Inc.
[3] Mendecki, A.J. (ed.), 1997. Seismic Monitoring in Mines. Chapman & Hall.
[4] Reynolds, J.M., 2011. An Introduction to Applied and Environmental Geophysics. Wiley – Blackwell. John Wiley & Sons.
[5] Sharma, Prem V., 2002. Environmental and engineering geophysics. Cambridge University Press.
[6] Torge, W., 1989. Gravimetry. Water de Gruyter. Berlin. New York.
[7] Selected Journal Publications (for example journals: Progress in Geophysics, Engineering Geophysics Journal, Environmental and Engineering Geophysics, Journal of Geophysics and Engineering, Pure and Applied Geophysics).

SECONDARY LITERATURE:

[1] Lowrie, W., 2007. Fundamentals of Geophysics. Cambridge University Press.
[2] Milsom, J., 2003. Field Geophysics. John Wiley & Sons Ltd.
[3] Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990. Applied Geophysics. Cambridge University Press.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

ANNA BARBARA GOGOLEWSKA, anna.gogolewska@pwr.edu.pl

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish Wspomagane komputerowo modelowanie geologiczne i geostatystyka.)
Name of subject in English: Computer Aided Geological Modelling and Geostatistics
Main field of study (if applicable): Górnictwo i geologia.
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Mineral Resource Exploration
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W06GIG-SM3002
Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	crediting with grade	Examination / crediting with grade*	crediting with grade	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,8		1,9		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Mathematical Statistics,
2. Fundamentals of Geology and Mineral Deposits

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SUBJECT OBJECTIVES

C1 Developing basic skills in computer modelling of 3-D objects.
C2 Introduction of the principles of digital modelling of typical geological structures.
C3 Introduction to the methods of deposit parameters estimation and resources evaluation.

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 Estimation methods, principles of geostatistics, kriging estimators PEU_W02 Geostatistical modelling of the selected deposit parameters (domain analysis, variogram modelling, PEU_W03 Creating and validating 3-D models of various geological structures in the comprehensive dedicated software environment. relating to skills: PEU_U01 Application of relevant estimation methods for quality modelling of a deposit PEU_U02 Evaluating 3-D objects against structural and quality block models (volumes, tonnages, grades) PEU_U03 Describing the interpretation and applied approach, creating models, evaluation results, recommendations for possible enhancements relating to social competences: PEK_K01 The student can think and act in a creative and enterprising way

PROGRAMME CONTENT		
Lecture		Number of hours
Lec 1	Introduction to the course. Geological database and validation of the geological data.	2
Lec 2	Geology of the seam.	2
Lec 3	Structural model of the stratified deposit. Methods of the prediction of the surface layer parameters.	2
Lec 4	Spatial distribution of samples values. Regionalized variable.	2
Lec 5	BLUE Estimator of the mean value: Kriging.	2
Lec 6	Quality model of the deposit – block model of the parameter layers. Estimation and evaluation of the block model.	2
Lec 7	Reserves modelling and evaluation.	2
Lec 8	Mineral resources. International reporting. The JORC Code	1
	Total hours	**15**

Laboratory		Number of hours
La1	Determining the rules of work at the laboratory.	3
La2	Assignment of the individual dataset for the exercises and creating initial data files.	3
La3	Data validation and creating initial geological database.	3
La4	Construction of the structural wireframe model of stratigraphy layers.	3
La5	Construction of the block model of the deposit and overburden layers. Thickness and stripping ratio analysis.	3
La6	Data preparation to geostatistical analysis. Compositing of the samples.	3
La7	Domain analysis with the use of the statistical methods.	3
La8	Determination of the empirical variogram. Anisotropy analysis.	3
La9	Variogram modelling.	3
La10	Kriging Neighborhood Analysis - defining optimal parameters of the	3

	estimation procedure.	
La11	Estimation of quality parameters in block model of the deposit layers. Validation of the estimation quality.	3
La12	Validation of the quality model and classification of the resources. Balance resources evaluation.	3
La13	Preparation of data for continuous surface mining ultimate pit design. Ultimate pit outlines generation	3
La14	Wireframe and block modelling of the ultimate pit	3
La15	Reserves evaluation, visualization and interrogation of created models	3
	Total hours	45

TEACHING TOOLS USED

N1. Form of lectures - traditional, multimedia presentations using specialized software and demonstrations of its application "live", individual development of specialist topics covered during the lecture,
N2. individual development of project tasks within the laboratories frames, individual development of electronic reports concerning project tasks within the laboratories frames,
N3. evaluation of laboratory tasks reports with multipoint grade of student's work, group analysis of the results obtained during laboratory tasks; preparation of conclusions concerning data dependencies and constraints of mining projects, skill control tests, duty hours in laboratory.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01, PEU_W02	Lecture grade on the basis of the written examination
F2	PEU_W03,	Laboratory task assessment: "structural modelling assessment
F3	PEU_U01	Laboratory task assessment: "geostatistical modelling"
F4	PEU_U02, PEU_U03	Laboratory task assessment: "reserves evaluation".
P average of F1, F2, F3, F4		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] M. Armstrong, Basic Linear Geostatistics, Springer Verlag, 1998.
[2] P. Goovaerts: "Geostatistics for Natural Resource Evaluation", Oxford University Press, 1997.
[3] R. H. Grishong, Jr., 3-D Structural Geology, Springer Verlag, 2008
[4] K. Hefferan, J. O'Brien, Earth materials, Willey-Blacwell, Chichester U.K., 2010
[5] W. Hustrulid, M. Kuchta, Open pit mine planning and design. Chapter 3. Orebody description, Taylor&Francis, 2013.
[6] A. G. Journel, and C.J. Huijbregts, Mining Geostatistics, Academic Press, 1978.
[7] Ch.C. Plummer, D.H. Carlson, L. Hammersley, Physical geology, McGraw-Hill I.E. N.Y. 2010
[8] D.R. Prothero, R.H. Dott Jr., Evolution of the Earth, McGraw-Hill I.E. N.Y., 2010
[9] M.W. Rossi, C.V. Deutsch, Mineral Resources Estimation, Springer Verlag 2014.

SECONDARY LITERATURE:

[10] Handouts, tutorials.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. Krzysztof Hołodnik
Dr inż. Witold Kawalec

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Cyfrowa kopalnia
Name in English: Digital Mine…………………….
Main field of study: Mining and geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
………………………. Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3006
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		15		
Number of hours of total student workload (CNPS)	25		25		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**1**		1		
including number of ECTS points for practical (P) classes			1		
Including number of ECTS points for direct teacher-student contact (BK) classes	0,8		0,8		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Computer literacy skills
2. Basic knowledge related to Mining Engineering and Mineral Processing
3. Programming

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SUBJECT OBJECTIVES

C1. Acquisition of the ability to create utility applications in the C / C ++ and LabVIEW environment
C2. Providing students with knowledge about embedded systems, their construction, selection of components, designing, programming and their exploitation.
C3. Familiarizing with the advances of technology & methods of future mining operations.
C4. Acquisition and consolidation of social competencies including emotional intelligence skills involving the cooperation in the group of students aiming to effectively solve problems. Responsibility, honesty and fairness in the proceedings; observance force in academia and society

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 A student has knowledge related to automation systems, control systems and measurement systems in various aspects of the mining industry. PEU_W02 The student has knowledge of the importance of automation and robotics systems in modern mining. **relating to skills:** PEU_U01 A student is able to select and integrate elements of a specialized measuring and control system including: control unit, executive system, measuring system as well as peripheral and communication modules PEU_U02 A student can design improvements in the existing design solutions for automation and robotics components and systems **relating to social competences:** PEU_K01 A student is aware of the need for a professional approach to technical issues, meticulous reading of documentation and knows environmental conditions in which devices and their components can function PEU_K02 The student has knowledge concerning the benefits of creation and implementation new solutions&technologies into mining industry

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec 1	Terminology (process, automation, robots, measurement devices, control systems). Definition of digital mine	2
Lec 2	Aims, benefits, drawbacks of automation. Industrial revolutions. Definition of industry 4.0. Overview of components of the 4th industrial revolution. Industry 4.0 and mining	2
Lec 3	Elements of technological process in mining. Automation of cyclic processes Measuring technologies in industry 4.0. Sensors systems. Data transmission and data storage technologies. Analytics in industry 4.0. Industrial BigData, Cloud Computing	2
Lec 4	Industrial Internet of Things. M2M communication, anti-collision systems, location of people underground	2
Lec 5	Virtual and augmented realities for industry. Simulators. Digital Twin. Digital models of processes and objects. Management information creation systems, reporting	2
Lec 6	Case study: Automation in open pit lignite mining (KTZ, Autonomous haulage (use case from Australia))	1
Lec 7	Case study: underground mine (Rock Vader – Sandvik project, other use cases from Sandvik, Epiroc, MineMaster, Zanam, AOT from ZGPS KGHM, KIC project on shaft inspection, …etc)	2
Lec 8	Case study: mineral processing (ConVis, FlowVis) in KGHM, OPMO project	2
	Total hours	**15**

Form of classes - laboratory		Number of hours
Lab1	Scope of the course, teaching purpose, crediting conditions, literature, data. Introduction to ARDUINO	3
Lab2	Basic sensors for physical parameters measurements	3
Lab3	Measurements in Labview	3
Lab4	Analysis and Visualization in Labview	3
Lab5	Control in labview	3
	Total hours	**15**

TEACHING TOOLS USED
N1. Type of lectures - traditional, illustrated with multimedia presentations with the usage of audio- visual equipment. N2. Discussion concerning lectures and laboratory. N3 Configuration on laboratory classes measuring systems (hardware and software), performing of measurements, teamwork N4. Projects defence - oral and written form. N5. Duty hours.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at the end of semester)	Educational effect number	Way of evaluating educational effect achievement
F1, P1	PEK_U02-PEK_U04	F1.1 Grade from laboratory work's performance and its merits F.1.2 Grade from laboratory work's oral or written defence P1.Final grade (weighted average of F1.1 - 60% and F1.2 - 40%).
F2, P2	PEK_U02-PEK_U04	F2.1 Grade from activity during the lecture (questions, discussions etc) F.2.2 Grade from written exam P2.Final grade (weighted average of F2.1 - 20% and F2.2 - 80%).

LITERATURE
PRIMARY LITERATURE: [1] LabVIEWTM Getting Started with LabVIEW http://www.ni.com/pdf/manuals/373427j.pdf [2] Monk Simon: Arduino dla początkujących. Podstawy i szkice, Anderson R., Cervo D., Helion, 2018 [3] Monk Simon: Arduino dla początkujących. Kolejny krok, Anderson R., Cervo D., Helion, 2015 **ONLINE LITERATURE:** [1] LabVIEW Tutorial [2] ARDUINO Tutorial [3] Materials prepared by Tutor [4] Internet websites
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Prof. dr hab. inż. Radosław Zimroz, radoslaw.zimroz@pwr.edu.pl **dr inż. Anna.Nowak-Szpak**

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Zarządzanie Środowiskiem
Name in English: Environmental Management
Faculty of studies (if applicable): Mining and Geology
Specialisation (if applicable): Mining Engineering
Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Subject Type: Obligatory
Subject code: W06GIG-SM3001
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in the University (ZZU)	**30**				**15**
Number of hours of total student workload (CNPS)	**50**				**25**
Form of crediting	**Crediting with grade**				**Crediting with grade**
For a group of courses mark (X) for the final course					
Number of ECTS points	**2**				**1**
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BU) classes	**1,3**				**0,8**

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.Basic knowledge of issues related to ecology and environmental protection.

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SUBJECT OBJECTIVES

C1. To get students acquainted with systems of environmental management both in Poland and other EU countries.
C2. To prepare students for rational and sustainable management of environmental components.
C3. To get students acquainted with the genesis of environmental management systems in Poland, review and standardization of environmental management systems.
C4. To get students acquainted with benefits and obligations arising from the implementation of an environmental management system.
C5. To present the relationship between an environmental management system and a quality

management system.
C6. To provide an overview of informative methods of supporting the implementation of environmental management systems (possibilities and practical usage of computerised systems of environmental information management, decision support in the area of environmental protection and choice of methods and tools used to support the implementation of an environmental management system).

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 – Possesses systematic knowledge of the origins of environmental management systems, review and standardization of environmental management systems.
PEU_W02 - Possesses knowledge of the possibilities and practical applications of tools supporting the implementation of the environmental management system.
PEU_W03 - knows basic formal and legal regulations regarding the implementation and functioning of management systems, tools and instruments of environmental management.
PEU_W04 - Possesses knowledge for rational and sustainable management of environmental components.

relating to skills:
PEU_U01 – Possesses linguistic resources appropriate for specialised language and is able to use it in linguistic activities in order to communicate in the professional environment regarding the field of studies; is able to obtain necessary information and interpret and critically evaluate it, reads and understands professional literature, is able to formulate and comprehensively justify opinions, provide presentations of problems related to a studied discipline and also participate in scientific and professional discussions.
PEU_U02 – Is able to use methods and appropriate IT tools in system management of environmental components.

relating to social competencies:
PEU_K01 - Is able to think and act in a creative and enterprising way.

PROGRAMME CONTENT		
	Form of classes - lecture	**Number of hours**
Lec.1	Basic concepts: - Environment, characteristics of individual elements of the environment - Characteristics of hazards for the natural environment which are a result of human activities - Environmental Management - The Environmental Management System	2
Lec.2	Legal aspects of environmental management	2
Lec.3	History and development of environmental management systems	2
Lec.4 Lec.5 Lec.6	Environmental management systems: - Business Charter for Sustainable Development of the International Chamber of Commerce - ICC Business Charter for Sustainable	6

	Development - EMAS – Directive of the European Community Commission regarding the approval for voluntary participation by organisations in a community eco-management and eco-audit scheme - CP - Clean Production - BS 7750 - Specification for Environmental Management Systems - ISO 9000 - ISO 14000 - ISO 14001 Characteristics of selected Environmental Management Systems. The benefits of the implementation of the EMS for a company. Experiences of Polish enterprises from the implementation of EMS. Process of implementation of the selected EMS in a company with an example of EMAS.	
Lec.7 Lec.8	Basic tools of environmental management: - Legal and administrative instruments (laws, standards, licenses and permits) - Economic instruments (fees, taxes, deposit and refund systems, transferable rights, subsidies, liens, fines) - Instruments (techniques) social impact (ecological education, ecological propaganda) Examples of basic tools of environmental management: - Procedure for an assessment of environmental impact - Integrated permits - Audits - Safety Reports - Monitoring of the Environment	4
Lec.9 Lec.10	Design of an environmental management system	4
Lec.11 Lec.12	IT systems supporting environmental management: - Decision Support Systems - Expert systems - Simulation Models - Geographical Information Systems Selected types of information systems which support environmental management, their characteristics, examples of implementation both in Poland and in the world	4
Lec.13	The benefits of an implemented and functioning environmental management system	2
Lec.14	Costs of implementation and functioning of an environmental management system	1
Lec.14 Lec.15	Environmental management systems in practice	3
	Total hours	**30**

Form of classes - seminar		Number of hours
Se1	The scope and form of an essay and presentation, terms of crediting and literature.	2

	Assignment of seminar topics for individual students.	
Se2 Se3 Se4 Se5 Se6 Se7 Se8	Student speeches with the use of multimedia presentations on the following issues: environmental management systems - specified examples, formal and legal conditions of administrative procedures (eg. receiving a decision on the environmental conditions of a project, an integrated decision etc.), life-cycle analysis of a selected company; fees, taxes, surcharges and environmental deposits; litter management systems, mineral resource management, renewable energy sources, selected monitoring systems, the institution of environmental protection in Poland and in the world and also alternative energy sources, etc. Group discussion on the content and form of speeches.	13
	Total hours	**15**

TEACHING TOOLS USED
N1. Informative lecture with elements of problematic lectures. N2. Multimedia presentations N3. Didactic discussion during lectures and seminars N4. Preparation of an essay in the form of a report N5. Presentation of the essay N6. Consultations

EVALUATION OF SUBJECT EDUCATIONAL OUTCOME ACHIEVEMENTS

Evaluation F – forming (during semester), P – concluding (at semester end)	Educational outcome number	Method of evaluating educational outcome achievement
F1- Grade from content value of an essay	PEU_U01 PEU_U02 PEU_K01	Text and graphical form of essay
F2 – Grade from presentation and issues included in an essay	PEU_U01 PEU_U02 PEU_K01	Presentation of essay
F3 – Grade from a written or oral test	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Positive grade
final grade from the subject (the weighted average, respectively: 35% for the substantive content of the essay, 25% for the presentation, 40% for the lecture)		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Ejdys J.,1998, Zarządzanie środowiskowe w przedsiębiorstwie – koszty i korzyści, Sterowanie ekorozwojem, t.2, Wyd. Politechniki Białostockiej, Bialystok, [2] Lukasheh A. F., Droste R. L., Warith M. A., 2001, Review of Expert System (ES), Geographic Information System (GIS), Decision Support System (DSS), and their applications in landfill design and management. W: Waste Management & Research nr 19, [3] Łunarski J. (red.), 2002, Zarządzanie środowiskiem", Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszow [4] Nowak Z., 2001, Zarządzanie środowiskiem, Wyd. Politechniki Śląskiej, Gliwice, [5] Matuszak-Flejszman A., 2001: Jak skutecznie wdrożyć system zarządzania środowiskowego wg normy ISO 14001. PZIiTS, Poznan [6] Pochyluk R. i inni, 1999, Zasady wdrażania systemu zarządzania środowiskowego zgodnego z wymaganiami normy ISO 14001, Eco-Konsult, Gdansk, [7] Poskrobko B., Poskrobko T., 2012, Zarządzanie środowiskiem w Polsce, Polskie Wydawnictwo Ekonomiczne, Warsaw [8] Poskrobko B., 1998: Zarządzanie środowiskiem. Polskie Wydawnictwo Ekonomiczne, Warsaw [9] Przybyłowski P. (red.), 2005, Podstawy zarządzania środowiskowego, Wyd. Akademii Morskiej, Gdynia. **SECONDARY LITERATURE** [1] Jeżowski P. (red.), 2007: Ekonomiczne problemy ochrony środowiska i rozwoju zrównoważonego w XXI wieku. Szkoła Główna Handlowa, Warsaw [2] Lemański J. F., Matuszak-Flejszman A., Zabawa S. (red.), 2000: Efektywność funkcjonowania wdrożonego systemu zarządzania środowiskowego wg normy ISO 14001. PZIiTS, AE, Poznan – Pila [3] Websites given during lectures and seminars
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr hab. inż. Justyna Woźniak **Dr hab. Inz. Katarzyna Pactwa,** **Dr inż. Danuta Szyszka**

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish Bezpieczeństwo i higiena pracy
Name of subject in English: Occupational Health and Safety
Main field of study (if applicable): Górnictwo i geologia.
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Mineral Resource Exploration
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W06GIG-SM3005
Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			25	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	**1**			1	
including number of ECTS points for practical classes (P)				1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,7			0,8	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Possesses basic knowledge of technologies used in open-pit mines and underground mines.
2. Is able to use Microsoft Office environment to prepare documents in Word, multimedia presentations in Power Point and work with Excel spreadsheets.
3. Is able to identify harmful, dangerous and nuisance factors in the workplace environment.

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SUBJECT OBJECTIVES

C1. To introduce the principles of occupational risk assessment in accordance with relevant standards
C2 To present the principles of occupational risk assessment and the determination of admissibility with the use of STER software and the RISC SCORE method.

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 Possesses general knowledge of rules of occupational risk assessment formulation PEU_W02 – Possesses knowledge of evaluating and determining the admissibility of occupational risk. PEU _W0 3 – Possesses general knowledge of corrective and preventive actions regarding hazards of typical work posts in the mining industry.… relating to skills: PEU_U01 Is able to identify hazards of harmful, dangerous and nuisance factors of typical work posts in the mining industry PEU_U02 Is able to estimate and determine risk acceptability with methods according to STER software and the RISC SCORE method. PEU_U03 - Is able to plan corrective and preventive actions for hazards of typical work posts in the mining industry.… relating to social competences: PEU_K01 - Is able to work in a team and together complete occupational risk assessment and develop its results and the required documentation in the form of a team report

PROGRAMME CONTENT		
	Lecture	**Number of hours**
Lec 1	Definition of occupational risk. Legal basics of occupational risk assessment. Risk assessment methods. Course of occupational risk assessment. Information necessary for occupational risk assessment. Identification of harmful, dangerous and nuisance factors in the work environment.	3
Lec 2	Estimation of occupational risk assessment and determination of admissibility. Corrective and preventive actions. Familiarising employees with the results of occupational risk assessment. Implementation of agreed corrective and preventive actions. Monitoring the effectiveness of implemented actions. Periodic occupational risk assessment. Harmful factors – identification and assessment of risks.	3
Lec 3	Dangerous factors - identification and assessment of risks.	3
Lec 4	Nuisance factors in occupational risk assessment: psychological burden, static burden, monotype.	3
Lec 5	Methods of occupational risk assessment: STER software, the RISC SCORE method, written test	3
	Total hours	**15**

	Project	Number of hours
Pr1	Occupational risk assessment with the use of STER software for two work posts – description of work post, identification of hazards. Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of harmful factors (dust, noise)	3
Pr2	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of	3

	harmful factors (vibration, chemical agents)	
Pr3	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of dangerous factors (slippery or uneven surfaces, falling elements, moving parts, moving machinery and transported bimi items)	3
Pr4	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility for nuisance factors (psychological burden, static burden, monotype)	3
Pr 5	Occupational risk assessment for a selected work post with the use of the RISC SCORE method, presentation of executed exercises, test	3
	Suma godzin	**15**

TEACHING TOOLS USED

N1. Informative lecture with elements of problematic lectures.
N2 Multimedia presentations.
N3 Didactic discussions during lectures.
N4 Didactic discussions during laboratory classes.
N5Computer presentation of executed occupational risk assessments.
N6Consultation.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01-W03	grade from a test
F2	PEU_W01-W03 PEU_U01- U03	grade from a presentation
P2	PEU_W01-W03 PEU_U01- U03	final grade from project classes (arithmetic average of F1 and F2)

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Occupational Safety and Health in Mining. Anthology on the situation in 16 mining countries. Ed.: Kaj Elgstrand and Eva Vingård. University of Gothenburg nr 2013;47(2) (gupea.ub.gu.se › bitstream › gupea_2077_32882_1)

[2] Boyle, Tony: Health and safety: Risk management. IOSH, 2001. (http://www.iosh.co.uk/index.cfm?go=publications.main)

[3] Encyclopaedia of occupational health and safety. Fourth edition Stellman, Jeanne M. (ed.). International Labour Organization, 1998 (http://www.ilo.org/public/english/support/publ/xtextre.htm#b103) http://www.ilo.org/public/english/support/publ/encyc/)

[4] McKeown, Céline; Twiss, Michael: Workplace ergonomics: A practical guide, IOSH, 2001, 160 p. http://www.iosh.co.uk/index.cfm?go=publications.main

SECONDARY LITERATURE: Handouts, articles
OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)
Dr inż. Żaklina Konopacka

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOIENGINEERING, MINING AND GEAOLOGY

SUBJECT CARD

Name in Polish: Modele Decyzyjne w Zarządzaniu
Name in English: Operations Research
Main field of study (if applicable): Mining and Geology
Specialization (if applicable): Mining Engineering, Mineral Resource Exploration
Level and form of studies: 2nd, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3000
Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**15**		**15**		
Number of hours of total student workload (CNPS)	**25**		**50**		
Form of crediting	**crediting with grade**		**Crediting with grade**		
For group of courses mark (X) final course					
Number of ECTS points	1		**2**		
including number of ECTS points for practical (P) classes of practical character (P)			**2**		
including number of ECTS points for direct teacher-student contact (BU) classes	**0,8**		**0,7**		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The student has basic knowledge of mining systems, technological and organizational systems in mining
2. The student has basic knowledge concerning economics in mining
3. The student has basic knowledge concerning mathematical analysis necessary to understand mathematical issues in science having engineering and economic character.
4. The student has basic knowledge and skills of using probability theory models and mathematical statistics
5. The student can use Excel spreadsheet
6. The student understands the need and knows the possibilities of lifelong learning, improving professional, personal and social skills

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SUBJECT OBJECTIVES

C1 Acquiring basic knowledge, taking into consideration its applicational aspects concerning mathematical decision models used in management:

C1.1 Linear programming models

C1.2 Models of planning, deposits and costs of projects
C1.3 Queuing system models
C1.4 Digital simulation models

C2. Learning of qualitative understanding, interpretation and quantitative analysis with applications of selected issues concerning optimization

C2.1. Production systems:
C2.2. Transport issues
C2.3. Flows in networks.
C2.4. Project schedules
C2.5. Queuing system models

C3. Acquiring and consolidating the competencies of thinking and acting in a system way.

SUBJECT LEARNING OUTCOMES

Subject educational effect (knowledge)

PEU_W01 The student has knowledge concerning basic decision models in management
PEU_W02 The student has knowledge concerning line programming models.
PEU_W03 The student has knowledge concerning models for planning and monitoring of activities, deposits, and costs of projects
PEU_W04 The student has knowledge concerning queuing system models
PEU_W05 The student has knowledge concerning simulation models.

Subject educational effect (skills)

PEU_U01 The student has the ability to apply and interpret models using linear programming applications
PEU_U02 The student has the ability to apply and interpret models of planning and monitoring of activities, deposits, and costs of projects with the use of programming applications
PEU_U03 The student has the ability to apply and interpret queuing system models using programming applications
PEU_U04 The student has the ability to apply and interpret simulation models using programming applications

Subject educational effect (social)

PEU_K01 The student can think and act in a system, creative and enterprising way
PEU_K02 The student is able to identify and solve problems with the use of decision models and applications

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Le1	Introduction to modelling systems	2
Le2	Linear programming issues - optimization of production	2
Le3	Linear programming issues - flow in networks optimization (optimal allocation issues, the issue of transportation, maximum flow, minimizing costs)	2
Le4	Projects scheduling using critical path	2
Le5	Planning and balancing of deposits in projects	2
Le6	Optimization issues of queuing systems	2
Le7	Monte Carlo methods and digital simulation	3
	Total hours	**15**

Form of classes - laboratory		Number of hours
La1	Defining and solving linear programming issues (Microsoft Excel-Solver)	2
La2	Production optimization (Microsoft Excel - Solver)	2
La3	Flows in networks optimization (Microsoft Excel - Solver)	2
La4	Projects scheduling (Microsoft Project)	2
La5	Planning and balancing of deposits in projects (Microsoft Project)	2
La6	Optimization issues of queuing systems (Microsoft Excel)	2
La7	Elements of Monte Carlo methods and digital simulation (Microsoft Excel)	3
	Total hours	**15**

TEACHING TOOLS USED
N1. Interactive lecture with slides and discussion N2. Laboratory exercises with the use of IT applications - discussion concerning solutions N3. Laboratory exercises - short written tests (calculating tasks, tests of knowledge) N4. Duty hours N5. Own work - preparation for laboratory classes, solving additional tasks N6. Own work - own literature studies.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at the end of semester)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_U01-04	short written test.
PEU_U01-04 written test (counting exercise)		
PEU_W01-05; PEU_K01-02 Written test (knowledge test)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE

[1] Ignasiak E., Borucki W., Badania operacyjne, PWE, 2001
[2] Krawczyk S., Badania operacyjne dla menedżerów, PWE
[3] Baranowska B, Badania operacyjne w zarządzaniu, PWSBIA, 1996

SECONDARY LITERATURE

[1] Szapiro T., Decyzje menedżerskie z Excelem, PWE 2000
[2] Trzaskalik T., Modelowanie optymalizacyjne, Absolwent
[3] Trzaskalik T., Badania operacyjne z komputerem, PWE

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. Witold Kawalec
Dr hab. inż. Leszek Jurdziak
Dr inż. Zbigniew Krysa

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish … Zarządzanie projektami, ocena ich opłacalności i ryzyka..
Name of subject in English: Project Management, Appraisal and Risk Evaluation.
Main field of study (if applicable): Mining and Geology
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
…………………….. Mineral Resource Exploration
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code … W06GIG-SM3003G ………….
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30	15	
Number of hours of total student workload (CNPS)	25		50	25	
Form of crediting	Examination				
For group of courses mark (X) final course	X				
Number of ECTS points	4				
including number of ECTS points for practical classes (P)	3				
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	3,1				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of basic mathematical analysis, probability and statistical models
2. Skills in using Excel spreadsheets
3. Understanding of the need of lifelong learning and the importance of application of Economics, Management and Social Sciences in engineering.

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SUBJECT OBJECTIVES

The course combines two groups of topics: basics of mineral economics and financial management and introduction to project management.
Part A: The purpose of the course is
C1 to introduce basic concepts of Microeconomics and financial management
C2 to introduce the concept of time value of money and present the methods used to evaluate investment projects. Different techniques are illustrated by examples and case studies. The range of application as well as the advantages and disadvantages of each method are discussed. The issues of inflation and risk analysis are included.

Part B:
C3 Introduction to project management basic concepts, methods and tools.
C4 Presentation of given project management areas: Project scope management, Project time management, Project cost management, Project risk management. Project planning, scheduling and control using Microsoft Project.
C5 Presentation of the issues of effective communication in project teams, group behaviour and leadership.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows the concepts of demand, supply and price elasticities, understands how they affect markets
PEU_W02 knows the concepts of costs in economics and accounting, understands how they differ
PEU_W03 knows the main cost categories and cost accounting methods
PEU_W04 has basic knowledge about the contents of financial statements
PEU_W05 has basic knowledge about the method of ratio analysis of financial statements
PEU_W06 knows and understands the concepts of Present Value and Future Value for simple cash flows and annuities.
PEU_W07 knows the capital budgeting methods (NPV, IRR, PBP) and understand how to interpret the results
PEU_W08 has basic knowledge about the project risk evaluation methods

relating to skills:

PEU_U01 is able to analyze the causes and effects of demand and supply changes
PEU_U02 is able to interpret and use information presented in financial statements also by means of ratio analysis
PEU_U03 is able to use different cost analysis methods and make decisions based on the rsults
PEU_U03 can calculate Future and Present value, also for annuities and solve simple calculation problems
PEU_U04 is able to perform discounted cash flow analysis and draw conclusions based on the results
PEU_U05 is able to carry out sensitivity analysis and scenario analysis using a financial model of an investment
PEU_U06 is able to work out basic project documentation and initiate a project
PEU_U07 is able to use basic methods of project management, monitoring and project risk management
PEU_U08 is able to implement basic conflict management methods in a project group
PEU_U09 is able to use basic group management methods, can undertake and shape the leadership position

relating to social competences:

PEU_K01 is able to think and act in a systematic, creative and entrepreneurial way
PEU_K02 has an established attitude of economic operation and decision-making based on available financial information and forecasts

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec.1	Supply and demand, equilibrium price, changes in demand and supply. Stock and commodity markets used by mineral industries	2
Lec.2	Costs in economics and in accounting. Cost and money outflow. Relevant cost, incremental cost, marginal cost, alternative cost. Short-term decision making.	2
Lec.3	Costs as the subject of cost accounting, different systems of cost accounting Different methods of cost data presentation (by types, divided into direct and indirect costs). Cost allocation	2
Lec.4	Variable and fixed costs. Break even point. Cost-volume –profit analysis.	1
Lec.5	Basics of financial accounting. Income statement and cash flow statement. Balance sheet. Working capital. Examples of financial statements of mining companies	2
Lec.6	Financial ratio analysis. Liquidity, profitability, activity and debt ratios. Financial and operating leverage.	2
Lec.7	The concept of time value of money. Computation of future and present value of money by means of spreadsheet functions. Basics of capital budgeting. Evaluation of different methods.	2
Lec.8	The concept of risk and return. Quantification of risk. Risk analysis in project evaluation: sensitivity analysis, scenario analysis, other methods.	2
	Total hours	15

Project		**Number of hours**
Pr 1	Issues of understanding communication: Definitions Models (Schramm model, Berlo’s SMCR (source, message, channel, receiver) model, McCroskey model, Reusch and Bateson model, Westley-MacLean model)	3
Pr 2	Conflict Sources of conflicts Kilmann and Thomas classification of conflict Kilmann and Thomas test Different styles of conflict solving Roles of conflict in group development.	3
Pr3	Team roles Team roles Belbin perspective Discussion group roles Effective managerial behaviour in the context of team roles	3
Pr4	Leadership Hersey and Blanchard theory Black and Mouton approach to leadership Fiedler theory and his Least Preferred Coworker Scale Situational leadership self-assessment	3
Pr5	Summary;	3

	Effective managerial behaviour from the different contexts.	
	Total hours	15

Laboratory		Number of hours
Part A		
La1	Supply and Demand curves. Elasticity of demand.	2
La2	Economic costs. Cost curves. Profit maximization cases.	2
La3	Managerial cost accounting. Decision making cases.	2
La4	Basic financial accounting. Creation of simple Balance Sheet, Profit and Loss Statement and Cash Flow Statement	2
La5	Ratio analysis based on financial statements of companies	2
La6	Time value of money and capital budgeting – calculation by means of Excel functions	2
La7	Financial model of an investment. Sensitivity and Scenario analysis.	3
Part B		
La8	Basic concepts (process, project, project management, management by projects, critical factors for project success, competences). Preparing and initiation of the project. Project analysis (project environment, stakeholders, project objectives).	3
La9	Planning and estimating of the project. Project phases and life cycle	3
La10	Project organization. Project scope management. Planning of activities, resources and costs.	3
La11	Project risk management. Project monitoring. Project management methodologies.	3
La12	Quality management. Change control. Project closing.	3
	Suma godzin	**30**

TEACHING TOOLS USED
N1. Interactive lecture with the use of multimedia and discussion
N2. Laboratory classes: individual problem solving with the use of Excel spreadsheet
N3. Laboratory classes part B and project classes: case studies solving in groups and individually. Project presentations, discussion
N4. Consultation
N5. Self-study: solving assigned problems, literature studies

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01-W08 PEU_K01-K02	Assesment of student class activity
F2	PEU_U01-U10 PEU_K01-K02	Evaluation of student's assignements
P1	PEU_W01-W08 PEU_U01-U10 PEU_K01-K02	Written test

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

1. Erhardt M., Brigham E.: Financial Management Theory and Practice. South-Western Cengage Learning, USA
2. Brigham E., Glapenski L.: Financial Management, 1997
3. Johnson H.: Making Capital Budgeting Decisions – Maximising the Value of the Firm. Financial Times/Prentice Hall (April 15, 1999)
4. Jonson H.: Strategic Capital Budgeting: Developing and Implementing the Corporate Capital Allocation Program, January 1994.
5. Lock Dennis, Project Management, Published April 11, 2013 by Routledge

SECONDARY LITERATURE:

1. Jonson H.: Determining Cost of Capital: The Key to Firm Value. Apr 1999.
2. A Guide to Project Management Body of Knowledge (PMBOK®Guide Fourth Edition), Project Management Institute, 2008 (2004). wydanie polskie, MT&DC Warszawa, 2009 (2006)
3. Johnson H.: Global Financial Institutions and Markets. December 1999

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. Gabriela Paszkowska, Gabriela.paszkowska@pwr.wroc.pl

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: ***Zasady i zastosowania InSAR oraz GIS w górnictwie***
Name in English: ***Principles and Application of InSAR and GIS in mining***
Main field of study: Mining and geology
Specialization: Geomatics for Mineral Resources Management
……………………….Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3007
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	Examination		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		
including number of ECTS points for practical (P) classes			3		
Including number of ECTS points for direct teacher-student contact (BU) classes	1,4		2,0		

*niepotrzebne skreślić

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of C ++ and Python programming language.
2. Basic knowledge of GIS functions and spatial data acquisition techniques
3. Ability to use GIS software package
4. Basic knowledge of databases

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SUBJECT OBJECTIVES

C1 Presentation of knowledge of satellite radar interferometry, as well as the possibility of using it in the ground deformation measurements.
C2 Acquiring the ability to determine surface displacements based on satellite radar data.
C3 Presentation of information on the use of GIS in advanced analysis of objects, phenomena and processes occurring in space.
C4 Acquiring the ability to formulate and solve tasks using GIS analytical functions.
C5 Acquiring skills to use spatial data and services in accordance with the INSPIRE Directive

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEK_W01 Has expanded knowledge in the field of using geoinformation systems to collect and process data used in modeling of both natural and anthropogenic phenomena and processes PEK_W02 Knows the principles of construction and functioning of geoinformation systems in the mining industry and public administration relating to skills: PEK_U01 has the ability to use advanced GIS tools in mining, studies of natural phenomena, the impact of mining on the environment and space development, PEK_U02 has the ability to formulate and solve spatial tasks in the GIS environment PEK_U03 has the ability to interpret the results obtained and draw conclusions relating to social competences: PEU_K01 has the ability to formulate and transfer knowledge on the use of geoinformation systems in spatial analysis and presentation of their results

PROGRAMME CONTENT		
	Lecture	**Number of hours**
Lec 1	Discussion of syllabus, requirements for passing the course, literature	2
Lec 2	Introduction to Microwave Signals for Earth Observation	2
Lec 3	Principles and Applications of Passive and Active Microwave Remote Sensing	2
Lec 4	Acquisition and processing of SAR data	2
Lec 5	SAR image theory (geometric properties, polarization)	2
Lec 6	Basics of SAR data calculation using the DInSAR and SBAS methods	2
Lec 7	Principlesand Applicationsof Interferometric SAR (monitoring surface activity, natural and anthropogenic phenomena)	2
Lec 8	Fundamental concepts of geographical information systems	2
Lec 9	Data modelling in GIS. Representation of spatial data. Spatial databases. Current status and development trends	2
Lec 10	Methods of spatial analysis in GIS	2
Lec 11	Spatial data interpolation	2
Lec 12	Map algebra. Surface analysis, local and zonal functions	2
Lec 13	Basics of spatial statistics	2
Lec 14	Spatial Information Infrastructure. Inspire Directive. Open Data	2
Lec 15	Examples of applications of geoinformation systems in mining and environmental protection	2
	Total hours	**30**

Laboratory		Number of hours
La1	Configuration of the environment for SAR calculations	3
La2-3	Introduction to radar data calculations - calculation tasks	6
La4	Acquiring radar data and calculating the interferogram - DInSAR method	3
La5	Unwrapping of the interferometric phase - calculations	3
La6-7	Presentation of results in the GMT environment	6
La8	Discrete data interpolation. Preparation of input data for analysis (e.g. deformation measurements in the mining area)	3
La9	Discrete data interpolation. Development mining area terrain deformation maps with various interpolation methods.	3
La10	Discrete data interpolation. Analysis and assessment of the quality and uncertainty of interpolation. Prediction map. Development of maps of changes between two periods using a raster calculator.	3
La11	Spatial analysis - assessment of the suitability of the area for the location	3
La12	of mining operation. Construction of a database of spatial location criteria	3
La13	Spatial analysis - assessment of the suitability of the area for the location	3
La14	of mining operation. Selection of analytical procedures and conducting analytical operations.	3
La15	Spatial analysis - assessment of the suitability of the area for the location	3
	Total hours	**45**

TEACHING TOOLS USED
N1. Lectures N2. Multimedia presentations N3. Preparation of individual written term paper on a given topic N4. Multimedia materials (MOOC) N5. Laboratory instructions N6. Reports from laboratory exercises N7. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F1 Final mark for the written examination F2 Mark for the written report, P Final mark for the lecture (weighted average of F1 and F2, where F1 – 80% and F2 - 20%)
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F3 Mark for the written assignment reports F4 Mark from written tests, P2 Final mark for the laboratory (weighted average of F3 and F4, where F3 – 80% and F4 - 20%)

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. 2015: Geographic Information Science and Systems, 4th Edition, John Wiley & Sons; [2] Maguire D., Batty M., Goodchild M., 2005. GIS Spatial Analysis and Modelling. ESRI Press [3] Berry J., 2007-2013. Beyond Mapping IV — GIS Modelling [4] Satellite InSAR Data: Reservoir Monitoring from Space, A. Ferretti, EAGE; 1st edition, 2014 [5] GMTSAR: An InSAR Processing System Based on Generic Mapping Tools (Second Edition), D. Sandwell i in., Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, 2016 [6] InSAR Principles - Guidelines for SAR Interferometry Processing and Interpretation, ESA Publications, 2008 **SECONDARY LITERATURE:** [1] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) [2] Kennedy M., 2009: Introducing Geographic Information Systems with ArcGIS: A Workbook Approach to Learning GIS, Second Edition, John Wiley and Sons; [3] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. W., 2006. GIS. Teoria i praktyka. Wydawnictwo Naukowe PWN, Warszawa [4] Urbański J., 2010. GIS w badaniach przyrodniczych, Wydawnictwo Uniwersytetu Gdańskiego [5] Dokumentacja środowiska GMT (Generic Mapping Tools) - http://gmt.soest.hawaii.edu/projects/gmt/wiki/Documentation
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Wojciech Milczarek, wojciech.milczarek@pwr.edu.pl Jan Blachowski, jan.blachowski@pwr.edu.pl

Semester 2 and 3
UNI ZAGREB

University of Zagreb, RGNF

Course title	**Sedimentology**		
European Credits (ECTS)	5	**Time (hours) given to the students**	75
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: 3, Seminar classes: , Fieldwork: x	**Student whole working time (hours)**	125
Description of content	to acquire the main techniques in defining sedimentary facies, to recognize sedimentation processes, to recognize the basic features of modern and palaeo- depositional environments, to recognize and interpret characteristic sedimentary sequences, to analyse all elements present in the sedimentary environment and interpret possible depositional environment This course gives students knowledge about sedimentary processes and its interpretation. L1 - DEFINITION OF FACIES CYCLES AND SEDIMENTARY SEQUENCES L2 - WAYS OF VERTICAL SUCCESSIONS DISPLAY (SEDIMENTARY COLUMNS); WAYS AND POSSIBILITIES OF CORRELATION L3 - SEDIMENTARY ENVIRONMENT OF ALUVIAL FANS; TECTONIC SETTINGS, PROCESSES, CHARACTERISTIC SEQUENCES L4 - DEPOSITIONAL ENVIRONMENT OF BRAIDED, MEANDRING AND ANASTOMOSING RIVERS; TECTONIC SETTINGS, PROCESSES, CHARACTERISTIC SEQUENCES L5 - DELTAIC SEDIMENTARY ENVIRONMENT; PROCESSES, TYPES OF DELTAS; PARTS OF THE DELTA; CHARACTERISTIC SEQUENCE L6 – SILICICLASTIC SHORELINE; SILICICLASTIC SHELF / RAMP DEPOSITIONAL ENVIRONMENT; NEARSHORE SHELF / RAMP PROCESSES L7 – WAVE- TIDE- STORM-INFLUENCED SILICICLASTIC SHORELINE (SHELF/ RAMP) L8 – SHALOW-MARINE CARBONATE ENVIRONMENTS; DEPOSITION ON CARBONATE PLATFORM (processes), CARBONATE RAMP / SHELF L9 - CHARACTERISTICS AND FACIES OF CARBONATE PLATFORM (according to Flügel, 2004) L10 - CHARACTERISTICS AND FACIES OF CARBONATE RAMP / SHELF (according to Flügel, 2004) L11 - EVAPORITIC SEDIMENTARY ENVIRONMENTS L12 - CARBONATE DIAGENESIS – DOLOMITES, KARST FORMATION L13 - DEEPWATER SEDIMENTARY ENVIRONMENTS - PELAGIC DEPOSITION IN THE OCEANS L14 - DEEPWATER SEDIMENTARY ENVIRONMENTS – RESEDIMENTED, MASS-FLOW DEPOSITS: DEBRITES, TURBIDITY		

	CURRENTS; CHARACTERISTICS OF TURBIDITE FANS L15 - MIXED (SILICLASTIC-CARBONATE) SEDIMENTARY ENVIRONMENTS - CHARACTERISTIC SEQUENCES					
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To conduct complex sedimentological investigations, including the construction of strata sequences, facies differentiation and interpretation of sedimentary environments. Skills: To construct general and thematic geological maps, as well as geological profiles with accompanying descriptions Competences: To engage in informed professional discussion and business communication,					
Assessment methods and criteria	exam During the semester the requirement for signature is atendance of leactures and practicum. Students will participate in research and practical work as part of practicum. At the end oral exam will be organized. Theoretical part is complemented by research work, practical work and field works where students will learn about sedimentology processes and depositional environment.					
Recommended readings	Flügel, E., (2004): Microfacies of Carbonate Rocks; Analysis, Interpretation and Application. Springer (976 pp)					
TU Coordinator	Dunja Aljinović, dunja.aljinovic@rgn.hr					
Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
	Students will be engaged in informed professional discussion and business communication		Students will have to construct general and thematic geological maps and profiles with accompanying descriptions			

Justification for OLO contribution	

Course title	**Mineral Deposits Exploration**		
European Credits (ECTS)	5	**Time (hours) given to the students**	75
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: 3, Seminar classes: x, Fieldwork:	**Student whole working time (hours)**	125
Description of content	The objective of the course is to get acquainted with geological methods of exploring mineral deposits and their evaluation. The course contributes to skills of students which should be applied during geological part of exploration of mineral resources. L1 - Classification of mineral deposits. Economic aspects of mineral deposits. L2 - Nature and morphology of orebodies. L3 - Metallogeny, metallogenetic provinces and periods. L4 - Geological criteria in the exploration of mineral deposits. Magmatic control factor. L5 - Structural control factor. L6 - Geological models of mineral deposits as a basis for exploration planning. Reconnaissance. Selection and definition of areas for exploration of a mineral deposit. L7 - Application of geophysical methods and remote sensing in the exploration of mineral deposits. L8 - Prospecting indications (alteration, alteration mineral assemblages, ore outcrops and remains of old mining). L9 - Prospecting indications (indicator elements, indicator minerals). L10 - Geochemical prospecting methods. L11 - Sampling media (stream sediments, soil, lake sediments, sediment cover, water, gases, vegetation, rocks). L12 - Statistical processing of geochemical prospecting results. L13 - Sampling of mineral resources. L14 - Mining legislation. Categorisation and classification of mineral reserves. L15 - Calculation of mineral reserves. Preparation of a mineral reserves study.		
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To describe all phases of raw materials exploration, from prospecting of deposits to the preparation of reports on raw materials reserves. To select basic geological, geochemical, geophysical, and statistical methods in exploration of selected mineral raw materials deposits. Skills: To apply statistical methods and spatial analyses in interpretation of laboratory and field measurements. To use information technology in computation and modelling of geological phenomena and processes. To identify the properties of geological materials and processes within hydrogeological, engineering geological and petroleum		

<table>
<tr><td></td><td colspan="6">engineering investigation and mineral exploration.
Competences: , To apply standards and (legal) regulations related to geological research, geohazards, environmental protection, water exploitation, exploitation of mineral resources or construction conditions. To interpret and summarize the results of field, laboratory and office research and prepare and present a geological expert report using other relevant data sources. To create geological reports for the economy and strategic documents.</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
The requirement for signature is atendance of leactures and practicum. Students will have to write seminar on specific topic, and have independent assigments. At the end oral exam will be organized.
Through seminars and workshops, independent assigmensts and field works students will learn about mineral deposits and importance and methods of its exploration.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">1. Moon, C.J., Whateley, M.G.K. & Evans, A.M. (2009): Introduction to mineral exploration, Blackwell Science, 496 s. 2. Annels, A.E. (1991): Mineral Deposits Evaluation, Chapman & Hall, 436 s</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Goran Durn, goran.durn@rgn.hr</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td>Students will create geological reports for the economy and strategic documents.</td><td>Students will apply statistical methods and spatial analyses in interpretation of laboratory and field measurements.</td><td>Students will apply statistical methods and spatial analyses in interpretation of laboratory and field measurements.</td><td></td><td>Students will apply standards and (legal) regulations.</td><td></td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
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<table>
<tr><td>Course title</td><td colspan="3">Petroleum Geology</td></tr>
<tr><td>European Credits (ECTS)</td><td>5</td><td>Time (hours) given to the students</td><td>75</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td>Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: 3, Seminar classes: x, Fieldwork: x</td><td>Student whole working time (hours)</td><td>125</td></tr>
<tr><td>Description of content</td><td colspan="3">The goal is to acquire specific knowledge and skills in the field of petroleum geology, which are intended to prepare the students, future engineers for all aspects of exploration and exploitation of oil, gas, condensate and geothermal waters as well as for professional interaction with engineers of related professions in teamwork.
Students aquire specific skills in the area of exploration and exploitation of oil and gas.
Lectures (30 hours)
Abiogenic theories of petroleum origin and biogenic theory of petroleum origin (presentation of arguments and guided discussion)
Biomarkers as indicators of origin of source rocks and deposition conditions
Types of kerogen (conditions of deposition of organic matter, composition and structure of kerogen)
Pyrolysis of source rocks (generation and maturation parameters)
Differences in porosity of clastic and carbonate sediments. Permeability of clastic and carbonate sediments. Correlations of porosity and permeability.
Directions and ranges of primary and secondary migration in different stratigraphic-tectonic conditions
Diagenetic processes important for the migration and accumulation of hydrocarbons
Diapirism. Origin and processes during diaper movement. The significance of diapirism in petroleum geology. Diapirs in the Adriatic s
An overview of the types of traps in the world
Theoretical foundations of basin modelling
Oil and natural gas reserves in conventional accumulations in the world
Reflective seismic surveys - significance in petroleum geological exploration and limitations with regard to reservoir type
Drilling of a deep exploratory well (TDC laboratory, Master Log)
Application of the results of interpretation of well logging. Measurement systems with respect to energy sources: electrical, radioactive, sound. Influences on the results of geophysical measurements in wells: temperature, well diameter, influence of mud
Specifics of exploration of unconventional oil and natural gas accumulations (ultra-deep accumulations, oil and natural</td></tr>
</table>

	gas in shales, natural gas in coal seams) Practical Exercises Comparison of effective porosity differences based on a simple experiment (weighing two dry samples of different effective porosity, immersing the samples in water for 15 minutes after which the samples are weighed again, and their porosity is estimated based on the change in mass) Luminescence of oil and natural gas (observation and description) Preparation of samples taken in the field (separation of fossil content by wet sieving, preparation of samples for analysis of total organic carbon content) Microscopy of fossil contents, discussion of observation results in terms of interpretation of sediment characteristics Analysis of total organic carbon content Project work (15 hours) Systematization of input data Shale volume analysis by interpreting the spontaneous potential curve Calculation of the share of rock thickness with reservoir properties within the total rock thickness (Net / Gross) Porosity analysis of reservoir rocks by interpretation of well - logs in a specialized computer program Making a contour map of the top of the reservoir in a computer software Making a contour map of the bottom of the reservoir in a computer software Making a map of the spatial distribution of the share of rock thickness with collector properties within the total rock thickness in a computer software Making a map of the spatial distribution of reservoir porosity in a computer software Making a cross-section through the reservoir Calculation of reserves based on the constructed reservoir model Making a simple 1D basin model Fieldwork (15 hours) Construction of geological column in clastic sedimentary rocks of Neogene age and sampling for assessment of generative potential of source rocks Construction of a geological column of a characteristic transgressive cycle of Neogene rocks Reconstruction of the circumstances that led to natural hydrocarbon outcrops
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: Interpret the results of analyses and measurements: laboratory and field (from outcrops and from wells) Bring conclusions about the generative-maturation properties of source rocks based on the results of pyrolysis Discuss the interconnectedness of the elements of the petrogeological system Describe the main elements of the drilling rig and the work of geologists during the drilling of deep wells Skills: Analyse the role of biomarkers in determining the origin of hydrocarbons (origin of organic matter and

<table>
<tr><td></td><td colspan="6">sedimentation environment). Estimate geological (total) reserves of hydrocarbon based on a simple reservoir model constructed in a computer software
Competences: Assess the significance of petrophysical properties of reservoir and cap rocks for hydrocarbon accumulation and production. Compare research on conventional and unconventional hydrocarbon accumulations,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
The requirement for signature is atendance of leactures and practicum. Students will have to write seminar on specific topic, and have independent assigments. At the end oral exam will be organized.
Theoretical part is complemented by practical work through seminars and workshops, independent assigments and field works where students will learn about importance of geology in petroleum exploration.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">Selected chapters: Velić, J. (2007): Geologija ležišta nafte i plina [Geology of Oil and Gas Reservoirs], Zagreb, Sveučilište u Zagrebu, Rudarsko-geološko-naftni fakultet, 2007 (university textbook)</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Marko Cvetković, Iva Kolenković Močilac, marko.cvetkovic@rgn.hr iva.kolenkovic@rgn.hr</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td>Student will learn how to have professional interaction with engineers of related professions.</td><td></td><td></td><td></td><td></td><td>Student will work in teamwork.</td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

Course title	**Engineering Geological Investigations**		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: 2, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	125
Description of content	The objective is to adopt basic knowledge about engineering geological investigations for the purpose of design in civil engineering and mining. This course covers all important aspects of engineering geological investigations. Course content elaborated according to the schedule of lectures and exercises: T1: Lectures - Types of engineering geological investigations; Exercises - Review of geotechnical reports T2: Lectures - Engineering geological investigations in site investigations; Exercises - Description of natural characteristics of the investigated area T3: Lectures – Methods of detailed engineering geological investigations; Exercises - Geomechanical classification and engineering description of coarse grained soil T4: Lectures - Genetic classification of soil and rock mass, rock mass weathering and engineering geological profile; Exercises – Geomechanical classification and engineering description of fine grained soil T5: Lectures - Classification and categorization of rock mass; Exercises - Engineering geological description of rock mass – clastic rocks T6: Lectures - Methods of engineering geological investigations for site investigations related to foundation construction; Exercises – Engineering geological description of rock mass – carbonate rocks T7: Lectures - Methods of engineering geological investigations for site investigations related to slope constructions; Exercises - Classification and categorization of rock mass T8: Lectures - Methods of engineering geological investigations for site investigations related to dam construction; Exercises – Construction of borehole log T9: Lectures - Methods of engineering geological investigations for site investigations related to tunnel construction; Exercises - Correlation of exploration boreholes T10: Lectures - Methods of engineering geological investigations of active geomorphological and geodynamic processes; Exercises - Construction of engineering geological profile T11: Lectures - Engineering geological investigations and potential problems in soluble and clastic rocks; Exercises - Engineering geological mapping of tunnels – 1st Par T12: Lectures - Engineering geological investigations and potential problems in magmatic and metamorphic rocks;		

<table>
<tr><td></td><td colspan="6">Exercises - Engineering geological mapping of tunnels – 2nd Part
T13: Lectures - Review of the results of engineering geological investigations and preparation of technical documentation; Exercises - Engineering geological mapping of the road route – 1st Part
T14: Lectures - Methods and results of regional engineering geological investigations; Exercises - Engineering geological mapping of the road route – 2nd Part
T15: Lectures – Application of results of regional engineering geological investigations; Exercises - Reconnaissance engineering geological mapping in scale 1:5000</td></tr>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="6">Knowledge: Select appropriate level of site investigations for the purpose of different types of studies and projects from geotechnical engineering.
Select appropriate type of regional engineering geological investigations for the purpose of different types of studies and projects.
To make concept of detailed engineering geological investigations for different types of structures/constructions.
Identify causes of active geomorphological processes (sliding, erosion, subsidence, etc.) and consequences of geodynamic processes (earthquakes) and to apply appropriate methods of engineering geological investigations.
Identify weathering profiles in different rock types and to apply appropriate methods of engineering geological investigations.
Identify potential geotechnical problems in different rock types for the purpose of performing engineering constructions in geotechnical engineering.
Classify and to describe soil and rock mass according to different recommendations and standards in engineering.
Skills: Evaluate the results of conducted research and testing.
Construct an engineering geological profile and technical tunnel drawings
Conduct reconnaissance engineering geological mapping
Competences: ,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
During the semester the requirement for signature is attendance of leactures. Students will participate in research and practical work as part of practicum. Students will have preliminary exam, writtena and oral exam.
Theoretical part is complemented by practical work through project work and independent assigmensts.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">Selected chapters from: De Vallejo, L.G., Ferrer, M., de Freitas, M. (2011): Geological Engineering. CRC Press, 700 p.</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Snježana Mihalić Arbanas, snjezana.mihalic-arbanas@rgn.hr</td></tr>
<tr><td>Contribution to EIT’s Overarching</td><td>OLO 1</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4</td><td>OLO5 Value</td><td>OLO6 Leadership</td></tr>
</table>

Learning Outcomes (tick relevant box/es)*	**Entrepreneurship**			**Intercultural**	**judgments / Sustainability**	
		Students will conduct reconnaissance engineering geological mapping.	Students will construct an engineering geological profile and technical tunnel drawings.		Students will apply standards and (legal) regulations.	
Justification for OLO contribution						

Course title	**Exploration Geochemistry**		
European Credits (ECTS)	4	**Time (hours) given to the students**	45
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: x, Practical classes: 1, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	100
Description of content	Students will be introduced to the basic principles of geochemical prospecting, i.e., finding the geochemical anomaly caused by the weathering of the ore deposit. Students will be introduced to the behavior of trace elements in surface environments, sampling media (soil, water, sediment, plant rocks), chemical analysis of geological materials (AAS, ICP), statistical methods and interpretation of geochemical data. Students will develop their communication skills through oral presentation and writing reports related to project assignments. Students will acquire a basic knowledge about importance of geochemical prospecting. LECTURES 1. Introduction to the course, basic principles of geochemical prospecting 2. Primary dispersion 3. Secondary dispersion 4. Sampling media, sampling and sample preparation for analysis 5. Instrumental analytical methods 6. Statistical methods in geochemical prospecting; background and threshold determination. 7. Construction of geochemical maps 8. Types of geochemical research and report writing 9-10. Principles of geochemical prospecting in environmental protection EXERCISES (5 blocks of 3 hours) The 15 hours of exercises will include a series of individual tasks that students will have to solve independently and present orally and in the form of an essay. In addition to individual assignments, students will receive a geochemical prospecting project on which they will work throughout the semester in synergy with exercises from two other courses (Remote Mineral Exploration and GIS in Mineral Exploration) and prepare an geological report.		
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To explain the behaviour of chemical elements in surface environments and the processes that control the geochemical anomaly. To select a suitable sampling medium, the proper sample preparation procedure, and the analytical method, as well as analyte in order to find the geochemical anomaly caused by the weathering of the ore body.		

<table>
<tr><td></td><td colspan="6">Skills: To apply univariate, bivariate and multivariate statistical methods in the interpretation of geochemical data. To construct geochemical maps. Design preliminary, regional and detailed geochemical survey of mineral resources.
Competences: To systematize and combine the results of geochemical prospecting with other data and prepare and present a geological report.,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
Students are required to attend classes, solve independent project tasks, participate in a team project and pass the written exam.
Through practical work and independent assigmensts studenst will be introduced to the basic principles of geochemical prospecting,</td></tr>
<tr><td>Recommended readings</td><td colspan="6">1. Moon, C.J. (2006): Exploration Geochemistry (pp 155-178). In: Introduction to Mineral Exploration; 2nd Edition; Charles J. Moon, Michael K.G. Whateley & Anthony M. Evans (Editors); Blackwell Publishing, 2006, 469p.</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Marta Mileusnić, marta.mileusnic@rgn.hr</td></tr>
<tr><td rowspan="2">Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td>Students will develop communication skills through oral presentation and writing reports related to project assignments.</td><td></td><td></td><td></td><td>Students will develop communication skills through oral presentation and writing reports related to project assignments.</td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

Course title	**Remote sensing of mineral resources**		
European Credits (ECTS)	3	**Time (hours) given to the students**	30
Type (Lecture, internship, exercise etc.)	Lectures: 1, Auditorium classes: , Lab. Classes: x, Project classes: x, Practical classes: 1, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	75
Description of content	Students will acquire basic knowledge from remote sensing, with an emphasis on their application in mineral exploration. To enable students to independently collect and analyse multispectral, hyperspectral and radar satellite images required for analysis at surface mineral resources. Introduce students to the automatic supervised and unsupervised classification of satellite images in the analysis of surface mineral raw materials. Through the course students will acquire basic knowledge about application of remote sensing in mineral raw materials exploration. P-1. Introduction, review and definition of remote sensing of mineral resources P-2. Electromagnetic radiation. Active and passive sensors for remote sensing. P-3. Electromagnetic radiation. Active and passive sensors for remote sensing of mineral resources. P-4. Satellite missions, sensors, accessories and equipment of existing satellite systems for remote sensing of mineral resources. P-5. Spatial, spectral, radiometric and temporal resolution of satellite images used in the analysis of mineral resources P-6. Use of software tools and programming languages for remote sensing of mineral resources 1 P-7. Use of software tools and programming languages for remote sensing of mineral resources 2. P-8. Pre-processing of satellite images. P-9. Elimination of geometric errors in sensor operation P-10. Elimination of atmospheric and morphological influences on the quality of satellite images 1 P-11. Elimination of atmospheric and morphological influences on the quality of satellite images 2 P-12. Supervised and unsupervised classification on the example of mineral resources research 1. P-13. Supervised and unsupervised classification on the example of mineral exploration 2. P-14. Use of Synthetic Antenna Radar (InSAR) for mineral analysis 1 P-15. Use of Synthetic Antenna Radar (InSAR) for mineral analysis 2		

<table>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="6">Knowledge: Describe the basic principles and methods of remote sensing for surface mineral raw materials.
Use multispectral and hyperspectral images for analysis at surface raw materials
Describe the characteristics of electromagnetic radiation for the purposes of remote sensing of mineral resources.

Skills: Develop a controlled and uncontrolled classification of mineral resources from satellite images
Apply at least one software tool for interpretation and processing in remote sensing of mineral resources.
Competences: ,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
Students will have lectures and project work. Students are required to attend classes and solve project tasks independently and / or in a team.
Students will learn about remote sensing, with an emphasis on their application in mineral exploration through lessons and practical work.</td></tr>
<tr><td>Recommended readings</td><td colspan="6"></td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Ivan Medved, ivan.medved@rgn.hr</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td>Students will independently collect and analyse mineral resources via remote sensing.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

Course title	**GIS in Exploration of Mineral Resources**		
European Credits (ECTS)	3	**Time (hours) given to the students**	30
Type (Lecture, internship, exercise etc.)	Lectures: 1, Auditorium classes: , Lab. Classes: x, Project classes: x, Practical classes: 1, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	75
Description of content	Master all significant options in GIS software while solving specific examples from the profession. Acquiring the knowledge needed to develop your own GIS projects. Advanced use of geoinformatics on computer and mobile platform. Visualization of GIS projects for the purpose of making cartographic contents of diploma theses. Through the course students will acquire basic knowledge about application of GIS software in mineral exploration. P1 Introductory lecture on the subject. Overview of teaching topics. V1 Curriculum in the semester. Merlin, ArcMap, networking, computer usage rules. P2 Basics of GIS (repetition of undergraduate material). V2 Reminder to ArcView, advantages and disadvantages. P3 Scanning and image processing. V3 Handling maps in paper and digital form. P4 Raster georeferencing. V4 Georeferencing three sheets with known points on geological maps. P5 Raster georeferencing V5 Raster georeferencing over vectors. P6 Raster georeferencing V6 Raster georeferencing over a raster. P7 Review projects and quick maps. V7 Development of an overview project and GIS map for each location. P8 Vectorization of geological map, part 1. V8 Vectorization of a geological map within a given area, Part 1. P9 Vectorization of geological map, part 2. V9 Vectorization of geological map within a given area, part 2. P10 Stages of GIS project development on the example of making a map of mineral resources of western Slavonia, introductory part. V10 Stages of GIS project development on the example of making a map of mineral resources of Western Slavonia, making a GIS project P11 Geotransformation of vector and raster GIS in HTRS96 / TM and WGS84, in general. V11 Geotransformation of vector and raster GIS in HTRS96 / TM and WGS84, data table. P12 SGA Geoportal data, in general. V12 Data from SGA Geoportal, use in GIS project. P13 Geoconversions of point data in Geotrans, in general. V13 Geoconversions of point data in Geotrans, task. P14 Geodetic transformations, parameters and test data, in general. V14 Geodetic transformations, parameters and test data, task. P15 Description of the RGNF WEBGIS system. V15 Work in RGNF WEBGIS system.		

Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To apply statistical methods and spatial analyses in interpretation of laboratory and field measurements To use information technology in computation and modelling of geological phenomena and processes To interpret the results of geological and geochemical prospecting, geophysical and remote sensing investigation of mineral deposits using geographic information system in the analysis of spatial data. Skills: To construct general and thematic geological maps, as well as geological cross-sections with accompanying descriptions To interpret and summarize the results of field, laboratory and office research and prepare and present a geological expert report using other relevant data sources Competences: ,
Assessment methods and criteria	practical mark The student is obliged to do all the exercises and attend 80% of the lectures. It is necessary to complete all project tasks and submit the final GIS projects for review and evaluation. Knowledge is evaluated based on assessment from project assignments, attendance at exercises and overall commitment to teaching. Students will learn about GIS softwers with an emphasis on their application in mineral exploration through lessons and project excercise and independent assigments.
Recommended readings	1. De Smith, M., Longley, P., Goodchild, M.: Geospatial Analysis - A comprehensive guide (online + PDF format), https://spatialanalysisonline.com/ 2. ESRI: Free eBooks as part of its “Best Practices” series, (online + PDF format), https://www.gislounge.com/free-gis-books/ 3. The Rutgers Center on Public Security (PDF format), https://www.rutgerscps.org/gis-book.html
TU Coordinator	Dario Perković, dario.perkovic@rgn.hr

Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
		Students will independently collect and analyse mineral resources via GIS softwares.	Students will independently collect and analyse mineral resources via GIS softwares.			

Justification for OLO contribution	

Course title	**Seismotectonics**		
European Credits (ECTS)	4	**Time (hours) given to the students**	45
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: x, Practical classes: 1, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	100
Description of content	To describe the basics on seismotectonics in different geodynamic settings on Earth, in particular in Croatia, in circum Adriatic region and in the Eastern Mediterranean, and to provide students general knowledge on field and lab methods used in evaluation of seismicity and seismic hazard, assessment of recent tectonic movements on local and regional scale, active stress regimes in the Earth's crust, and in identification and characterization of active, seismogenic faults and seismogenic sources. The course cover all the important data and seismotectonic properties of certain areas. L1. Introduction to Seismology. Seismicity in Croatia and in neighbouring countries. Global seismicity. Seismic waves, seismometers and seismograms. Earthquake intensity and magnitude. Earthquake cycle. Elastic Rebound Theory. Models of earthquake recurrence. Ex1. Seismogram analysis, definition of spatial and surface seismic waves L2. Introduction to seismic hazard and risk in Croatia. Croatian Seismological Survey, seismograph network and Croatian Earthquake Catalogue. Gutenberg-Richter Relationship. Seismic hazard maps in Croatia and in neighbouring countries. Ex 2. Calculation of earthquake epicentre and magnitude based on seismicity data (Part 1) L3. An overview of geodetic methods to measure tectonic movements. Conceptual models of deformation and slip on faults and in fault zones. Trilateration network, Precise leveling: principles and examples. VLB Interferometry and GPS measurements: principles and examples. GPS data in Croatia and in surrounding region used in interpretation of geodynamics in circum Adriatic region and in the eastern Mediterranean. Ex 3. Calculation of earthquake epicentre and magnitude based on seismicity data (Part 2). L4. Type of stresses in the Earth's crust. Stress regimes at the tectonic plate boundaries and far - field stresses. World stress map database. Introduction to borehole breakouts. Fault plane solutions: basic theoretical principles and examples. Ex 4. Analysis of earthquake focal mechanisms (EFM) – interpretation of EFMs L5. Stress regimes and distribution and in circum-Adriatic region. Individual and composite seismogenic sources: definitions and characterization, examples from DISS and SHARE seismogenic databases. Ex 5. Analysis of earthquake focal mechanisms (EFM) - construction of EFM (Part 1). L6. Integration of geological and seismological data in identification and characterization of seismogenic faults/sources.		

	Ex. 6. Analysis of earthquake focal mechanisms (EFM) - construction of EFM (Part 2). L7. Integration of geological and seismological data in construction of seismotectonic maps and profiles: basic principles. Ex. 7. Visit to Croatian Seismological Survey – Earthquake monitoring and analysis L8. Seismotectonics in extensional geodynamic settings. Global distribution of extensional settings. An overview of structural styles and potential seismogenic sources in extensional settings. Ex. 8. Integration of geological and seismological data for construction of seismotectonic profile – Construction of geological profile L9. Seismotectonics in continental graben structures: examples from the East African Rift, Rhone-Rhine Graben, Basin & Range Province. Seismotectonic properties of back-arc basin areas: examples from Aegean and Tyrrhenian sea. Ex. 9. Construction of seismotectonic profile – Construction of geological profile L10. Seismotectonics in compressional geodynamic settings. Global distribution of compressional settings. An overview of structural styles and potential seismogenic sources in compressional settings. Ex. 10. Construction of seismotectonic profile – Earthquake Catalogue analysis and delineation of earthquake series in the profile buffer 10 km wide L11. Seismotectonics in fold-thrust belts: examples from the Alps and External Dinarides. Ex. 11. Construction of seismotectonic profile – Earthquake hypocentre projection on geological profile and correction of structural framework corrections L12. Seismotectonics in strike-slip geodynamic settings. Global distribution of strike-slip settings. An overview of structural styles and potential seismogenic sources in strike-slip settings. Ex. 12. Construction of seismotectonic profile – Identification of seismogenic faults/sources along the profile L13. Seismotectonics in strike-slip geodynamic settings: examples from Dinarides, California, New Zealand and Eastern Mediterranean. Ex. 13. Student's presentations of constructed seismotectonic profiles (Part 1). L14. An overview on seismotectonics in Croatia: key examples from Pannonian basin, Dinarides and Adriatic region. Ex. 14. Student's presentations of constructed seismotectonic profiles (Part 2). L15 & Ex 15. Student's seminar presentations
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: Distinguish stress type and its distribution in Earth's crust in respect to tectonic plate boundary types, regional and local geodynamic processes Explain general terms in Seismology (seismicity, seismic waves, earthquake magnitude, earthquake hazard and risk, Earthquake Cycle and Elastic Rebound Theory) Describe basic properties of global and local seismicity Describe seismotectonic properties of the extensional, compressional and strike-slip tectonic regions Define geodetic methods that are used in measurements of tectonic movements Categorize seismotectonically active regions on Earth, in more detail Mediterranean area and Croatia

<table>
<tr><td></td><td colspan="6">Skills: Compute earthquake epicentre location based on seismic station seismogram analysis
Compute focal mechanism solutions based on geometric and kinematic features of investigated faults
Compute values of moment magnitude and assess earthquake intensity
Competences: , Construct and analyse seismotectonics maps and profiles. Integrate geological and seismic data in identification and categorization of seismogenic faults/seismogenic sources in seismotectonic active regions.</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
Teaching methodologies are: lectures, project and independent assigments and partial e-learning.
Course attendance (minimum 70% attendance), tasks constructed and given for evaluation.
Course evaluation: constructed programs, seminar paper, written exam and oral exam.

Students will be introduced to seismotectonics via lectures, project work and independent assigments and partial e-learning.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">Yeats, R. (2012): Active Faults of the World. Cambridge Univ. Press, 600 str. (selected chapters)</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Bruno Tomljenović/Bojan Matoš,</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td></td><td>During the course students will construct seismotectonic profiles and have presentations.</td><td></td><td>Students will learn about importance of determining seismicity and about seismic hazards and tectonic activities and its impact.</td><td></td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

Course title	**Regional Hydrogeology**		
European Credits (ECTS)	4	**Time (hours) given to the students**	60
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: x, Practical classes: 2, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	100
Description of content	Hydrogeological interpretations on a regional scale and the acquisition of skills in presenting hydrogeological features and calculating groundwater reserves. The student will acquire basic knowledge about the aquifer systems of the Republic of Croatia and strategic groundwater reserves. Students aquire specific skills in the area of hydrogeological interpretation on regional scale. Energy conditions of groundwater movement, Basic concept of thermal regime. Map of the geothermal gradient of Croatia, geothermal potential analysis. Geochemical cycle, Hydrochemical facies. Examples of laboratory chemical analyzes of water, Piper diagrams Groundwater chemistry and its impact on water use (water supply, industry, agriculture) and legislation. Examples of water classifications depending on the intended use (Doneen, USDA). Regional hydrogeology, scale effect (spatial and temporal), the continuity equation. The concept of scales cartographic and physical, scale effect on permeability Hydrogeological parameters. Heterogeneity and anisotropy of hydraulic conductivity (example of parallel and vertical flow in relation to the position of layers) Basic flow of inclined aquifer systems and unit hydrograph, runoff coefficient and recovery coefficient. Hydrogeological significance of the recession coefficient on the example Radial flow, well hydraulics, direct integration of Darcy's law. Calculation (identification) of hydrogeological parameters Unconfined aquifer, flow below water surface, Dupit assumption. Flow through horizontally and vertically stratified aquifer Hydrogeological objects (wells, piezometers), construction and use. Examples of hydrogeological objects (question of aquifer heterogeneity) Hydrogeological maps and issues of graphical representation of hydrogeological properties, phenomena and relationships. Examples of hydrogeological maps of different scales Hydrogeology of the Republic of Croatia, division of territories by basins, catchment areas. Hydrogeological characteristics of the Sava River Basin, the valley part of the Sava River Basin, the basins of the left tributaries of the Sava. Analysis of the water level and flow of the Sava on significant water meter profiles, comparison of the Sava water level and groundwater level and conclusion on the hydraulic connection of the Sava and the banks, drainage, recharge.		

	Basins of right tributaries of the Sava, Kupa basin, Dobra basin, Mrežnica basin, Korana basin, Una basin. Analysis of hydrographs of significant sources in the basins of the right tributaries of the Sava, definition of the equation of the recession part of the hydrograph, recession coefficient and dynamic reserves. Drava basin, valley part of the Drava basin, hilly and hilly area of the Drava basin. Analysis of water level and flow of the Drava on significant water meter profiles, comparison of Drava water level and groundwater level in the hinterland, inference about the hydraulic connection of the Drava and the hinterland, drainage and recharge. Hydrogeology of Istria, Croatian Littoral, Lika and Podvelebita (Gacka and Lika basins), Zrmanja basin, Krka basin. Analysis of hydrographs of significant sources in the Mirna, Gacka, Lika, Zrmanja and Krka basins, definition of the equation of the recession part of the hydrograph, recession coefficient and dynamic reserves. Cetina basin, lower Neretva basin, coastal basin from Neretva to Boka Kotorska, basins of significant coastal springs. Ranking of watersheds by quantity and quality of water, strategic reserves of Croatian groundwater from the first to the fifth level. Analysis of data on groundwater tracing carried out in the area of southern Dalmatia and conclusion on karst watersheds.
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: Define the concept of scale in hydrogeology and explain its effect through permeability properties Describe the basic concept of the Earth's thermal regime and relate it to the genesis and dynamics of thermal waters Describe the geochemical cycle Interpret the chemical composition of water Define and graphically represent hydrochemical facies Analyze the spring hydrograph Explain how to determine groundwater reserves Describe the hydrogeological systems of Croatia Skills: Apply hydrogeological maps in the description of hydrogeological features of the area Assess the significance of a particular hydrogeological system for a water supply Competences: ,
Assessment methods and criteria	exam Teaching methodologies are: lectures, project and independent assigments. Students will have to finish hidrogeological project for evaluation. Through the course students will learn about hydrogeological interpretations on a regional scale.
Recommended readings	Struckmeier, W.F. & Margat, J. (1995): Hydrogeological maps, A guide and a standard legend, pp. 177.,International association of hydrogeologist, Verlag Heinz Heise, Hannover

<table>
<tr><td>TU Coordinator</td><td colspan="6">Željko Duić/Jelena Parlov,</td></tr>
<tr><td rowspan="2">Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Students will learn about importance of groundwater reserves and its preservation.</td><td></td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

Course title	**Industrial Mineral Deposits and Applications**		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: 2, Seminar classes: x, Fieldwork:	**Student whole working time (hours)**	125
Description of content	The objective of the course is to learn about the physicochemical and geological conditions of formation of deposits of the main industrial minerals and their application in industry. The course covers all important data about industrial minerals and its application. L1 - Definitions of terms: (1) ore mineral and (2) industrial mineral. Classifications of industrial minerals. L2 - Physicochemical conditions for the formation of clay deposits. Industrial clays: Kaolins, bentonites, sepiolites and palygorskites. L3 - Mineralogy and geology of kaolin deposits. Application of kaolin in industry. L4 - Mineralogy and geology of bentonite, sepiolite and palygorskite deposits. Application in industry. L5 - Construction clays and industrial applications. L6 - Physicochemical conditions of bauxite deposits. Laterite and karst bauxites. Application of bauxite in industry. L7 - Quartz mineral raw materials (quartz crystals, quartz sands and sandstones, SiO_2 as chemical and biogenic sediment, diatomite, flint). Feldspar deposits. Application of quartz mineral raw materials and feldspar in industry. L8 - Physicochemical conditions of evaporite formation. Deposits of gypsum and anhydrite. L9 - Deposits of halite, sylvine, soda, borate, Mg and Li salts. L10 - Physicochemical conditions of phosphate formation. Apatite and phosphorite deposits. Phosphate application in industry. L11 - Deposits of barite, fluorite and refractory materials. Application of barite, fluorite and refractory materials in industry. L12 - Deposits of pyrite and sulphur. Application of pyrite and sulphur in industry. L13 - Physicochemical conditions of zeolite formation. Zeolite deposits. Application of zeolite in industry. L14 - Pigments and their application in industry. L15 - Graphite deposits. Application of graphite in industry.		
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: Identify and describe the types of deposits of industrial minerals Analyse and argue the physicochemical and geological conditions for the formation of deposits of industrial minerals Prepare a plan for the exploration of industrial mineral deposits to determine the potential for industrial application Evaluate the quality of industrial mineral deposits		

	Demonstrate the technological processes of manufacturing bricks, tiles, glass, cement and refractory materials. Evaluate and recommend the application of industrial minerals in agriculture and various industries. Skills: Competences: ,					
Assessment methods and criteria	exam Methodologies are: lectures, seminars, workshops and independent assigment. The examination will be taken orally. Requirements for taking the exam are: 1. committed and positively evaluated assignments in the internship 2. submitted and held seminar paper 3. submitted field report 4. positively evaluated both colloquia Main proceses of forming industrial mineral and its application will be introduced to students through the lectures and practical work.					
Recommended readings	1.Manning, D.A.C. (1995): Introduction to industrial minerals, Chapman & Hall, 276s. 1.Manning, D.A.C. (1995): Introduction to industrial minerals, Chapman & Hall, 276s. 2. Evans, A. M. (1993): Ore geology and industrial minerals, Blackwell Science Publications, 389s. 3. Chang, L. L. Y. (2002): Industrial mineralogy, Prentice Hall, 472. 4. Harben, P. W. & Kužvart, M. (1997): Industrial minerals-A global geology, Industrial Minerals Information, 476s.					
TU Coordinator	Goran Durn, goran.durn@rgn.hr					
Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
	Students will prepare a plan for the exploration of industrial mineral deposits to determine the potential for industrial application.				Students will learn about importance of Industrial Mineral Deposits and its Applications and applying of the regulations.	
Justification for OLO contribution						

<table>
<tr><td>Course title</td><td colspan="3">Analytical methods in ore deposits</td></tr>
<tr><td>European Credits (ECTS)</td><td>5</td><td>Time (hours) given to the students</td><td>60</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td>Lectures: 2, Auditorium classes: , Lab. Classes: x, Project classes: , Practical classes: 2, Seminar classes: , Fieldwork:</td><td>Student whole working time (hours)</td><td>125</td></tr>
<tr><td>Description of content</td><td colspan="3">The aim of this course is to review the most important analytical methods and applications in the mineral deposits investigation in order to determine mineralogical, geochemical and isotopic composition and reconstruction of genetic processes. The course covers: microscopy in transmitted and reflected light, electron microscopy and electron microprobe, microthermometry of fluid inclusions, ion chromatography, vitrinite reflection, crystallinity of chlorite, illite and graphite, atomic absorption and emission spectroscopy, inductively coupled plasma mass spectrometry (ICP-MS), stable and radiogenic isotopes.
This course gives students knowledge about analytical methods in mineral deposits exploration.
Polarised light microscopy - Contact-metamorphic reactions; Mineral stability fields; Alteration reactions. Reflected light microscopy - Fundamentals of ore microscopy (optical properties in reflected light); examples of the most important structures and textures; Interpretation. Electron microscopy / EMPA - Basics principles; Detectors; Application and interpretation; Geothermobarometric use in equilibrium systems; Sample preparation. Microthermometry of fluid inclusions - Basics principles; Application and interpretation; Sample preparation. Ion chromatography - Basics principles; Application in ore deposits; t / c conditions; Sample preparation. Vitrinite reflection / Crystallinity of chlorite / illite / graphite - Basics principles; Application in ore deposits; t / c conditions; Sample preparation (illiterate crystallinity); AAS; AES; ICP-MS; Stable isotopes (oxygen, hydrogen, carbon); Radiogenic isotopes (K / Ar; Rb / Sr; Sm / Nd; U / Th / Pb, fission-tracks) - Basics principles; Application in ore deposits; Data interpretation.</td></tr>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="3">Knowledge: To explain the application of individual method, principle, sample preparation and instrument characteristics
To prepare a geological sample for selected methods (sawing, grinding, polishing, pulverizing, dissolving, diluting, etc)
To determine mineral paragenesis, structures and textures in plane-polarised regular and reflected light
To determine the succession (phases) of crystallization (pre-ore; ore and post-ore stage) and subsequent alterations
To interpret obtained analytical data and determine composition of fluids, pressures and temperatures of formation of ore deposits and alterations.
To interpret the micro, macro and trace element composition.
To interpret the results of stable isotope analysis and conclude on the source fluid.
To interpret the results of radiogenic isotopes in order to determine the age of the host rock, mineralization, and</td></tr>
</table>

<table>
<tr><td></td><td colspan="6">subsequent events.
Skills:
Competences: ,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
Students will have lectures, practicum, independent assigments, and at the end oral exam.
Students will learn about most important analytical methods and applications in the mineral deposits investigation through practicum, and independent assigments.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">Reed, S. J. B. (2010): Electron Microprobe Analysis and Scanning Electron Microscopy in Geology. Cambridge University Press, 201 p.</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Sibila Borojević Šoštarić, sibila.borojevic-sostaric@rgn.hr</td></tr>
<tr><td rowspan="2">Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td></td><td>Students will review the most important analytical methods and applications in the mineral deposits investigation.</td><td></td><td></td><td></td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

Course title	**Geophysical Exploration of Mineral Resources**		
European Credits (ECTS)	3	**Time (hours) given to the students**	30
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: x, Project classes: , Practical classes: 0, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	75
Description of content	Mastering the specialist geophysical methods of measurement and interpretation applied in the exploration of construction materials deposits and solid raw mineral materials. The course goes through the key points of geophysical methods for prospection and exploration of mineral deposits. Magnetometric exploration. Magnetometric data interpretation methods. Aeromagnetometric exploration. Magnetometric exploration of solid raw materials. Field survey design for characteristic geological models. Gravity exploration. Gravity map transformations - goal, transformation methods, application. Microgravity exploration. Gravity modelling and application in raw minerals exploration. Electrical tomography. Theoretical foundations. Measurement geometry. Tomographic inversion. Electrical tomography instruments. Electrical tomography in the exploration of construction materials deposits. Electromagnetic exploration. TURAM method, Electromagnetic method using moving transmitter, VLF method, magnetotelluric method - theoretical foundations, instruments, data processing, interpretation and application. Georadar - theoretical foundations, field measurement methods, resolution and depth, instruments, application. Seismic measurements in wells. "Down-hole" and "Cross-hole" methods – measuring methods, instruments, application. Refraction seismics. Methods of refraction data interpretation: DTM, Delta – t – V, GRM and refraction tomography. High resolution reflection seismics (HRS method) – conducting exploration, data processing, interpretation. Seismic modelling. Synthetic seismogram - construction of synthetic seismogram, application of synthetic seismogram.		
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To control principles of working with instruments for magnetometric exploration. To control principles of working with instruments for electric and electromagnetic exploration. Skills: To be able to interpret the obtained magnetometric measurements data. To be able to interpret the obtained gravimetric measurements data. To be able to interpret the obtained electrical tomography data. To be able to determine the first arrivals of the waves when measuring seismic velocities in a well.		

<table>
<tr><td></td><td colspan="6">To be able to calculate mean and interval speeds and interpret the obtained data.
To be able to choose the optimal geophysical exploration methods in the construction material deposits exploration.
To be able to conduct geophysical exploration in the specific geological models in terms of solid raw materials exploration.
Competences: ,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
Students will have lectures, practicum, independent assigments, and at the end oral exam.
By lectures, seminars and workshops students will study about specialistic geophysical methods in the exploration of materials deposits.</td></tr>
<tr><td>Recommended readings</td><td colspan="6"></td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Franjo Šumanovac,</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td></td><td>Students will have to interpret different geophisical data and make conclusions about mineral deposits and its main characteristics.</td><td></td><td></td><td></td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

Course title	**Field and laboratory practicum**		
European Credits (ECTS)	6	**Time (hours) given to the students**	120
Type (Lecture, internship, exercise etc.)	Lectures: , Auditorium classes: , Lab. Classes: x, Project classes: , Practical classes: 128, Seminar classes: , Fieldwork: x	**Student whole working time (hours)**	150
Description of content	Students will be introduced to various field and laboratory methods used in exploration of mineral deposits. Students will be trained to recognize mineralization, visualize 3D geological structures, and reconstruct geological history. Most of the activities will be related to proper geological fieldwork: observation, personal filed book, interpretation and sampling. Furthermore, students will analyse the collected geological samples of water, soil, rocks, sediments, minerals in the laboratories. Finally, they will learn to combine and interpret obtained field and laboratory results with previous geological research and produce and present geological expert reports. Through the course students will be introduced to various field and laboratory methods used in exploration of mineral deposits. The course consists of geophysical, geological and geochemical field exercises and laboratory analysis on sampled geological materials, and takes place in 15 terms of 8 hours. The field part of the course will be conducted jointly on two training grounds for the exploration of mineral deposits and two selected deposits of industrial minerals in the Republic of Croatia. At the training grounds for exploration of the mineral deposits, students will perform geophysical measurements, surface and underground mapping with the preparation of associated geological maps and profiles with indicated mineralization positions and conduct field geochemical prospecting on selected media. At selected deposits of industrial minerals, students will be introduced to the complete cycle of mineral raw materials, from geological prospecting and exploitation to the processing, final products and waste disposal. The laboratory part will include the preparation and analysis of sampled geological materials. Field days (13 days) Training grounds for exploration of mineral deposits (11 days of joint fieldwork) 1) Geophysical prospecting (2 days) 2) Mapping of surface mineralization and preparation of geological map and profile (2 days) 3) Mapping of underground exploitation (3 days) 4) Sampling of host rocks and alteration zones proximal and distal to mineralization (2 days) 5) Geochemical prospecting - sampling of geological materials and in-situ measurement of basic geochemical		

<table>
<tr><td></td><td colspan="6">parameters (1 day)
6) Additional independent work of students (1 day)

Mineral raw materials cycle - industrial materials of the Republic of Croatia (2 days):
7) From ceramic clay and quartz sand to bricks (ceramic clay deposit, quartz sand deposit, brick factory; 1 day)
8) From natural gypsum to gypsum boards (gypsum bed, gypsum board factory; 1 day)
Laboratory days (2 days)
1) Preparation and analysis of geological materials sampled during geochemical prospecting at the polygon for exploration of mineral deposits.</td></tr>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="6">Knowledge: To select a suitable geophysical method for exploration of the mineral deposit
To prepare a geological map and the corresponding profile with the indicated types of mineralization
To prepare laterally developed underground mine map
To analyse chemical composition of the geological materials using standardised laboratory procedures and normative.
To describe the overall process of mineral raw materials starting from exploration and exploitation to the processing and final product, highlighting the primary raw materials properties.
Skills: To sample various geological materials (minerals, rocks, sediment, soil, water) for the purpose of exploration of the mineral deposits. To conduct field measurements of selected parameters in geological materials (eg pH, EC, redox potential, radioactivity) for the purpose of geochemical prospecting.
Competences: ,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">practical mark
Students will have field and laboratory work, work with mentor, project assigments.
Students will be introduced to various field and laboratory methods used in exploration of mineral deposits through field and laboratory work.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">FOREGS Geochemical Mapping Field Manual. Geological Survey of Finland, Espo, 1998.
Marjoribanks, R. (2010) Geological Methods in Mineral Exploration and Mining, Springer, 238 s.</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Sibila Borojevic Šoštarić, sibila.borojevic-sostaric@rgn.hr</td></tr>
<tr><td rowspan="2">Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td>Students will be introduced to</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

	various field and laboratory methods and work used in exploration of mineral deposits where all skills will be developed.					
Justification for OLO contribution						

<table>
<tr><td>Course title</td><td colspan="3">Analyses of mineral paragenesis</td></tr>
<tr><td>European Credits (ECTS)</td><td>3</td><td>Time (hours) given to the students</td><td>45</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td>Lectures: 1, Auditorium classes: , Lab. Classes: x, Project classes: , Practical classes: 2, Seminar classes: , Fieldwork:</td><td>Student whole working time (hours)</td><td>75</td></tr>
<tr><td>Description of content</td><td colspan="3">The goal of the course is to train the students in microscopic analysis of different generations of mineral parageneses in magmatic and metamorphic rocks and their interpretation in the light of petrogenesis and later evolution of these rocks in the certain geotectonic environment.
Students will aquire knowledge about mineral paragenesis of magmatic and metamorphic rocks and its interpretation. The definition of the mineral paragenesis. Primary and secondary mineral parageneses in the magmatic rocks. Postequlibration and postconsolidation changes of primary magmatic minerals and the origin of secondary parageneses: (1) resorption and late magmatic subsolidus reactions; (2) hydrothermal alterations and (3) the changes caused by weathering. Phase relations in the crystallisation systems as the result of fractionation processes and reactions in the magmatic rocks. Phase diagrams (liquidus, solidus, binary and ternary eutectic, cotectic curves, solvus, peritectic point). Two-component systems with the eutectic point, with continuing solid solution crystal serie and the new compound which melts incongruently. Three-component systems with the clinopyroxene and plagioclase, with alkali feldspars and quartz, with plagioclase, clinopyroxene and olivine and forsterite, anorthite and quartz.. The influence of volatiles on the crystallisation of the system. The explanation of genesis of different magmatic textures, intergrowths and exsolutions by phase diagrams (ophitic texture, intergranular texture, graphic and myrmekitic intergrowths, perthite/antiperthite). The exsolution process in the different minerals (pyroxenes, feldspars, calcite, ilmenite, biotite). Disequilibrium state: a) the occurrence of zoning (concentric, patchy, sector, normal, reversal and oscillatory zoning) in different minerals; b) the occurrence of “sieve” texture. Enclaves in the magmatic rocks: xenoliths, xenocrystalls and microgranitoid enclaves. The differences in the mineral parageneses and textures in the crust peridotites and mantle peridotites. Ophiolite and their metamorphic sole. Precise classification and nomenclature of magmatic rocks on the basis of microtexture, primary and secondary parageneses and petrogenetic interpretation of the sequence of the processes in the evolution of certain magmatic rocks.</td></tr>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="3">Knowledge: To explain the ways of the origin of primary and secondary mineral parageneses in magmatic rocks.
To distinguish mineral parageneses and microtextures in crust peridotites from those in the mantle peridotites in the ophiolite complexes.
To classify magmatic rocks on the basis of microtextures, primary and secondary mineral parageneses and reconstruct the sequence of processes in the evolution of certain magmatic rocks.</td></tr>
</table>

	To distinguish different mineral parageneses and the sequence of their formation in the metamorphic rocks. Skills: To apply phase diagrams in the interpretation of genesis of different microtextures, intergrowths and exsolutions inside of minerals in magmatic rocks. To use evident signs of disequilibrium in minerals and rocks in the interpretation of their crystallisation and later evolution and petrogenesis, respectively. To apply different types of mineral recrystallization and their deformations to deduce the p-T evolution of the metamorphic rocks. Competences: ,					
Assessment methods and criteria	exam Teaching methodologies are: lectures, laboratory, independent assigments and exercises with petrographic microscope. At the end students will have oral exam. Main emphasis is on application of determining mineral paragenesis in determining different samples through excercises and independent assigments.					
Recommended readings						
TU Coordinator	Vesnica Garašić, vesnica.garasic@rgn.hr					
Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
			Students will have to interpret mineral paragenesis and make conclusions about genesis of rocks.			
Justification for OLO contribution						

Course title	**MSc thesis**					
European Credits (ECTS)	20	**Time (hours) given to the students**	15			
Type (Lecture, internship, exercise etc.)	Lectures: , Auditorium classes: , Lab. Classes: , Project classes 1: , Practical classes: , Seminar classes: , Fieldwork:	**Student whole working time (hours)**	500			
Description of content	The master thesis for the student aims to prove the ability of independent analysing and solving complex engineering tasks/problems in the field of geology related to the master thesis topic. The master thesis is a paper in which the student must demonstrate the ability of independent analysis and solving a given engineering problem/task in the field of geology using the knowledge acquired through graduate study from a theoretical and practical point of view.					
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To define a professional problem / task To summarise master thesis in English To apply the methodology of writing a professional and scientific paper To write master thesis linguistically and ethically correct To apply the acquired knowledge and general competencies acquired through graduate study To interpret research results Skills: To solve a complex practical problem / task. To argue the results of the conducted research in an expert discussion Competences: To respect ethical norms and rules of citing literature, To design and conduct research.					
Assessment methods and criteria	practical mark The student is obliged to apply for one of the offered topics, make a plan of activities with the mentor and submit the master thesis for evaluation within the given deadlines, prepare a presentation and defend the master thesis in front of the committee.					
Recommended readings	Selected literature based on the topic of master thesis and according to the mentor's recommendation.					
TU Coordinator	All teachers in the scientific-teaching profession					
Contribution to EIT's Overarching Learning Outcomes (tick relevant	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments /**	**OLO6 Leadership**

box/es)*					**Sustainability**	
	The student will develop all skills through work on the master thesis and through solving complex engineering tasks/problems.					
Justification for OLO contribution						

Semester 4
WUST

EIT label – Teaching units <TIMREX – T-shaped Master Programme for Innovative Mineral Resource Exploration>

Course title	**Applied field exploration**					
European Credits (ECTS)	3		**Time (hours) given to the students**		45	
Type (Lecture, internship, exercise etc.)	Lectures: , Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: , Seminar classes: , Fieldwork: 3		**Student whole working time (hours)**		75	
Description of content	The goal of the course is that students should acquire a hands-on understanding of different field exploration methodologies, and how they can be integrated for targeting VMS deposits. Geological, geophysical and geochemical exploration methods in VMS exploration. Practical field mapping exercises in structural geology, stratigraphy, hydrothermal alteration. Practical geophysical surveying using UAV technology. GIS-based data synthesis for exploration target selection. Drill core logging and assaying.					
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: when passed the student is expected to have: -knowledge about different field methods and their use during an exploration program. -knowledge about drilling and sampling methods. -knowledge about different methods for field mapping. Skills: when passed the student is expected to have the ability to - acquire in-depth structural, volcanological and alteration data from outcrops in the field - contextualize field observations in relation to ore genetic model for VMS deposits. - synthesize different types of geological and geophysical data for targeting a VMS deposit. Competences: ,					
Assessment methods and criteria	Exercises U G# 1.20 Project work G U 3 4 5 1.80 The course is mainly presented via practicals in the field, but also with complementary lectures and excercises, in addition to project work.					
Recommended readings	Online compendium in Canvas room					
TU Coordinator	Nils Jansson, Nils.Jansson@ltu.se					
Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**

Justification for OLO contribution	

<table>
<tr><td>Course title</td><td colspan="3">SOC Internship</td></tr>
<tr><td>European Credits (ECTS)</td><td>2</td><td>Time (hours) given to the students</td><td>30</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td>Lectures:, Auditorium classes: , Lab. Classes: , Project classes: 2 , Practical classes:, Seminar classes: , Fieldwork: x</td><td>Student whole working time (hours)</td><td>50</td></tr>
<tr><td>Description of content</td><td colspan="3">The aim of the course is to enable students to work in socially responsible workplaces, and apply their skills and knowledge to promote social good. While this develops them to become work-ready professionals, it also nurtures them to become advocates who help build a better world.
EDUCATIONAL GOALS:
1. To actively participate in the affairs of the community and in concrete actions on the ground that aim to promote the public interest, equality and solidarity.
2. To reflect on social license to operate issues
3. To work in direct contact with the beneficiaries of the civic activities undertaken e.g.: reception, facilitation, support, social assistance, etc.
EXAMPLES OF SOCIAL AND CIVIC ISSUES IN MINERALS INDUSTRIES:
• Depletion of natural capital (degradation of air, land and water quality), land use conflicts, health impacts
• Digitalization and automation generate particular challenges for well-being in mining regions. Limited job opportunities for local workforce and skills mismatches.
• High and continuous transparency and accountability standards of the industry, effective methods of information sharing and dialogue
• A more equitable value-sharing, Corporate Social Responsibility issues
• Facilitation of environmental awareness
• Preservation and restoring of historic sites,</td></tr>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="3">Knowledge: to understand that social responsibility incorporates an ethical, social and environmentally-friendly perspective to our personal and professional activities
Skills: To be able to engage in an informal professional discussion and business communication
Competences: To cope with complexity, uncertainty and change in global contexts</td></tr>
</table>

Assessment methods and criteria	Criterion: Submission of a project report					
Recommended readings						
TU Coordinator	Supervisors of the student's Master thesis					
Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
	Students will be engaged in professional discussion and business communication				Students will be able to understand that social responsibility incorporates an ethical, social and environmentally-friendly perspective to our personal and professional activities	
Justification for OLO contribution						

<table>
<tr><td>Course title</td><td colspan="3">Exploration entrepreneurship</td></tr>
<tr><td>European Credits (ECTS)</td><td>4</td><td>Time (hours) given to the students</td><td>60</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td>Lectures: 1, Auditorium classes: , Lab. Classes: , Project classes: 1, Practical classes: 3, Seminar classes: 2, Fieldwork:</td><td>Student whole working time (hours)</td><td>100</td></tr>
<tr><td>Description of content</td><td colspan="3">To equip students with the professional skills to increase their employability and entrepreneurship skills to meet the current market demands. The EFGeoMentoring scheme aims at improving international networking and supporting the life-long learning and CPD requirements of experienced geology professionals. In addition, it allows students to benefit from insider knowledge about international work perspectives in different sectors of geological profession and countries.
Mentoring within the course is a process during which an experienced professional with and EurGeol title (mentor) accompanies the student in a targeted way. Mentoring contributes to developing personal, entrepreneurial, networking, social and professional skills regarding the mineral prospecting and exploration activity. It allows learning from professional experiences that can only be acquired through practice and can't be found in any textbook. Mentoring improves the opportunities of career beginners by providing career-enhancing contacts and involvement in professional networks.
At the beginning of the mentoring cooperation, students formulate clear goals and communicate them to their mentor. In consultation with the mentor, concrete topics and the respective roles within the mentoring process will be defined. Since the student is at the centre of the process, it is their task to become aware of their own plans and their support needs.
OBJECTIVES OF THE MODULE:

Intensify international networking among geologists all across Europe and beyond
Provide young professionals with contacts helping them to think through, plan and access their short, medium or long-term career development
Contribute on internship positions
Improve gender balance and increase diversity in leadership positions by providing targeted support to women and under-represented minorities
Facilitate life-long learning and Continuing Professional Development (CPD)

The EFG mentors are professionals who have acquired a high level of industrial and/or academic experience and work in industrial practice, business, academia, education or administration.

Coaching: The mentor actively guides and encourages the student to develop essential skills and attitudes for the future ("How do I assert myself? How do I behave in negotiations? What do I do in challenging work contexts?")
Advice: The mentor advises the student in concrete situations, in current questions and difficulties. Mentors support students in solving problems and assist them in making tough decisions.
</td></tr>
</table>

	• **Help:** The mentor can help open otherwise locked doors that allow the student to pursue their goals. • **Support:** The mentor supports the student in essential decisions without deciding. Mentors assist in the development of professional strategies, as well as in career planning and review of possible obstacles. • **Inform:** The mentor informs the student about (informal) rules and processes applied in organisations or professional life in general. According to the student's background, mentors can also inform about seminars or conferences that they consider helpful. • **Participation:** Mentors allow students to participate in parts of their professional career, experiences and strategic decisions. They allow students to share their professional life and invite them, for instance, to participate in meetings or appointments. • **Give feedback:** Mentor and student provide each other with constructive feedback about their appearance and public perception. • **Networking:** Mentors give the students hints on maintaining and using contacts. They introduce the students into active networks and provide professional contacts. The mentor provides the student with the chance to create a successful CV and take a chance on social networks such as LinkedIn.
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: to provide background training to support the learning process; make students aware of broad professional issues; provide business and entrepreneurship skills to develop an awareness of business management and commercial practices regarding mineral prospecting and exploration. Skills: Develop relationships with other persons and maintain them. Can talk frankly about his ideas, fears and weaknesses. Identifying investment opportunities in the mineral resources sector. Competences: To define professional targets, wants to succeed and is actively committed to implementing these targets. Not afraid of making mistakes and experimenting with new ideas. Willing to question himself critically, accept external advice, and implement it.
Assessment methods and criteria	Practical mark At the end of the mentoring process, students will a) reflect their mentoring experience on a two-page report highlighting benefits and potential gaps for future implementation b) prepare a small business plan for an identified innovative idea of their own. Slack channel will allow for student-mentor exchange and networking within the whole cohort of participants. Mentoring is a one-to-one relationship between a mentor and a student. • Mentoring takes place beyond a dependent relationship (e.g. supervisor-subordinate or professor-student relationships). • During the mentoring process, learning and experimentation occur in a protected environment. • An integral part of mentoring is the development of professional skills and competencies. Mentoring is a reciprocal process of "give and take". Both sides learn from each

<table>
<tr><td></td><td colspan="6">other because even the mentor will have the opportunity to critically question his professional perspective and discover new perspectives, software and applications, and previously unperceived situations.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">Mentoring Mindset, Skills and Tools 4th Edition: Make it easy for mentors and students, 2020, Synergetic People Development Pty Ltd, 252 pages, ISBN 0980356458

The Mentoring Guide: Helping Mentors and Students Succeed, 2019, Michigan Publishing Services, ISBN: 1607855399.

Wang, J., Shibayama, S., 2022. Mentorship and creativity: Effects of mentor creativity and mentoring style. Research Policy 51, 104451. doi:10.1016/j.respol.2021.104451

Entrepreneurship: A Guide To Success For Entrepreneurs And Aspiring Entrepreneurs, 2018, ISBN 978-1720221654
Entrepreneurship: Successfully Launching New Ventures, Global Edition, 2018, Pearson, ISBN: 9781292255330</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Pavlos Tyrologou, pavlos.tyrologou@gmail.com</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td>XX</td><td></td><td>X</td><td>XX</td><td>XX</td><td>XX</td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

COURSE DESCRIPTIONS/
KARTY PRZEDMIOTÓW

second-level studies/ studia II stopnia
main field of study/ kierunek studiów:
Mining and Geology/ Górnictwo I Geologia

specjalność/specialisation:
Mineral Resources Exploration
- Track UNI ZAGREB -WUST

Semester 1 and 2
UNI ZG

University of Zagreb, RGNF

Course title	**Sedimentology**		
European Credits (ECTS)	5	**Time (hours) given to the students**	75
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: 3, Seminar classes: , Fieldwork: x	**Student whole working time (hours)**	125
Description of content	to acquire the main techniques in defining sedimentary facies, to recognize sedimentation processes, to recognize the basic features of modern and palaeo- depositional environments, to recognize and interpret characteristic sedimentary sequences, to analyse all elements present in the sedimentary environment and interpret possible depositional environment This course gives students knowledge about sedimentary processes and its interpretation. L1 - DEFINITION OF FACIES CYCLES AND SEDIMENTARY SEQUENCES L2 - WAYS OF VERTICAL SUCCESSIONS DISPLAY (SEDIMENTARY COLUMNS); WAYS AND POSSIBILITIES OF CORRELATION L3 - SEDIMENTARY ENVIRONMENT OF ALUVIAL FANS; TECTONIC SETTINGS, PROCESSES, CHARACTERISTIC SEQUENCES L4 - DEPOSITIONAL ENVIRONMENT OF BRAIDED, MEANDRING AND ANASTOMOSING RIVERS; TECTONIC SETTINGS, PROCESSES, CHARACTERISTIC SEQUENCES L5 - DELTAIC SEDIMENTARY ENVIRONMENT; PROCESSES, TYPES OF DELTAS; PARTS OF THE DELTA; CHARACTERISTIC SEQUENCE L6 – SILICICLASTIC SHORELINE; SILICICLASTIC SHELF / RAMP DEPOSITIONAL ENVIRONMENT; NEARSHORE SHELF / RAMP PROCESSES L7 – WAVE- TIDE- STORM-INFLUENCED SILICICLASTIC SHORELINE (SHELF/ RAMP) L8 – SHALOW-MARINE CARBONATE ENVIRONMENTS; DEPOSITION ON CARBONATE PLATFORM (processes), CARBONATE RAMP / SHELF L9 - CHARACTERISTICS AND FACIES OF CARBONATE PLATFORM (according to Flügel, 2004) L10 - CHARACTERISTICS AND FACIES OF CARBONATE RAMP / SHELF (according to Flügel, 2004) L11 - EVAPORITIC SEDIMENTARY ENVIRONMENTS L12 - CARBONATE DIAGENESIS – DOLOMITES, KARST FORMATION L13 - DEEPWATER SEDIMENTARY ENVIRONMENTS - PELAGIC DEPOSITION IN THE OCEANS L14 - DEEPWATER SEDIMENTARY ENVIRONMENTS – RESEDIMENTED, MASS-FLOW DEPOSITS: DEBRITES, TURBIDITY		

	CURRENTS; CHARACTERISTICS OF TURBIDITE FANS L15 - MIXED (SILICLASTIC-CARBONATE) SEDIMENTARY ENVIRONMENTS - CHARACTERISTIC SEQUENCES					
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To conduct complex sedimentological investigations, including the construction of strata sequences, facies differentiation and interpretation of sedimentary environments. Skills: To construct general and thematic geological maps, as well as geological profiles with accompanying descriptions Competences: To engage in informed professional discussion and business communication,					
Assessment methods and criteria	exam During the semester the requirement for signature is atendance of leactures and practicum. Students will participate in research and practical work as part of practicum. At the end oral exam will be organized. Theoretical part is complemented by research work, practical work and field works where students will learn about sedimentology processes and depositional environment.					
Recommended readings	Flügel, E., (2004): Microfacies of Carbonate Rocks; Analysis, Interpretation and Application. Springer (976 pp)					
TU Coordinator	Dunja Aljinović, dunja.aljinovic@rgn.hr					
Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
	Students will be engaged in informed professional discussion and business communication		Students will have to construct general and thematic geological maps and profiles with accompanying descriptions			

Justification for OLO contribution	

<table>
<tr><td>Course title</td><td colspan="3">Mineral Deposits Exploration</td></tr>
<tr><td>European Credits (ECTS)</td><td>5</td><td>Time (hours) given to the students</td><td>75</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td>Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: 3, Seminar classes: x, Fieldwork:</td><td>Student whole working time (hours)</td><td>125</td></tr>
<tr><td>Description of content</td><td colspan="3">The objective of the course is to get acquainted with geological methods of exploring mineral deposits and their evaluation.
The course contributes to skills of students which should be applied during geological part of exploration of mineral resources.
L1 - Classification of mineral deposits. Economic aspects of mineral deposits.
L2 - Nature and morphology of orebodies.
L3 - Metallogeny, metallogenetic provinces and periods.
L4 - Geological criteria in the exploration of mineral deposits. Magmatic control factor.
L5 - Structural control factor.
L6 - Geological models of mineral deposits as a basis for exploration planning. Reconnaissance. Selection and definition of areas for exploration of a mineral deposit.
L7 - Application of geophysical methods and remote sensing in the exploration of mineral deposits.
L8 - Prospecting indications (alteration, alteration mineral assemblages, ore outcrops and remains of old mining).
L9 - Prospecting indications (indicator elements, indicator minerals).
L10 - Geochemical prospecting methods.
L11 - Sampling media (stream sediments, soil, lake sediments, sediment cover, water, gases, vegetation, rocks).
L12 - Statistical processing of geochemical prospecting results.
L13 - Sampling of mineral resources.
L14 - Mining legislation. Categorisation and classification of mineral reserves.
L15 - Calculation of mineral reserves. Preparation of a mineral reserves study.</td></tr>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="3">Knowledge: To describe all phases of raw materials exploration, from prospecting of deposits to the preparation of reports on raw materials reserves. To select basic geological, geochemical, geophysical, and statistical methods in exploration of selected mineral raw materials deposits.
Skills: To apply statistical methods and spatial analyses in interpretation of laboratory and field measurements. To use information technology in computation and modelling of geological phenomena and processes. To identify the properties of geological materials and processes within hydrogeological, engineering geological and petroleum</td></tr>
</table>

	engineering investigation and mineral exploration. Competences: , To apply standards and (legal) regulations related to geological research, geohazards, environmental protection, water exploitation, exploitation of mineral resources or construction conditions. To interpret and summarize the results of field, laboratory and office research and prepare and present a geological expert report using other relevant data sources. To create geological reports for the economy and strategic documents.					
Assessment methods and criteria	exam The requirement for signature is atendance of leactures and practicum. Students will have to write seminar on specific topic, and have independent assigments. At the end oral exam will be organized. Through seminars and workshops, independent assigmensts and field works students will learn about mineral deposits and importance and methods of its exploration.					
Recommended readings	1. Moon, C.J., Whateley, M.G.K. & Evans, A.M. (2009): Introduction to mineral exploration, Blackwell Science, 496 s. 2. Annels, A.E. (1991): Mineral Deposits Evaluation, Chapman & Hall, 436 s					
TU Coordinator	Goran Durn, goran.durn@rgn.hr					
Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
	Students will create geological reports for the economy and strategic documents.	Students will apply statistical methods and spatial analyses in interpretation of laboratory and field measurements.	Students will apply statistical methods and spatial analyses in interpretation of laboratory and field measurements.		Students will apply standards and (legal) regulations.	
Justification for OLO contribution						

Course title	**Petroleum Geology**		
European Credits (ECTS)	5	**Time (hours) given to the students**	75
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: 3, Seminar classes: x, Fieldwork: x	**Student whole working time (hours)**	125
Description of content	The goal is to acquire specific knowledge and skills in the field of petroleum geology, which are intended to prepare the students, future engineers for all aspects of exploration and exploitation of oil, gas, condensate and geothermal waters as well as for professional interaction with engineers of related professions in teamwork. Students aquire specific skills in the area of exploration and exploitation of oil and gas. Lectures (30 hours) Abiogenic theories of petroleum origin and biogenic theory of petroleum origin (presentation of arguments and guided discussion) Biomarkers as indicators of origin of source rocks and deposition conditions Types of kerogen (conditions of deposition of organic matter, composition and structure of kerogen) Pyrolysis of source rocks (generation and maturation parameters) Differences in porosity of clastic and carbonate sediments. Permeability of clastic and carbonate sediments. Correlations of porosity and permeability. Directions and ranges of primary and secondary migration in different stratigraphic-tectonic conditions Diagenetic processes important for the migration and accumulation of hydrocarbons Diapirism. Origin and processes during diaper movement. The significance of diapirism in petroleum geology. Diapirs in the Adriatic s An overview of the types of traps in the world Theoretical foundations of basin modelling Oil and natural gas reserves in conventional accumulations in the world Reflective seismic surveys - significance in petroleum geological exploration and limitations with regard to reservoir type Drilling of a deep exploratory well (TDC laboratory, Master Log) Application of the results of interpretation of well logging. Measurement systems with respect to energy sources: electrical, radioactive, sound. Influences on the results of geophysical measurements in wells: temperature, well diameter, influence of mud Specifics of exploration of unconventional oil and natural gas accumulations (ultra-deep accumulations, oil and natural		

	gas in shales, natural gas in coal seams) Practical Exercises Comparison of effective porosity differences based on a simple experiment (weighing two dry samples of different effective porosity, immersing the samples in water for 15 minutes after which the samples are weighed again, and their porosity is estimated based on the change in mass) Luminescence of oil and natural gas (observation and description) Preparation of samples taken in the field (separation of fossil content by wet sieving, preparation of samples for analysis of total organic carbon content) Microscopy of fossil contents, discussion of observation results in terms of interpretation of sediment characteristics Analysis of total organic carbon content Project work (15 hours) Systematization of input data Shale volume analysis by interpreting the spontaneous potential curve Calculation of the share of rock thickness with reservoir properties within the total rock thickness (Net / Gross) Porosity analysis of reservoir rocks by interpretation of well - logs in a specialized computer program Making a contour map of the top of the reservoir in a computer software Making a contour map of the bottom of the reservoir in a computer software Making a map of the spatial distribution of the share of rock thickness with collector properties within the total rock thickness in a computer software Making a map of the spatial distribution of reservoir porosity in a computer software Making a cross-section through the reservoir Calculation of reserves based on the constructed reservoir model Making a simple 1D basin model Fieldwork (15 hours) Construction of geological column in clastic sedimentary rocks of Neogene age and sampling for assessment of generative potential of source rocks Construction of a geological column of a characteristic transgressive cycle of Neogene rocks Reconstruction of the circumstances that led to natural hydrocarbon outcrops
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: Interpret the results of analyses and measurements: laboratory and field (from outcrops and from wells) Bring conclusions about the generative-maturation properties of source rocks based on the results of pyrolysis Discuss the interconnectedness of the elements of the petrogeological system Describe the main elements of the drilling rig and the work of geologists during the drilling of deep wells Skills: Analyse the role of biomarkers in determining the origin of hydrocarbons (origin of organic matter and

<table>
<tr><td></td><td colspan="6">sedimentation environment). Estimate geological (total) reserves of hydrocarbon based on a simple reservoir model constructed in a computer software
Competences: Assess the significance of petrophysical properties of reservoir and cap rocks for hydrocarbon accumulation and production. Compare research on conventional and unconventional hydrocarbon accumulations,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
The requirement for signature is atendance of leactures and practicum. Students will have to write seminar on specific topic, and have independent assigments. At the end oral exam will be organized.
Theoretical part is complemented by practical work through seminars and workshops, independent assigments and field works where students will learn about importance of geology in petroleum exploration.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">Selected chapters: Velić, J. (2007): Geologija ležišta nafte i plina [Geology of Oil and Gas Reservoirs], Zagreb, Sveučilište u Zagrebu, Rudarsko-geološko-naftni fakultet, 2007 (university textbook)</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Marko Cvetković, Iva Kolenković Močilac, marko.cvetkovic@rgn.hr iva.kolenkovic@rgn.hr</td></tr>
<tr><td rowspan="2">Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td>Student will learn how to have professional interaction with engineers of related professions.</td><td></td><td></td><td></td><td></td><td>Student will work in teamwork.</td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
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<table>
<tr><td>Course title</td><td colspan="3">Engineering Geological Investigations</td></tr>
<tr><td>European Credits (ECTS)</td><td>5</td><td>Time (hours) given to the students</td><td>60</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td>Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: 2, Seminar classes: , Fieldwork:</td><td>Student whole working time (hours)</td><td>125</td></tr>
<tr><td>Description of content</td><td colspan="3">The objective is to adopt basic knowledge about engineering geological investigations for the purpose of design in civil engineering and mining.
This course covers all important aspects of engineering geological investigations.
Course content elaborated according to the schedule of lectures and exercises:
T1: Lectures - Types of engineering geological investigations; Exercises - Review of geotechnical reports
T2: Lectures - Engineering geological investigations in site investigations; Exercises - Description of natural characteristics of the investigated area
T3: Lectures – Methods of detailed engineering geological investigations; Exercises - Geomechanical classification and engineering description of coarse grained soil
T4: Lectures - Genetic classification of soil and rock mass, rock mass weathering and engineering geological profile; Exercises – Geomechanical classification and engineering description of fine grained soil
T5: Lectures - Classification and categorization of rock mass; Exercises - Engineering geological description of rock mass – clastic rocks
T6: Lectures - Methods of engineering geological investigations for site investigations related to foundation construction; Exercises – Engineering geological description of rock mass – carbonate rocks
T7: Lectures - Methods of engineering geological investigations for site investigations related to slope constructions; Exercises - Classification and categorization of rock mass
T8: Lectures - Methods of engineering geological investigations for site investigations related to dam construction; Exercises – Construction of borehole log
T9: Lectures - Methods of engineering geological investigations for site investigations related to tunnel construction; Exercises - Correlation of exploration boreholes
T10: Lectures - Methods of engineering geological investigations of active geomorphological and geodynamic processes; Exercises - Construction of engineering geological profile
T11: Lectures - Engineering geological investigations and potential problems in soluble and clastic rocks; Exercises - Engineering geological mapping of tunnels – 1st Par
T12: Lectures - Engineering geological investigations and potential problems in magmatic and metamorphic rocks;</td></tr>
</table>

	Exercises - Engineering geological mapping of tunnels – 2nd Part T13: Lectures - Review of the results of engineering geological investigations and preparation of technical documentation; Exercises - Engineering geological mapping of the road route – 1st Part T14: Lectures - Methods and results of regional engineering geological investigations; Exercises - Engineering geological mapping of the road route – 2nd Part T15: Lectures – Application of results of regional engineering geological investigations; Exercises - Reconnaissance engineering geological mapping in scale 1:5000					
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: Select appropriate level of site investigations for the purpose of different types of studies and projects from geotechnical engineering. Select appropriate type of regional engineering geological investigations for the purpose of different types of studies and projects. To make concept of detailed engineering geological investigations for different types of structures/constructions. Identify causes of active geomorphological processes (sliding, erosion, subsidence, etc.) and consequences of geodynamic processes (earthquakes) and to apply appropriate methods of engineering geological investigations. Identify weathering profiles in different rock types and to apply appropriate methods of engineering geological investigations. Identify potential geotechnical problems in different rock types for the purpose of performing engineering constructions in geotechnical engineering. Classify and to describe soil and rock mass according to different recommendations and standards in engineering. Skills: Evaluate the results of conducted research and testing. Construct an engineering geological profile and technical tunnel drawings Conduct reconnaissance engineering geological mapping Competences: ,					
Assessment methods and criteria	exam During the semester the requirement for signature is attendance of leactures. Students will participate in research and practical work as part of practicum. Students will have preliminary exam, writtena and oral exam. Theoretical part is complemented by practical work through project work and independent assigmensts.					
Recommended readings	Selected chapters from: De Vallejo, L.G., Ferrer, M., de Freitas, M. (2011): Geological Engineering. CRC Press, 700 p.					
TU Coordinator	Snježana Mihalić Arbanas, snjezana.mihalic-arbanas@rgn.hr					
Contribution to EIT's Overarching	**OLO 1**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4**	**OLO5 Value**	**OLO6 Leadership**

Learning Outcomes (tick relevant box/es)*	**Entrepreneurship**			**Intercultural**	**judgments / Sustainability**	
		Students will conduct reconnaissance engineering geological mapping.	Students will construct an engineering geological profile and technical tunnel drawings.		Students will apply standards and (legal) regulations.	
Justification for OLO contribution						

Course title	**Exploration Geochemistry**		
European Credits (ECTS)	4	**Time (hours) given to the students**	45
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: x, Practical classes: 1, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	100
Description of content	Students will be introduced to the basic principles of geochemical prospecting, i.e., finding the geochemical anomaly caused by the weathering of the ore deposit. Students will be introduced to the behavior of trace elements in surface environments, sampling media (soil, water, sediment, plant rocks), chemical analysis of geological materials (AAS, ICP), statistical methods and interpretation of geochemical data. Students will develop their communication skills through oral presentation and writing reports related to project assignments. Students will acquire a basic knowledge about importance of geochemical prospecting. LECTURES 1. Introduction to the course, basic principles of geochemical prospecting 2. Primary dispersion 3. Secondary dispersion 4. Sampling media, sampling and sample preparation for analysis 5. Instrumental analytical methods 6. Statistical methods in geochemical prospecting; background and threshold determination. 7. Construction of geochemical maps 8. Types of geochemical research and report writing 9-10. Principles of geochemical prospecting in environmental protection EXERCISES (5 blocks of 3 hours) The 15 hours of exercises will include a series of individual tasks that students will have to solve independently and present orally and in the form of an essay. In addition to individual assignments, students will receive a geochemical prospecting project on which they will work throughout the semester in synergy with exercises from two other courses (Remote Mineral Exploration and GIS in Mineral Exploration) and prepare an geological report.		
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To explain the behaviour of chemical elements in surface environments and the processes that control the geochemical anomaly. To select a suitable sampling medium, the proper sample preparation procedure, and the analytical method, as well as analyte in order to find the geochemical anomaly caused by the weathering of the ore body.		

<table>
<tr><td></td><td colspan="6">Skills: To apply univariate, bivariate and multivariate statistical methods in the interpretation of geochemical data. To construct geochemical maps. Design preliminary, regional and detailed geochemical survey of mineral resources.
Competences: To systematize and combine the results of geochemical prospecting with other data and prepare and present a geological report.,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
Students are required to attend classes, solve independent project tasks, participate in a team project and pass the written exam.
Through practical work and independent assigmensts studenst will be introduced to the basic principles of geochemical prospecting,</td></tr>
<tr><td>Recommended readings</td><td colspan="6">1. Moon, C.J. (2006): Exploration Geochemistry (pp 155-178). In: Introduction to Mineral Exploration; 2nd Edition; Charles J. Moon, Michael K.G. Whateley & Anthony M. Evans (Editors); Blackwell Publishing, 2006, 469p.</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Marta Mileusnić, marta.mileusnic@rgn.hr</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td>Students will develop communication skills through oral presentation and writing reports related to project assignments.</td><td></td><td></td><td></td><td>Students will develop communication skills through oral presentation and writing reports related to project assignments.</td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
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Course title	**Remote sensing of mineral resources**		
European Credits (ECTS)	3	**Time (hours) given to the students**	30
Type (Lecture, internship, exercise etc.)	Lectures: 1, Auditorium classes: , Lab. Classes: x, Project classes: x, Practical classes: 1, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	75
Description of content	Students will acquire basic knowledge from remote sensing, with an emphasis on their application in mineral exploration. To enable students to independently collect and analyse multispectral, hyperspectral and radar satellite images required for analysis at surface mineral resources. Introduce students to the automatic supervised and unsupervised classification of satellite images in the analysis of surface mineral raw materials. Through the course students will acquire basic knowledge about application of remote sensing in mineral raw materials exploration. P-1. Introduction, review and definition of remote sensing of mineral resources P-2. Electromagnetic radiation. Active and passive sensors for remote sensing. P-3. Electromagnetic radiation. Active and passive sensors for remote sensing of mineral resources. P-4. Satellite missions, sensors, accessories and equipment of existing satellite systems for remote sensing of mineral resources. P-5. Spatial, spectral, radiometric and temporal resolution of satellite images used in the analysis of mineral resources P-6. Use of software tools and programming languages for remote sensing of mineral resources 1 P-7. Use of software tools and programming languages for remote sensing of mineral resources 2. P-8. Pre-processing of satellite images. P-9. Elimination of geometric errors in sensor operation P-10. Elimination of atmospheric and morphological influences on the quality of satellite images 1 P-11. Elimination of atmospheric and morphological influences on the quality of satellite images 2 P-12. Supervised and unsupervised classification on the example of mineral resources research 1. P-13. Supervised and unsupervised classification on the example of mineral exploration 2. P-14. Use of Synthetic Antenna Radar (InSAR) for mineral analysis 1 P-15. Use of Synthetic Antenna Radar (InSAR) for mineral analysis 2		

<table>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="6">Knowledge: Describe the basic principles and methods of remote sensing for surface mineral raw materials.
Use multispectral and hyperspectral images for analysis at surface raw materials
Describe the characteristics of electromagnetic radiation for the purposes of remote sensing of mineral resources.

Skills: Develop a controlled and uncontrolled classification of mineral resources from satellite images
Apply at least one software tool for interpretation and processing in remote sensing of mineral resources.
Competences: ,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
Students will have lectures and project work. Students are required to attend classes and solve project tasks independently and / or in a team.
Students will learn about remote sensing, with an emphasis on their application in mineral exploration through lessons and practical work.</td></tr>
<tr><td>Recommended readings</td><td colspan="6"></td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Ivan Medved, ivan.medved@rgn.hr</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td>Students will independently collect and analyse mineral resources via remote sensing.</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
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Course title	**GIS in Exploration of Mineral Resources**		
European Credits (ECTS)	3	**Time (hours) given to the students**	30
Type (Lecture, internship, exercise etc.)	Lectures: 1, Auditorium classes: , Lab. Classes: x, Project classes: x, Practical classes: 1, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	75
Description of content	Master all significant options in GIS software while solving specific examples from the profession. Acquiring the knowledge needed to develop your own GIS projects. Advanced use of geoinformatics on computer and mobile platform. Visualization of GIS projects for the purpose of making cartographic contents of diploma theses. Through the course students will acquire basic knowledge about application of GIS software in mineral exploration. P1 Introductory lecture on the subject. Overview of teaching topics. V1 Curriculum in the semester. Merlin, ArcMap, networking, computer usage rules. P2 Basics of GIS (repetition of undergraduate material). V2 Reminder to ArcView, advantages and disadvantages. P3 Scanning and image processing. V3 Handling maps in paper and digital form. P4 Raster georeferencing. V4 Georeferencing three sheets with known points on geological maps. P5 Raster georeferencing V5 Raster georeferencing over vectors. P6 Raster georeferencing V6 Raster georeferencing over a raster. P7 Review projects and quick maps. V7 Development of an overview project and GIS map for each location. P8 Vectorization of geological map, part 1. V8 Vectorization of a geological map within a given area, Part 1. P9 Vectorization of geological map, part 2. V9 Vectorization of geological map within a given area, part 2. P10 Stages of GIS project development on the example of making a map of mineral resources of western Slavonia, introductory part. V10 Stages of GIS project development on the example of making a map of mineral resources of Western Slavonia, making a GIS project P11 Geotransformation of vector and raster GIS in HTRS96 / TM and WGS84, in general. V11 Geotransformation of vector and raster GIS in HTRS96 / TM and WGS84, data table. P12 SGA Geoportal data, in general. V12 Data from SGA Geoportal, use in GIS project. P13 Geoconversions of point data in Geotrans, in general. V13 Geoconversions of point data in Geotrans, task. P14 Geodetic transformations, parameters and test data, in general. V14 Geodetic transformations, parameters and test data, task. P15 Description of the RGNF WEBGIS system. V15 Work in RGNF WEBGIS system.		

<table>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="6">Knowledge: To apply statistical methods and spatial analyses in interpretation of laboratory and field measurements
To use information technology in computation and modelling of geological phenomena and processes
To interpret the results of geological and geochemical prospecting, geophysical and remote sensing investigation of mineral deposits using geographic information system in the analysis of spatial data.
Skills: To construct general and thematic geological maps, as well as geological cross-sections with accompanying descriptions
To interpret and summarize the results of field, laboratory and office research and prepare and present a geological expert report using other relevant data sources
Competences: ,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">practical mark
The student is obliged to do all the exercises and attend 80% of the lectures. It is necessary to complete all project tasks and submit the final GIS projects for review and evaluation. Knowledge is evaluated based on assessment from project assignments, attendance at exercises and overall commitment to teaching.
Students will learn about GIS softwers with an emphasis on their application in mineral exploration through lessons and project excercise and independent assigments.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">1. De Smith, M., Longley, P., Goodchild, M.: Geospatial Analysis - A comprehensive guide (online + PDF format), https://spatialanalysisonline.com/
2. ESRI: Free eBooks as part of its “Best Practices” series, (online + PDF format), https://www.gislounge.com/free-gis-books/
3. The Rutgers Center on Public Security (PDF format), https://www.rutgerscps.org/gis-book.html</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Dario Perković, dario.perkovic@rgn.hr</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td>Students will independently collect and analyse mineral resources via GIS softwares.</td><td>Students will independently collect and analyse mineral resources via GIS softwares.</td><td></td><td></td><td></td></tr>
</table>

Justification for OLO contribution	

Course title	**Seismotectonics**		
European Credits (ECTS)	4	**Time (hours) given to the students**	45
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: x, Practical classes: 1, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	100
Description of content	To describe the basics on seismotectonics in different geodynamic settings on Earth, in particular in Croatia, in circum Adriatic region and in the Eastern Mediterranean, and to provide students general knowledge on field and lab methods used in evaluation of seismicity and seismic hazard, assessment of recent tectonic movements on local and regional scale, active stress regimes in the Earth's crust, and in identification and characterization of active, seismogenic faults and seismogenic sources. The course cover all the important data and seismotectonic properties of certain areas. L1. Introduction to Seismology. Seismicity in Croatia and in neighbouring countries. Global seismicity. Seismic waves, seismometers and seismograms. Earthquake intensity and magnitude. Earthquake cycle. Elastic Rebound Theory. Models of earthquake recurrence. Ex1. Seismogram analysis, definition of spatial and surface seismic waves L2. Introduction to seismic hazard and risk in Croatia. Croatian Seismological Survey, seismograph network and Croatian Earthquake Catalogue. Gutenberg-Richter Relationship. Seismic hazard maps in Croatia and in neighbouring countries. Ex 2. Calculation of earthquake epicentre and magnitude based on seismicity data (Part 1) L3. An overview of geodetic methods to measure tectonic movements. Conceptual models of deformation and slip on faults and in fault zones. Trilateration network, Precise leveling: principles and examples. VLB Interferometry and GPS measurements: principles and examples. GPS data in Croatia and in surrounding region used in interpretation of geodynamics in circum Adriatic region and in the eastern Mediterranean. Ex 3. Calculation of earthquake epicentre and magnitude based on seismicity data (Part 2). L4. Type of stresses in the Earth's crust. Stress regimes at the tectonic plate boundaries and far - field stresses. World stress map database. Introduction to borehole breakouts. Fault plane solutions: basic theoretical principles and examples. Ex 4. Analysis of earthquake focal mechanisms (EFM) – interpretation of EFMs L5. Stress regimes and distribution and in circum-Adriatic region. Individual and composite seismogenic sources: definitions and characterization, examples from DISS and SHARE seismogenic databases. Ex 5. Analysis of earthquake focal mechanisms (EFM) - construction of EFM (Part 1). L6. Integration of geological and seismological data in identification and characterization of seismogenic faults/sources.		

	Ex. 6. Analysis of earthquake focal mechanisms (EFM) - construction of EFM (Part 2). L7. Integration of geological and seismological data in construction of seismotectonic maps and profiles: basic principles. Ex. 7. Visit to Croatian Seismological Survey – Earthquake monitoring and analysis L8. Seismotectonics in extensional geodynamic settings. Global distribution of extensional settings. An overview of structural styles and potential seismogenic sources in extensional settings. Ex. 8. Integration of geological and seismological data for construction of seismotectonic profile – Construction of geological profile L9. Seismotectonics in continental graben structures: examples from the East African Rift, Rhone-Rhine Graben, Basin & Range Province. Seismotectonic properties of back-arc basin areas: examples from Aegean and Tyrrhenian sea. Ex. 9. Construction of seismotectonic profile – Construction of geological profile L10. Seismotectonics in compressional geodynamic settings. Global distribution of compressional settings. An overview of structural styles and potential seismogenic sources in compressional settings. Ex. 10. Construction of seismotectonic profile – Earthquake Catalogue analysis and delineation of earthquake series in the profile buffer 10 km wide L11. Seismotectonics in fold-thrust belts: examples from the Alps and External Dinarides. Ex. 11. Construction of seismotectonic profile – Earthquake hypocentre projection on geological profile and correction of structural framework corrections L12. Seismotectonics in strike-slip geodynamic settings. Global distribution of strike-slip settings. An overview of structural styles and potential seismogenic sources in strike-slip settings. Ex. 12. Construction of seismotectonic profile – Identification of seismogenic faults/sources along the profile L13. Seismotectonics in strike-slip geodynamic settings: examples from Dinarides, California, New Zealand and Eastern Mediterranean. Ex. 13. Student's presentations of constructed seismotectonic profiles (Part 1). L14. An overview on seismotectonics in Croatia: key examples from Pannonian basin, Dinarides and Adriatic region. Ex. 14. Student's presentations of constructed seismotectonic profiles (Part 2). L15 & Ex 15. Student's seminar presentations
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: Distinguish stress type and its distribution in Earth's crust in respect to tectonic plate boundary types, regional and local geodynamic processes Explain general terms in Seismology (seismicity, seismic waves, earthquake magnitude, earthquake hazard and risk, Earthquake Cycle and Elastic Rebound Theory) Describe basic properties of global and local seismicity Describe seismotectonic properties of the extensional, compressional and strike-slip tectonic regions Define geodetic methods that are used in measurements of tectonic movements Categorize seismotectonically active regions on Earth, in more detail Mediterranean area and Croatia

	Skills: Compute earthquake epicentre location based on seismic station seismogram analysis Compute focal mechanism solutions based on geometric and kinematic features of investigated faults Compute values of moment magnitude and assess earthquake intensity Competences: , Construct and analyse seismotectonics maps and profiles. Integrate geological and seismic data in identification and categorization of seismogenic faults/seismogenic sources in seismotectonic active regions.					
Assessment methods and criteria	exam Teaching methodologies are: lectures, project and independent assigments and partial e-learning. Course attendance (minimum 70% attendance), tasks constructed and given for evaluation. Course evaluation: constructed programs, seminar paper, written exam and oral exam. Students will be introduced to seismotectonics via lectures, project work and independent assigments and partial e-learning.					
Recommended readings	Yeats, R. (2012): Active Faults of the World. Cambridge Univ. Press, 600 str. (selected chapters)					
TU Coordinator	Bruno Tomljenović/Bojan Matoš,					
Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
			During the course students will construct seismotectonic profiles and have presentations.		Students will learn about importance of determining seismicity and about seismic hazards and tectonic activities and its impact.	
Justification for OLO contribution						

Course title	**Regional Hydrogeology**		
European Credits (ECTS)	4	**Time (hours) given to the students**	60
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: x, Practical classes: 2, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	100
Description of content	Hydrogeological interpretations on a regional scale and the acquisition of skills in presenting hydrogeological features and calculating groundwater reserves. The student will acquire basic knowledge about the aquifer systems of the Republic of Croatia and strategic groundwater reserves. Students aquire specific skills in the area of hydrogeological interpretation on regional scale. Energy conditions of groundwater movement, Basic concept of thermal regime. Map of the geothermal gradient of Croatia, geothermal potential analysis. Geochemical cycle, Hydrochemical facies. Examples of laboratory chemical analyzes of water, Piper diagrams Groundwater chemistry and its impact on water use (water supply, industry, agriculture) and legislation. Examples of water classifications depending on the intended use (Doneen, USDA). Regional hydrogeology, scale effect (spatial and temporal), the continuity equation. The concept of scales cartographic and physical, scale effect on permeability Hydrogeological parameters. Heterogeneity and anisotropy of hydraulic conductivity (example of parallel and vertical flow in relation to the position of layers) Basic flow of inclined aquifer systems and unit hydrograph, runoff coefficient and recovery coefficient. Hydrogeological significance of the recession coefficient on the example Radial flow, well hydraulics, direct integration of Darcy's law. Calculation (identification) of hydrogeological parameters Unconfined aquifer, flow below water surface, Dupit assumption. Flow through horizontally and vertically stratified aquifer Hydrogeological objects (wells, piezometers), construction and use. Examples of hydrogeological objects (question of aquifer heterogeneity) Hydrogeological maps and issues of graphical representation of hydrogeological properties, phenomena and relationships. Examples of hydrogeological maps of different scales Hydrogeology of the Republic of Croatia, division of territories by basins, catchment areas. Hydrogeological characteristics of the Sava River Basin, the valley part of the Sava River Basin, the basins of the left tributaries of the Sava. Analysis of the water level and flow of the Sava on significant water meter profiles, comparison of the Sava water level and groundwater level and conclusion on the hydraulic connection of the Sava and the banks, drainage, recharge.		

	Basins of right tributaries of the Sava, Kupa basin, Dobra basin, Mrežnica basin, Korana basin, Una basin. Analysis of hydrographs of significant sources in the basins of the right tributaries of the Sava, definition of the equation of the recession part of the hydrograph, recession coefficient and dynamic reserves. Drava basin, valley part of the Drava basin, hilly and hilly area of the Drava basin. Analysis of water level and flow of the Drava on significant water meter profiles, comparison of Drava water level and groundwater level in the hinterland, inference about the hydraulic connection of the Drava and the hinterland, drainage and recharge. Hydrogeology of Istria, Croatian Littoral, Lika and Podvelebita (Gacka and Lika basins), Zrmanja basin, Krka basin. Analysis of hydrographs of significant sources in the Mirna, Gacka, Lika, Zrmanja and Krka basins, definition of the equation of the recession part of the hydrograph, recession coefficient and dynamic reserves. Cetina basin, lower Neretva basin, coastal basin from Neretva to Boka Kotorska, basins of significant coastal springs. Ranking of watersheds by quantity and quality of water, strategic reserves of Croatian groundwater from the first to the fifth level. Analysis of data on groundwater tracing carried out in the area of southern Dalmatia and conclusion on karst watersheds.
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: Define the concept of scale in hydrogeology and explain its effect through permeability properties Describe the basic concept of the Earth's thermal regime and relate it to the genesis and dynamics of thermal waters Describe the geochemical cycle Interpret the chemical composition of water Define and graphically represent hydrochemical facies Analyze the spring hydrograph Explain how to determine groundwater reserves Describe the hydrogeological systems of Croatia Skills: Apply hydrogeological maps in the description of hydrogeological features of the area Assess the significance of a particular hydrogeological system for a water supply Competences: ,
Assessment methods and criteria	exam Teaching methodologies are: lectures, project and independent assigments. Students will have to finish hidrogeological project for evaluation. Through the course students will learn about hydrogeological interpretations on a regional scale.
Recommended readings	Struckmeier, W.F. & Margat, J. (1995): Hydrogeological maps, A guide and a standard legend, pp. 177.,International association of hydrogeologist, Verlag Heinz Heise, Hannover

TU Coordinator	Željko Duić/Jelena Parlov,					
Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
					Students will learn about importance of groundwater reserves and its preservation.	
Justification for OLO contribution						

<table>
<tr><td>Course title</td><td colspan="3">Industrial Mineral Deposits and Applications</td></tr>
<tr><td>European Credits (ECTS)</td><td>5</td><td>Time (hours) given to the students</td><td>60</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td>Lectures: 2, Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: 2, Seminar classes: x, Fieldwork:</td><td>Student whole working time (hours)</td><td>125</td></tr>
<tr><td>Description of content</td><td colspan="3">The objective of the course is to learn about the physicochemical and geological conditions of formation of deposits of the main industrial minerals and their application in industry.
The course covers all important data about industrial minerals and its application.
L1 - Definitions of terms: (1) ore mineral and (2) industrial mineral. Classifications of industrial minerals.
L2 - Physicochemical conditions for the formation of clay deposits. Industrial clays: Kaolins, bentonites, sepiolites and palygorskites.
L3 - Mineralogy and geology of kaolin deposits. Application of kaolin in industry.
L4 - Mineralogy and geology of bentonite, sepiolite and palygorskite deposits. Application in industry.
L5 - Construction clays and industrial applications.
L6 - Physicochemical conditions of bauxite deposits. Laterite and karst bauxites. Application of bauxite in industry.
L7 - Quartz mineral raw materials (quartz crystals, quartz sands and sandstones, SiO_2 as chemical and biogenic sediment, diatomite, flint). Feldspar deposits. Application of quartz mineral raw materials and feldspar in industry.
L8 - Physicochemical conditions of evaporite formation. Deposits of gypsum and anhydrite.
L9 - Deposits of halite, sylvine, soda, borate, Mg and Li salts.
L10 - Physicochemical conditions of phosphate formation. Apatite and phosphorite deposits. Phosphate application in industry.
L11 - Deposits of barite, fluorite and refractory materials. Application of barite, fluorite and refractory materials in industry.
L12 - Deposits of pyrite and sulphur. Application of pyrite and sulphur in industry.
L13 - Physicochemical conditions of zeolite formation. Zeolite deposits. Application of zeolite in industry.
L14 - Pigments and their application in industry.
L15 - Graphite deposits. Application of graphite in industry.</td></tr>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="3">Knowledge: Identify and describe the types of deposits of industrial minerals
Analyse and argue the physicochemical and geological conditions for the formation of deposits of industrial minerals
Prepare a plan for the exploration of industrial mineral deposits to determine the potential for industrial application
Evaluate the quality of industrial mineral deposits</td></tr>
</table>

	Demonstrate the technological processes of manufacturing bricks, tiles, glass, cement and refractory materials. Evaluate and recommend the application of industrial minerals in agriculture and various industries. Skills: Competences: ,					
Assessment methods and criteria	exam Methodologies are: lectures, seminars, workshops and independent assigment. The examination will be taken orally. Requirements for taking the exam are: 1. committed and positively evaluated assignments in the internship 2. submitted and held seminar paper 3. submitted field report 4. positively evaluated both colloquia Main proceses of forming industrial mineral and its application will be introduced to students through the lectures and practical work.					
Recommended readings	1.Manning, D.A.C. (1995): Introduction to industrial minerals, Chapman & Hall, 276s. 1.Manning, D.A.C. (1995): Introduction to industrial minerals, Chapman & Hall, 276s. 2. Evans, A. M. (1993): Ore geology and industrial minerals, Blackwell Science Publications, 389s. 3. Chang, L. L. Y. (2002): Industrial mineralogy, Prentice Hall, 472. 4. Harben, P. W. & Kužvart, M. (1997): Industrial minerals-A global geology, Industrial Minerals Information, 476s.					
TU Coordinator	Goran Durn, goran.durn@rgn.hr					
Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
	Students will prepare a plan for the exploration of industrial mineral deposits to determine the potential for industrial application.				Students will learn about importance of Industrial Mineral Deposits and its Applications and applying of the regulations.	
Justification for OLO contribution						

Course title	**Analytical methods in ore deposits**		
European Credits (ECTS)	5	**Time (hours) given to the students**	60
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: x, Project classes: , Practical classes: 2, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	125
Description of content	The aim of this course is to review the most important analytical methods and applications in the mineral deposits investigation in order to determine mineralogical, geochemical and isotopic composition and reconstruction of genetic processes. The course covers: microscopy in transmitted and reflected light, electron microscopy and electron microprobe, microthermometry of fluid inclusions, ion chromatography, vitrinite reflection, crystallinity of chlorite, illite and graphite, atomic absorption and emission spectroscopy, inductively coupled plasma mass spectrometry (ICP-MS), stable and radiogenic isotopes. This course gives students knowledge about analytical methods in mineral deposits exploration. Polarised light microscopy - Contact-metamorphic reactions; Mineral stability fields; Alteration reactions. Reflected light microscopy - Fundamentals of ore microscopy (optical properties in reflected light); examples of the most important structures and textures; Interpretation. Electron microscopy / EMPA - Basics principles; Detectors; Application and interpretation; Geothermobarometric use in equilibrium systems; Sample preparation. Microthermometry of fluid inclusions - Basics principles; Application and interpretation; Sample preparation. Ion chromatography - Basics principles; Application in ore deposits; t / c conditions; Sample preparation. Vitrinite reflection / Crystallinity of chlorite / illite / graphite - Basics principles; Application in ore deposits; t / c conditions; Sample preparation (illiterate crystallinity); AAS; AES; ICP-MS; Stable isotopes (oxygen, hydrogen, carbon); Radiogenic isotopes (K / Ar; Rb / Sr; Sm / Nd; U / Th / Pb, fission-tracks) - Basics principles; Application in ore deposits; Data interpretation.		
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To explain the application of individual method, principle, sample preparation and instrument characteristics To prepare a geological sample for selected methods (sawing, grinding, polishing, pulverizing, dissolving, diluting, etc) To determine mineral paragenesis, structures and textures in plane-polarised regular and reflected light To determine the succession (phases) of crystallization (pre-ore; ore and post-ore stage) and subsequent alterations To interpret obtained analytical data and determine composition of fluids, pressures and temperatures of formation of ore deposits and alterations. To interpret the micro, macro and trace element composition. To interpret the results of stable isotope analysis and conclude on the source fluid. To interpret the results of radiogenic isotopes in order to determine the age of the host rock, mineralization, and		

<table>
<tr><td></td><td colspan="6">subsequent events.
Skills:
Competences: ,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
Students will have lectures, practicum, independent assigments, and at the end oral exam.
Students will learn about most important analytical methods and applications in the mineral deposits investigation through practicum, and independent assigments.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">Reed, S. J. B. (2010): Electron Microprobe Analysis and Scanning Electron Microscopy in Geology. Cambridge University Press, 201 p.</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Sibila Borojević Šoštarić, sibila.borojevic-sostaric@rgn.hr</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td></td><td>Students will review the most important analytical methods and applications in the mineral deposits investigation.</td><td></td><td></td><td></td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

Course title	**Geophysical Exploration of Mineral Resources**		
European Credits (ECTS)	3	**Time (hours) given to the students**	30
Type (Lecture, internship, exercise etc.)	Lectures: 2, Auditorium classes: , Lab. Classes: x, Project classes: , Practical classes: 0, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	75
Description of content	Mastering the specialist geophysical methods of measurement and interpretation applied in the exploration of construction materials deposits and solid raw mineral materials. The course goes through the key points of geophysical methods for prospection and exploration of mineral deposits. Magnetometric exploration. Magnetometric data interpretation methods. Aeromagnetometric exploration. Magnetometric exploration of solid raw materials. Field survey design for characteristic geological models. Gravity exploration. Gravity map transformations - goal, transformation methods, application. Microgravity exploration. Gravity modelling and application in raw minerals exploration. Electrical tomography. Theoretical foundations. Measurement geometry. Tomographic inversion. Electrical tomography instruments. Electrical tomography in the exploration of construction materials deposits. Electromagnetic exploration. TURAM method, Electromagnetic method using moving transmitter, VLF method, magnetotelluric method - theoretical foundations, instruments, data processing, interpretation and application. Georadar - theoretical foundations, field measurement methods, resolution and depth, instruments, application. Seismic measurements in wells. "Down-hole" and "Cross-hole" methods – measuring methods, instruments, application. Refraction seismics. Methods of refraction data interpretation: DTM, Delta – t – V, GRM and refraction tomography. High resolution reflection seismics (HRS method) – conducting exploration, data processing, interpretation. Seismic modelling. Synthetic seismogram - construction of synthetic seismogram, application of synthetic seismogram.		
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To control principles of working with instruments for magnetometric exploration. To control principles of working with instruments for electric and electromagnetic exploration. Skills: To be able to interpret the obtained magnetometric measurements data. To be able to interpret the obtained gravimetric measurements data. To be able to interpret the obtained electrical tomography data. To be able to determine the first arrivals of the waves when measuring seismic velocities in a well.		

	To be able to calculate mean and interval speeds and interpret the obtained data. To be able to choose the optimal geophysical exploration methods in the construction material deposits exploration. To be able to conduct geophysical exploration in the specific geological models in terms of solid raw materials exploration. Competences: ,					
Assessment methods and criteria	exam Students will have lectures, practicum, independent assigments, and at the end oral exam. By lectures, seminars and workshops students will study about specialistic geophysical methods in the exploration of materials deposits.					
Recommended readings						
TU Coordinator	Franjo Šumanovac,					
Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
			Students will have to interpret different geophisical data and make conclusions about mineral deposits and its main characteristics.			
Justification for OLO contribution						

<table>
<tr><td>Course title</td><td colspan="3">Field and laboratory practicum</td></tr>
<tr><td>European Credits (ECTS)</td><td>6</td><td>Time (hours) given to the students</td><td>120</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td>Lectures: , Auditorium classes: , Lab. Classes: x, Project classes: , Practical classes: 128, Seminar classes: , Fieldwork: x</td><td>Student whole working time (hours)</td><td>150</td></tr>
<tr><td>Description of content</td><td colspan="3">Students will be introduced to various field and laboratory methods used in exploration of mineral deposits. Students will be trained to recognize mineralization, visualize 3D geological structures, and reconstruct geological history. Most of the activities will be related to proper geological fieldwork: observation, personal filed book, interpretation and sampling. Furthermore, students will analyse the collected geological samples of water, soil, rocks, sediments, minerals in the laboratories. Finally, they will learn to combine and interpret obtained field and laboratory results with previous geological research and produce and present geological expert reports.
Through the course students will be introduced to various field and laboratory methods used in exploration of mineral deposits.
The course consists of geophysical, geological and geochemical field exercises and laboratory analysis on sampled geological materials, and takes place in 15 terms of 8 hours. The field part of the course will be conducted jointly on two training grounds for the exploration of mineral deposits and two selected deposits of industrial minerals in the Republic of Croatia. At the training grounds for exploration of the mineral deposits, students will perform geophysical measurements, surface and underground mapping with the preparation of associated geological maps and profiles with indicated mineralization positions and conduct field geochemical prospecting on selected media. At selected deposits of industrial minerals, students will be introduced to the complete cycle of mineral raw materials, from geological prospecting and exploitation to the processing, final products and waste disposal. The laboratory part will include the preparation and analysis of sampled geological materials.

Field days (13 days)

Training grounds for exploration of mineral deposits (11 days of joint fieldwork)
1) Geophysical prospecting (2 days)
2) Mapping of surface mineralization and preparation of geological map and profile (2 days)
3) Mapping of underground exploitation (3 days)
4) Sampling of host rocks and alteration zones proximal and distal to mineralization (2 days)
5) Geochemical prospecting - sampling of geological materials and in-situ measurement of basic geochemical</td></tr>
</table>

	parameters (1 day) 6) Additional independent work of students (1 day) Mineral raw materials cycle - industrial materials of the Republic of Croatia (2 days): 7) From ceramic clay and quartz sand to bricks (ceramic clay deposit, quartz sand deposit, brick factory; 1 day) 8) From natural gypsum to gypsum boards (gypsum bed, gypsum board factory; 1 day) Laboratory days (2 days) 1) Preparation and analysis of geological materials sampled during geochemical prospecting at the polygon for exploration of mineral deposits.					
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To select a suitable geophysical method for exploration of the mineral deposit To prepare a geological map and the corresponding profile with the indicated types of mineralization To prepare laterally developed underground mine map To analyse chemical composition of the geological materials using standardised laboratory procedures and normative. To describe the overall process of mineral raw materials starting from exploration and exploitation to the processing and final product, highlighting the primary raw materials properties. Skills: To sample various geological materials (minerals, rocks, sediment, soil, water) for the purpose of exploration of the mineral deposits. To conduct field measurements of selected parameters in geological materials (eg pH, EC, redox potential, radioactivity) for the purpose of geochemical prospecting. Competences: ,					
Assessment methods and criteria	practical mark Students will have field and laboratory work, work with mentor, project assigments. Students will be introduced to various field and laboratory methods used in exploration of mineral deposits through field and laboratory work.					
Recommended readings	FOREGS Geochemical Mapping Field Manual. Geological Survey of Finland, Espo, 1998. Marjoribanks, R. (2010) Geological Methods in Mineral Exploration and Mining, Springer, 238 s.					
TU Coordinator	Sibila Borojevic Šoštarić, sibila.borojevic-sostaric@rgn.hr					
Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**
	Students will be introduced to					

	various field and laboratory methods and work used in exploration of mineral deposits where all skills will be developed.					
Justification for OLO contribution						

Course title	**Analyses of mineral paragenesis**		
European Credits (ECTS)	3	**Time (hours) given to the students**	45
Type (Lecture, internship, exercise etc.)	Lectures: 1, Auditorium classes: , Lab. Classes: x, Project classes: , Practical classes: 2, Seminar classes: , Fieldwork:	**Student whole working time (hours)**	75
Description of content	The goal of the course is to train the students in microscopic analysis of different generations of mineral parageneses in magmatic and metamorphic rocks and their interpretation in the light of petrogenesis and later evolution of these rocks in the certain geotectonic environment. Students will aquire knowledge about mineral paragenesis of magmatic and metamorphic rocks and its interpretation. The definition of the mineral paragenesis. Primary and secondary mineral parageneses in the magmatic rocks. Postequlibration and postconsolidation changes of primary magmatic minerals and the origin of secondary parageneses: (1) resorption and late magmatic subsolidus reactions; (2) hydrothermal alterations and (3) the changes caused by weathering. Phase relations in the crystallisation systems as the result of fractionation processes and reactions in the magmatic rocks. Phase diagrams (liquidus, solidus, binary and ternary eutectic, cotectic curves, solvus, peritectic point). Two-component systems with the eutectic point, with continuing solid solution crystal serie and the new compound which melts incongruently. Three-component systems with the clinopyroxene and plagioclase, with alkali feldspars and quartz, with plagioclase, clinopyroxene and olivine and forsterite, anorthite and quartz.. The influence of volatiles on the crystallisation of the system. The explanation of genesis of different magmatic textures, intergrowths and exsolutions by phase diagrams (ophitic texture, intergranular texture, graphic and myrmekitic intergrowths, perthite/antiperthite). The exsolution process in the different minerals (pyroxenes, feldspars, calcite, ilmenite, biotite). Disequilibrium state: a) the occurrence of zoning (concentric, patchy, sector, normal, reversal and oscillatory zoning) in different minerals; b) the occurrence of “sieve” texture. Enclaves in the magmatic rocks: xenoliths, xenocrystalls and microgranitoid enclaves. The differences in the mineral parageneses and textures in the crust peridotites and mantle peridotites. Ophiolite and their metamorphic sole. Precise classification and nomenclature of magmatic rocks on the basis of microtexture, primary and secondary parageneses and petrogenetic interpretation of the sequence of the processes in the evolution of certain magmatic rocks.		
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To explain the ways of the origin of primary and secondary mineral parageneses in magmatic rocks. To distinguish mineral parageneses and microtextures in crust peridotites from those in the mantle peridotites in the ophiolite complexes. To classify magmatic rocks on the basis of microtextures, primary and secondary mineral parageneses and reconstruct the sequence of processes in the evolution of certain magmatic rocks.		

<table>
<tr><td></td><td colspan="6">To distinguish different mineral parageneses and the sequence of their formation in the metamorphic rocks.

Skills: To apply phase diagrams in the interpretation of genesis of different microtextures, intergrowths and exsolutions inside of minerals in magmatic rocks.
To use evident signs of disequilibrium in minerals and rocks in the interpretation of their crystallisation and later evolution and petrogenesis, respectively. To apply different types of mineral recrystallization and their deformations to deduce the p-T evolution of the metamorphic rocks.
Competences: ,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">exam
Teaching methodologies are: lectures, laboratory, independent assigments and exercises with petrographic microscope. At the end students will have oral exam.
Main emphasis is on application of determining mineral paragenesis in determining different samples through excercises and independent assigments.</td></tr>
<tr><td>Recommended readings</td><td colspan="6"></td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Vesnica Garašić, vesnica.garasic@rgn.hr</td></tr>
<tr><td rowspan="2">Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td></td><td>Students will have to interpret mineral paragenesis and make conclusions about genesis of rocks.</td><td></td><td></td><td></td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

Course title	**MSc thesis**					
European Credits (ECTS)	20		**Time (hours) given to the students**		15	
Type (Lecture, internship, exercise etc.)	Lectures: , Auditorium classes: , Lab. Classes: , Project classes 1: , Practical classes: , Seminar classes: , Fieldwork:		**Student whole working time (hours)**		500	
Description of content	The master thesis for the student aims to prove the ability of independent analysing and solving complex engineering tasks/problems in the field of geology related to the master thesis topic. The master thesis is a paper in which the student must demonstrate the ability of independent analysis and solving a given engineering problem/task in the field of geology using the knowledge acquired through graduate study from a theoretical and practical point of view.					
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: To define a professional problem / task To summarise master thesis in English To apply the methodology of writing a professional and scientific paper To write master thesis linguistically and ethically correct To apply the acquired knowledge and general competencies acquired through graduate study To interpret research results Skills: To solve a complex practical problem / task. To argue the results of the conducted research in an expert discussion Competences: To respect ethical norms and rules of citing literature, To design and conduct research.					
Assessment methods and criteria	practical mark The student is obliged to apply for one of the offered topics, make a plan of activities with the mentor and submit the master thesis for evaluation within the given deadlines, prepare a presentation and defend the master thesis in front of the committee.					
Recommended readings	Selected literature based on the topic of master thesis and according to the mentor's recommendation.					
TU Coordinator	All teachers in the scientific-teaching profession					
Contribution to EIT's Overarching Learning Outcomes (tick relevant	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments /**	**OLO6 Leadership**

box/es)*					**Sustainability**	
	The student will develop all skills through work on the master thesis and through solving complex engineering tasks/problems.					
Justification for OLO contribution						

Semester 3
WUST

Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish … Geofizyka inżynierska
Name of subject in English Engineering Geophysics
Main field of study: Mining and geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
………………………. Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code ………… W06GIG-SM3004….
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			50	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	1			2	
including number of ECTS points for practical classes (P)				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,8			0,9	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. has knowledge of fundamentals of applied geophysics, physics and geology.
2. knows fundamentals of soil and rock mechanics.
3. is able to use MS Office software.
4. is able to work in a team.

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SUBJECT OBJECTIVES

C1 familiarize with physical phenomena in geosphere of the Earth
C2 familiarize with engineering problems solved by means of geophysical surveying
C3 familiarize with various geophysical surveys.
C4 acquisition of skills to plan geophysical field surveying and to interpret its results.
C5 development of skills to work in a group.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 recognizes, names and explains engineering problems in different fields.
PEU_W02 identifies, describes and chooses geophysical surveying methods.
PEU_W03 analyses and assesses case studies from solving the engineering problems.

relating to skills:

PEU_U01 is able to coordinate team work, create field research plans and manage the work progress.

PEU_U02 is able to independently create solutions for complex practical problems in engineering and geoengineering applying knowledge about geophysical surveying, mining geophysics, utilizing modern methods in geophysical data acquisition and interpretation.

PEU_U03 is able to critically assess, process and interpreted results of the geophysical surveying and provide recommendations related to engineering problems in mining, civil engineering, engineering geology, municipal waste site, archeology, engineering properties of soil and rocks, hydrogeology, monitoring seepage in river dykes or dams.

PEU_U04 is able to solve geophysical problems.

PEU_U05 is able to conduct auto-didactical education related to detailed handling of typical software.

relating to social competences:

PEU_K01 understands the need to create and transfer to the society – among others by mass media- information and opinions related to mining engineering achievements and other activities of mining engineer; tries to transfer the information in commonly understood way, presenting different points of view; is aware of the quality and need to shape the work safety culture in mining and the responsibility for the health and life of other employees.

PROGRAMME CONTENT

	Lecture	Number of hours
Lec 1	Physical properties of rocks. Inter-relationships between the various subdisciplines of applied geophysics. Overview of geophysical methods, their physical principles and applications. Methodology of geophysical surveying.	1
Lec 2	Engineering problems solved with geophysical surveying. Case studies.	2
Lec 3	Electrical resistivity methods. Tomography and VSE. IP method. Physical principles. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
Lec 4	Electromagnetic methods. FDEM and TDEM methods. Magnetotelluric methods. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Lec 5	GPR surveying. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Lec 6	Seismic tomography. Seismic interferometry. Physical principles. Applications. Case studies.	2
Lec 7	Mine geophysics. Seismology. Seismic methods. Active and passive seismic tomography. Microgravimetry. Case studies.	2
Lec 8	Gravity and magnetic surveying. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
	Total hours	15

Project	Number of hours

Proj 1	One selected geophysical technique. Fundamentals and equipment. Field surveying	4
Proj 2	Processing and interpretation of field data.	3
Proj 3	Solving the geophysical problems.	8
	Total hours	15

TEACHING TOOLS USED

N1. N1.Lecture aided by presentation.
N2.Demonstration.
N3.Discussion and consultations
N3Calculations
N5Practical field surveying

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
P1	W01-W03	Test related to lecture content. Final grade.
F1	U01-U02, U05	Test. Project 1. Report on Project 1
F2	U03, U05	Test. Project 2. Report on Project 2
F3	U04, U05	Test. Solving geophysical problems
F1-F3, P2	U01-U05 K02	Grades are given for each of three project tasks including tests and reports. The final grade P2 for the project course is the weighted average grade of F1-F3.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Aki, K., Richards P.G., 1980. Quantitative Seismology: Theory and Methods. W.H. Freeman Co.. San Francisco.
[2] Burger, H.R., Sheehan, A.F., Jones, C.H., 2006. Introduction to Applied Geophysics: Exploring the Shallow Subsurface. W.W. Norton & Company, Inc.
[3] Mendecki, A.J. (ed.), 1997. Seismic Monitoring in Mines. Chapman & Hall.
[4] Reynolds, J.M., 2011. An Introduction to Applied and Environmental Geophysics. Wiley – Blackwell. John Wiley & Sons.
[5] Sharma, Prem V., 2002. Environmental and engineering geophysics. Cambridge University Press.
[6] Torge, W., 1989. Gravimetry. Water de Gruyter. Berlin. New York.
[7] Selected Journal Publications (for example journals: Progress in Geophysics, Engineering Geophysics Journal, Environmental and Engineering Geophysics, Journal of Geophysics and Engineering, Pure and Applied Geophysics).

SECONDARY LITERATURE:

[1] Lowrie, W., 2007. Fundamentals of Geophysics. Cambridge University Press.
[2] Milsom, J., 2003. Field Geophysics. John Wiley & Sons Ltd.
[3] Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990. Applied Geophysics. Cambridge University Press.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

ANNA BARBARA GOGOLEWSKA, anna.gogolewska@pwr.edu.pl

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish Wspomagane komputerowo modelowanie geologiczne i geostatystyka.)
Name of subject in English: Computer Aided Geological Modelling and Geostatistics
Main field of study (if applicable): Górnictwo i geologia.
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Mineral Resource Exploration
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W06GIG-SM3002
Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	crediting with grade	Examination / crediting with grade*	crediting with grade	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,8		1,9		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Mathematical Statistics,
2. Fundamentals of Geology and Mineral Deposits

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SUBJECT OBJECTIVES

C1 Developing basic skills in computer modelling of 3-D objects.
C2 Introduction of the principles of digital modelling of typical geological structures.
C3 Introduction to the methods of deposit parameters estimation and resources evaluation.

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 Estimation methods, principles of geostatistics, kriging estimators PEU_W02 Geostatistical modelling of the selected deposit parameters (domain analysis, variogram modelling, PEU_W03 Creating and validating 3-D models of various geological structures in the comprehensive dedicated software environment. relating to skills: PEU_U01 Application of relevant estimation methods for quality modelling of a deposit PEU_U02 Evaluating 3-D objects against structural and quality block models (volumes, tonnages, grades) PEU_U03 Describing the interpretation and applied approach, creating models, evaluation results, recommendations for possible enhancements relating to social competences: PEK_K01 The student can think and act in a creative and enterprising way

PROGRAMME CONTENT		
Lecture		Number of hours
Lec 1	Introduction to the course. Geological database and validation of the geological data.	2
Lec 2	Geology of the seam.	2
Lec 3	Structural model of the stratified deposit. Methods of the prediction of the surface layer parameters.	2
Lec 4	Spatial distribution of samples values. Regionalized variable.	2
Lec 5	BLUE Estimator of the mean value: Kriging.	2
Lec 6	Quality model of the deposit – block model of the parameter layers. Estimation and evaluation of the block model.	2
Lec 7	Reserves modelling and evaluation.	2
Lec 8	Mineral resources. International reporting. The JORC Code	1
	Total hours	**15**

Laboratory		Number of hours
La1	Determining the rules of work at the laboratory.	3
La2	Assignment of the individual dataset for the exercises and creating initial data files.	3
La3	Data validation and creating initial geological database.	3
La4	Construction of the structural wireframe model of stratigraphy layers.	3
La5	Construction of the block model of the deposit and overburden layers. Thickness and stripping ratio analysis.	3
La6	Data preparation to geostatistical analysis. Compositing of the samples.	3
La7	Domain analysis with the use of the statistical methods.	3
La8	Determination of the empirical variogram. Anisotropy analysis.	3
La9	Variogram modelling.	3
La10	Kriging Neighborhood Analysis - defining optimal parameters of the	3

	estimation procedure.	
La11	Estimation of quality parameters in block model of the deposit layers. Validation of the estimation quality.	3
La12	Validation of the quality model and classification of the resources. Balance resources evaluation.	3
La13	Preparation of data for continuous surface mining ultimate pit design. Ultimate pit outlines generation	3
La14	Wireframe and block modelling of the ultimate pit	3
La15	Reserves evaluation, visualization and interrogation of created models	3
	Total hours	45

TEACHING TOOLS USED

N1. Form of lectures - traditional, multimedia presentations using specialized software and demonstrations of its application "live", individual development of specialist topics covered during the lecture,
N2. individual development of project tasks within the laboratories frames, individual development of electronic reports concerning project tasks within the laboratories frames,
N3. evaluation of laboratory tasks reports with multipoint grade of student's work, group analysis of the results obtained during laboratory tasks; preparation of conclusions concerning data dependencies and constraints of mining projects, skill control tests, duty hours in laboratory.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01, PEU_W02	Lecture grade on the basis of the written examination
F2	PEU_W03,	Laboratory task assessment: "structural modelling assessment
F3	PEU_U01	Laboratory task assessment: "geostatistical modelling"
F4	PEU_U02, PEU_U03	Laboratory task assessment: "reserves evaluation".
P average of F1, F2, F3, F4		

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] M. Armstrong, Basic Linear Geostatistics, Springer Verlag, 1998. [2] P. Goovaerts: “Geostatistics for Natural Resource Evaluation“, Oxford University Press, 1997. [3] R. H. Grishong, Jr., 3-D Structural Geology, Springer Verlag, 2008 [4] K. Hefferan, J. O’Brien, Earth materials, Willey-Blacwell, Chichester U.K., 2010 [5] W. Hustrulid, M. Kuchta, Open pit mine planning and design. Chapter 3. Orebody description, Taylor&Francis, 2013. [6] A. G. Journel, and C.J. Huijbregts, Mining Geostatistics, Academic Press, 1978. [7] Ch.C. Plummer, D.H. Carlson, L. Hammersley, Physical geology, McGraw-Hill I.E. N.Y. 2010 [8] D.R. Prothero, R.H. Dott Jr., Evolution of the Earth, McGraw-Hill I.E. N.Y., 2010 [9] M.W. Rossi, C.V. Deutsch, Mineral Resources Estimation, Springer Verlag 2014. **SECONDARY LITERATURE:** [10] Handouts, tutorials.
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr inż. Krzysztof Hołodnik **Dr inż. Witold Kawalec**

Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Cyfrowa kopalnia
Name in English: Digital Mine…………………….
Main field of study: Mining and geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
………………………. Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3006
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		15		
Number of hours of total student workload (CNPS)	25		25		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**1**		1		
including number of ECTS points for practical (P) classes			1		
Including number of ECTS points for direct teacher-student contact (BK) classes	0,8		0,8		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Computer literacy skills
2. Basic knowledge related to Mining Engineering and Mineral Processing
3. Programming

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SUBJECT OBJECTIVES

C1. Acquisition of the ability to create utility applications in the C / C ++ and LabVIEW environment
C2. Providing students with knowledge about embedded systems, their construction, selection of components, designing, programming and their exploitation.
C3. Familiarizing with the advances of technology & methods of future mining operations.
C4. Acquisition and consolidation of social competencies including emotional intelligence skills involving the cooperation in the group of students aiming to effectively solve problems. Responsibility, honesty and fairness in the proceedings; observance force in academia and society

SUBJECT EDUCATIONAL EFFECTS **relating to knowledge:** PEU_W01 A student has knowledge related to automation systems, control systems and measurement systems in various aspects of the mining industry. PEU_W02 The student has knowledge of the importance of automation and robotics systems in modern mining. **relating to skills:** PEU_U01 A student is able to select and integrate elements of a specialized measuring and control system including: control unit, executive system, measuring system as well as peripheral and communication modules PEU_U02 A student can design improvements in the existing design solutions for automation and robotics components and systems **relating to social competences:** PEU_K01 A student is aware of the need for a professional approach to technical issues, meticulous reading of documentation and knows environmental conditions in which devices and their components can function PEU_K02 The student has knowledge concerning the benefits of creation and implementation new solutions&technologies into mining industry

PROGRAMME CONTENT		
	Form of classes - lecture	**Number of hours**
Lec 1	Terminology (process, automation, robots, measurement devices, control systems). Definition of digital mine	2
Lec 2	Aims, benefits, drawbacks of automation. Industrial revolutions. Definition of industry 4.0. Overview of components of the 4th industrial revolution. Industry 4.0 and mining	2
Lec 3	Elements of technological process in mining. Automation of cyclic processes Measuring technologies in industry 4.0. Sensors systems. Data transmission and data storage technologies. Analytics in industry 4.0. Industrial BigData, Cloud Computing	2
Lec 4	Industrial Internet of Things. M2M communication, anti-collision systems, location of people underground	2
Lec 5	Virtual and augmented realities for industry. Simulators. Digital Twin. Digital models of processes and objects. Management information creation systems, reporting	2
Lec 6	Case study: Automation in open pit lignite mining (KTZ, Autonomous haulage (use case from Australia))	1
Lec 7	Case study: underground mine (Rock Vader – Sandvik project, other use cases from Sandvik, Epiroc, MineMaster, Zanam, AOT from ZGPS KGHM, KIC project on shaft inspection, …etc)	2
Lec 8	Case study: mineral processing (ConVis, FlowVis) in KGHM, OPMO project	2
	Total hours	**15**

Form of classes - laboratory		Number of hours
Lab1	Scope of the course, teaching purpose, crediting conditions, literature, data. Introduction to ARDUINO	3
Lab2	Basic sensors for physical parameters measurements	3
Lab3	Measurements in Labview	3
Lab4	Analysis and Visualization in Labview	3
Lab5	Control in labview	3
	Total hours	**15**

TEACHING TOOLS USED
N1. Type of lectures - traditional, illustrated with multimedia presentations with the usage of audio- visual equipment. N2. Discussion concerning lectures and laboratory. N3 Configuration on laboratory classes measuring systems (hardware and software), performing of measurements, teamwork N4. Projects defence - oral and written form. N5. Duty hours.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at the end of semester)	Educational effect number	Way of evaluating educational effect achievement
F1, P1	PEK_U02- PEK_U04	F1.1 Grade from laboratory work's performance and its merits F.1.2 Grade from laboratory work's oral or written defence P1.Final grade (weighted average of F1.1 - 60% and F1.2 - 40%).
F2, P2	PEK_U02- PEK_U04	F2.1 Grade from activity during the lecture (questions, discussions etc) F.2.2 Grade from written exam P2.Final grade (weighted average of F2.1 - 20% and F2.2 - 80%).

LITERATURE
PRIMARY LITERATURE: [1] LabVIEWTM Getting Started with LabVIEW http://www.ni.com/pdf/manuals/373427j.pdf [2] Monk Simon: Arduino dla początkujących. Podstawy i szkice, Anderson R., Cervo D., Helion, 2018 [3] Monk Simon: Arduino dla początkujących. Kolejny krok, Anderson R., Cervo D., Helion, 2015 **ONLINE LITERATURE:** [1] LabVIEW Tutorial [2] ARDUINO Tutorial [3] Materials prepared by Tutor [4] Internet websites
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Prof. dr hab. inż. Radosław Zimroz, radoslaw.zimroz@pwr.edu.pl **dr inż. Anna.Nowak-Szpak**

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Zarządzanie Środowiskiem
Name in English: Environmental Management
Faculty of studies (if applicable): Mining and Geology
Specialisation (if applicable): Mining Engineering
Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Subject Type: Obligatory
Subject code: W06GIG-SM3001
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in the University (ZZU)	**30**				**15**
Number of hours of total student workload (CNPS)	**50**				**25**
Form of crediting	**Crediting with grade**				**Crediting with grade**
For a group of courses mark (X) for the final course					
Number of ECTS points	**2**				**1**
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BU) classes	**1,3**				**0,8**

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of issues related to ecology and environmental protection.

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SUBJECT OBJECTIVES

C1. To get students acquainted with systems of environmental management both in Poland and other EU countries.
C2. To prepare students for rational and sustainable management of environmental components.
C3. To get students acquainted with the genesis of environmental management systems in Poland, review and standardization of environmental management systems.
C4. To get students acquainted with benefits and obligations arising from the implementation of an environmental management system.
C5. To present the relationship between an environmental management system and a quality

management system.
C6. To provide an overview of informative methods of supporting the implementation of environmental management systems (possibilities and practical usage of computerised systems of environmental information management, decision support in the area of environmental protection and choice of methods and tools used to support the implementation of an environmental management system).

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 – Possesses systematic knowledge of the origins of environmental management systems, review and standardization of environmental management systems.
PEU_W02 - Possesses knowledge of the possibilities and practical applications of tools supporting the implementation of the environmental management system.
PEU_W03 - knows basic formal and legal regulations regarding the implementation and functioning of management systems, tools and instruments of environmental management.
PEU_W04 - Possesses knowledge for rational and sustainable management of environmental components.

relating to skills:
PEU_U01 – Possesses linguistic resources appropriate for specialised language and is able to use it in linguistic activities in order to communicate in the professional environment regarding the field of studies; is able to obtain necessary information and interpret and critically evaluate it, reads and understands professional literature, is able to formulate and comprehensively justify opinions, provide presentations of problems related to a studied discipline and also participate in scientific and professional discussions.
PEU_U02 – Is able to use methods and appropriate IT tools in system management of environmental components.

relating to social competencies:
PEU_K01 - Is able to think and act in a creative and enterprising way.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec.1	Basic concepts: - Environment, characteristics of individual elements of the environment - Characteristics of hazards for the natural environment which are a result of human activities - Environmental Management - The Environmental Management System	2
Lec.2	Legal aspects of environmental management	2
Lec.3	History and development of environmental management systems	2
Lec.4 Lec.5 Lec.6	Environmental management systems: - Business Charter for Sustainable Development of the International Chamber of Commerce - ICC Business Charter for Sustainable	6

	Development - EMAS – Directive of the European Community Commission regarding the approval for voluntary participation by organisations in a community eco-management and eco-audit scheme - CP - Clean Production - BS 7750 - Specification for Environmental Management Systems - ISO 9000 - ISO 14000 - ISO 14001 Characteristics of selected Environmental Management Systems. The benefits of the implementation of the EMS for a company. Experiences of Polish enterprises from the implementation of EMS. Process of implementation of the selected EMS in a company with an example of EMAS.	
Lec.7 Lec.8	Basic tools of environmental management: - Legal and administrative instruments (laws, standards, licenses and permits) - Economic instruments (fees, taxes, deposit and refund systems, transferable rights, subsidies, liens, fines) - Instruments (techniques) social impact (ecological education, ecological propaganda) Examples of basic tools of environmental management: - Procedure for an assessment of environmental impact - Integrated permits - Audits - Safety Reports - Monitoring of the Environment	4
Lec.9 Lec.10	Design of an environmental management system	4
Lec.11 Lec.12	IT systems supporting environmental management: - Decision Support Systems - Expert systems - Simulation Models - Geographical Information Systems Selected types of information systems which support environmental management, their characteristics, examples of implementation both in Poland and in the world	4
Lec.13	The benefits of an implemented and functioning environmental management system	2
Lec.14	Costs of implementation and functioning of an environmental management system	1
Lec.14 Lec.15	Environmental management systems in practice	3
	Total hours	**30**

Form of classes - seminar		Number of hours
Se1	The scope and form of an essay and presentation, terms of crediting and literature.	2

	Assignment of seminar topics for individual students.	
Se2 Se3 Se4 Se5 Se6 Se7 Se8	Student speeches with the use of multimedia presentations on the following issues: environmental management systems - specified examples, formal and legal conditions of administrative procedures (eg. receiving a decision on the environmental conditions of a project, an integrated decision etc.), life-cycle analysis of a selected company; fees, taxes, surcharges and environmental deposits; litter management systems, mineral resource management, renewable energy sources, selected monitoring systems, the institution of environmental protection in Poland and in the world and also alternative energy sources, etc. Group discussion on the content and form of speeches.	13
	Total hours	**15**

TEACHING TOOLS USED
N1. Informative lecture with elements of problematic lectures. N2. Multimedia presentations N3. Didactic discussion during lectures and seminars N4. Preparation of an essay in the form of a report N5. Presentation of the essay N6. Consultations

EVALUATION OF SUBJECT EDUCATIONAL OUTCOME ACHIEVEMENTS

Evaluation F – forming (during semester), P – concluding (at semester end)	Educational outcome number	Method of evaluating educational outcome achievement
F1- Grade from content value of an essay	PEU_U01 PEU_U02 PEU_K01	Text and graphical form of essay
F2 – Grade from presentation and issues included in an essay	PEU_U01 PEU_U02 PEU_K01	Presentation of essay
F3 – Grade from a written or oral test	PEU_W01 PEU_W02 PEU_W03 PEU_W04	Positive grade
final grade from the subject (the weighted average, respectively: 35% for the substantive content of the essay, 25% for the presentation, 40% for the lecture)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Ejdys J.,1998, Zarządzanie środowiskowe w przedsiębiorstwie – koszty i korzyści, Sterowanie ekorozwojem, t.2, Wyd. Politechniki Białostockiej, Bialystok,
[2] Lukasheh A. F., Droste R. L., Warith M. A., 2001, Review of Expert System (ES), Geographic Information System (GIS), Decision Support System (DSS), and their applications in landfill design and management. W: Waste Management & Research nr 19,
[3] Łunarski J. (red.), 2002, Zarządzanie środowiskiem", Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszow
[4] Nowak Z., 2001, Zarządzanie środowiskiem, Wyd. Politechniki Śląskiej, Gliwice,
[5] Matuszak-Flejszman A., 2001: Jak skutecznie wdrożyć system zarządzania środowiskowego wg normy ISO 14001. PZIiTS, Poznan
[6] Pochyluk R. i inni, 1999, Zasady wdrażania systemu zarządzania środowiskowego zgodnego z wymaganiami normy ISO 14001, Eco-Konsult, Gdansk,
[7] Poskrobko B., Poskrobko T., 2012, Zarządzanie środowiskiem w Polsce, Polskie Wydawnictwo Ekonomiczne, Warsaw
[8] Poskrobko B., 1998: Zarządzanie środowiskiem. Polskie Wydawnictwo Ekonomiczne, Warsaw
[9] Przybyłowski P. (red.), 2005, Podstawy zarządzania środowiskowego, Wyd. Akademii Morskiej, Gdynia.

SECONDARY LITERATURE

[1] Jeżowski P. (red.), 2007: Ekonomiczne problemy ochrony środowiska i rozwoju zrównoważonego w XXI wieku. Szkoła Główna Handlowa, Warsaw
[2] Lemański J. F., Matuszak-Flejszman A., Zabawa S. (red.), 2000: Efektywność funkcjonowania wdrożonego systemu zarządzania środowiskowego wg normy ISO 14001. PZIiTS, AE, Poznan – Pila
[3] Websites given during lectures and seminars

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr hab. inż. Justyna Woźniak
Dr hab. Inz. Katarzyna Pactwa,
Dr inż. Danuta Szyszka

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish Bezpieczeństwo i higiena pracy
Name of subject in English: Occupational Health and Safety
Main field of study (if applicable): Górnictwo i geologia.
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Mineral Resource Exploration
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W06GIG-SM3005
Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			25	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	**1**			1	
including number of ECTS points for practical classes (P)				1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,7			0,8	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Possesses basic knowledge of technologies used in open-pit mines and underground mines.
2. Is able to use Microsoft Office environment to prepare documents in Word, multimedia presentations in Power Point and work with Excel spreadsheets.
3. Is able to identify harmful, dangerous and nuisance factors in the workplace environment.

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SUBJECT OBJECTIVES

C1. To introduce the principles of occupational risk assessment in accordance with relevant standards
C2 To present the principles of occupational risk assessment and the determination of admissibility with the use of STER software and the RISC SCORE method.

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 Possesses general knowledge of rules of occupational risk assessment formulation PEU_W02 – Possesses knowledge of evaluating and determining the admissibility of occupational risk. PEU _W0 3 – Possesses general knowledge of corrective and preventive actions regarding hazards of typical work posts in the mining industry.… relating to skills: PEU_U01 Is able to identify hazards of harmful, dangerous and nuisance factors of typical work posts in the mining industry PEU_U02 Is able to estimate and determine risk acceptability with methods according to STER software and the RISC SCORE method. PEU_U03 - Is able to plan corrective and preventive actions for hazards of typical work posts in the mining industry.… relating to social competences: PEU_K01 - Is able to work in a team and together complete occupational risk assessment and develop its results and the required documentation in the form of a team report

PROGRAMME CONTENT		
	Lecture	**Number of hours**
Lec 1	Definition of occupational risk. Legal basics of occupational risk assessment. Risk assessment methods. Course of occupational risk assessment. Information necessary for occupational risk assessment. Identification of harmful, dangerous and nuisance factors in the work environment.	3
Lec 2	Estimation of occupational risk assessment and determination of admissibility. Corrective and preventive actions. Familiarising employees with the results of occupational risk assessment. Implementation of agreed corrective and preventive actions. Monitoring the effectiveness of implemented actions. Periodic occupational risk assessment. Harmful factors – identification and assessment of risks.	3
Lec 3	Dangerous factors - identification and assessment of risks.	3
Lec 4	Nuisance factors in occupational risk assessment: psychological burden, static burden, monotype.	3
Lec 5	Methods of occupational risk assessment: STER software, the RISC SCORE method, written test	3
	Total hours	**15**

	Project	Number of hours
Pr1	Occupational risk assessment with the use of STER software for two work posts – description of work post, identification of hazards. Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of harmful factors (dust, noise)	3
Pr2	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of	3

	harmful factors (vibration, chemical agents)	
Pr3	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of dangerous factors (slippery or uneven surfaces, falling elements, moving parts, moving machinery and transported bimi items)	3
Pr4	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility for nuisance factors (psychological burden, static burden, monotype)	3
Pr 5	Occupational risk assessment for a selected work post with the use of the RISC SCORE method, presentation of executed exercises, test	3
	Suma godzin	**15**

TEACHING TOOLS USED

N1. Informative lecture with elements of problematic lectures.
N2 Multimedia presentations.
N3 Didactic discussions during lectures.
N4 Didactic discussions during laboratory classes.
N5Computer presentation of executed occupational risk assessments.
N6Consultation.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01-W03	grade from a test
F2	PEU_W01-W03 PEU_U01- U03	grade from a presentation
P2	PEU_W01-W03 PEU_U01- U03	final grade from project classes (arithmetic average of F1 and F2)

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Occupational Safety and Health in Mining. Anthology on the situation in 16 mining countries. Ed.: Kaj Elgstrand and Eva Vingård. University of Gothenburg nr 2013;47(2) (gupea.ub.gu.se › bitstream › gupea_2077_32882_1)
[2] Boyle, Tony: Health and safety: Risk management. IOSH, 2001. (http://www.iosh.co.uk/index.cfm?go=publications.main)
[3] Encyclopaedia of occupational health and safety. Fourth edition Stellman, Jeanne M. (ed.). International Labour Organization, 1998 (http://www.ilo.org/public/english/support/publ/xtextre.htm#b103) http://www.ilo.org/public/english/support/publ/encyc/)
[4] McKeown, Céline; Twiss, Michael: Workplace ergonomics: A practical guide, IOSH, 2001, 160 p. http://www.iosh.co.uk/index.cfm?go=publications.main

<u>SECONDARY LITERATURE:</u> Handouts, articles
OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)
Dr inż. Żaklina Konopacka

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOIENGINEERING, MINING AND GEAOLOGY

SUBJECT CARD

Name in Polish: Modele Decyzyjne w Zarządzaniu
Name in English: Operations Research
Main field of study (if applicable): Mining and Geology
Specialization (if applicable): Mining Engineering, Mineral Resource Exploration
Level and form of studies: 2nd, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3000
Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**15**		**15**		
Number of hours of total student workload (CNPS)	**25**		**50**		
Form of crediting	**crediting with grade**		**Crediting with grade**		
For group of courses mark (X) final course					
Number of ECTS points	1		**2**		
including number of ECTS points for practical (P) classes of practical character (P)			**2**		
including number of ECTS points for direct teacher-student contact (BU) classes	**0,8**		**0,7**		

*delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. The student has basic knowledge of mining systems, technological and organizational systems in mining
2. The student has basic knowledge concerning economics in mining
3. The student has basic knowledge concerning mathematical analysis necessary to understand mathematical issues in science having engineering and economic character.
4. The student has basic knowledge and skills of using probability theory models and mathematical statistics
5. The student can use Excel spreadsheet
6. The student understands the need and knows the possibilities of lifelong learning, improving professional, personal and social skills

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SUBJECT OBJECTIVES

C1 Acquiring basic knowledge, taking into consideration its applicational aspects concerning mathematical decision models used in management:

C1.1 Linear programming models

C1.2 Models of planning, deposits and costs of projects
C1.3 Queuing system models
C1.4 Digital simulation models
C2. Learning of qualitative understanding, interpretation and quantitative analysis with applications of selected issues concerning optimization
C2.1. Production systems:
C2.2. Transport issues
C2.3. Flows in networks.
C2.4. Project schedules
C2.5. Queuing system models
C3. Acquiring and consolidating the competencies of thinking and acting in a system way.

SUBJECT LEARNING OUTCOMES

Subject educational effect (knowledge)

PEU_W01 The student has knowledge concerning basic decision models in management
PEU_W02 The student has knowledge concerning line programming models.
PEU_W03 The student has knowledge concerning models for planning and monitoring of activities, deposits, and costs of projects
PEU_W04 The student has knowledge concerning queuing system models
PEU_W05 The student has knowledge concerning simulation models.

Subject educational effect (skills)

PEU_U01 The student has the ability to apply and interpret models using linear programming applications
PEU_U02 The student has the ability to apply and interpret models of planning and monitoring of activities, deposits, and costs of projects with the use of programming applications
PEU_U03 The student has the ability to apply and interpret queuing system models using programming applications
PEU_U04 The student has the ability to apply and interpret simulation models using programming applications

Subject educational effect (social)

PEU_K01 The student can think and act in a system, creative and enterprising way
PEU_K02 The student is able to identify and solve problems with the use of decision models and applications

PROGRAMME CONTENT

	Form of classes - lecture	**Number of hours**
Le1	Introduction to modelling systems	2
Le2	Linear programming issues - optimization of production	2
Le3	Linear programming issues - flow in networks optimization (optimal allocation issues, the issue of transportation, maximum flow, minimizing costs)	2
Le4	Projects scheduling using critical path	2
Le5	Planning and balancing of deposits in projects	2
Le6	Optimization issues of queuing systems	2
Le7	Monte Carlo methods and digital simulation	3
	Total hours	**15**

Form of classes - laboratory		Number of hours
La1	Defining and solving linear programming issues (Microsoft Excel-Solver)	2
La2	Production optimization (Microsoft Excel - Solver)	2
La3	Flows in networks optimization (Microsoft Excel - Solver)	2
La4	Projects scheduling (Microsoft Project)	2
La5	Planning and balancing of deposits in projects (Microsoft Project)	2
La6	Optimization issues of queuing systems (Microsoft Excel)	2
La7	Elements of Monte Carlo methods and digital simulation (Microsoft Excel)	3
	Total hours	**15**

TEACHING TOOLS USED

N1. Interactive lecture with slides and discussion
N2. Laboratory exercises with the use of IT applications - discussion concerning solutions
N3. Laboratory exercises - short written tests (calculating tasks, tests of knowledge)
N4. Duty hours
N5. Own work - preparation for laboratory classes, solving additional tasks
N6. Own work - own literature studies.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at the end of semester)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_U01-04	short written test.
PEU_U01-04 written test (counting exercise)		
PEU_W01-05; PEU_K01-02 Written test (knowledge test)		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE

[1] Ignasiak E., Borucki W., Badania operacyjne, PWE, 2001
[2] Krawczyk S., Badania operacyjne dla menedżerów, PWE
[3] Baranowska B, Badania operacyjne w zarządzaniu, PWSBIA, 1996

SECONDARY LITERATURE

[1] Szapiro T., Decyzje menedżerskie z Excelem, PWE 2000
[2] Trzaskalik T., Modelowanie optymalizacyjne, Absolwent
[3] Trzaskalik T., Badania operacyjne z komputerem, PWE

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Dr inż. Witold Kawalec
Dr hab. inż. Leszek Jurdziak
Dr inż. Zbigniew Krysa

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish … Zarządzanie projektami, ocena ich opłacalności i ryzyka..
Name of subject in English: Project Management, Appraisal and Risk Evaluation.
Main field of study (if applicable): Mining and Geology
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
…………………….. Mineral Resource Exploration
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code … W06GIG-SM3003G …………
Group of courses YES

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30	15	
Number of hours of total student workload (CNPS)	25		50	25	
Form of crediting	Examination				
For group of courses mark (X) final course	X				
Number of ECTS points	4				
including number of ECTS points for practical classes (P)	3				
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	3,1				

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge of basic mathematical analysis, probability and statistical models
2. Skills in using Excel spreadsheets
3. Understanding of the need of lifelong learning and the importance of application of Economics, Management and Social Sciences in engineering.

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SUBJECT OBJECTIVES

The course combines two groups of topics: basics of mineral economics and financial management and introduction to project management.
Part A: The purpose of the course is
C1 to introduce basic concepts of Microeconomics and financial management
C2 to introduce the concept of time value of money and present the methods used to evaluate investment projects. Different techniques are illustrated by examples and case studies. The range of application as well as the advantages and disadvantages of each method are discussed. The issues of inflation and risk analysis are included.

Part B:
C3 Introduction to project management basic concepts, methods and tools.
C4 Presentation of given project management areas: Project scope management, Project time management, Project cost management, Project risk management. Project planning, scheduling and control using Microsoft Project.
C5 Presentation of the issues of effective communication in project teams, group behaviour and leadership.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEU_W01 knows the concepts of demand, supply and price elasticities, understands how they affect markets
PEU_W02 knows the concepts of costs in economics and accounting, understands how they differ
PEU_W03 knows the main cost categories and cost accounting methods
PEU_W04 has basic knowledge about the contents of financial statements
PEU_W05 has basic knowledge about the method of ratio analysis of financial statements
PEU_W06 knows and understands the concepts of Present Value and Future Value for simple cash flows and annuities.
PEU_W07 knows the capital budgeting methods (NPV, IRR, PBP) and understand how to interpret the results
PEU_W08 has basic knowledge about the project risk evaluation methods

relating to skills:

PEU_U01 is able to analyze the causes and effects of demand and supply changes
PEU_U02 is able to interpret and use information presented in financial statements also by means of ratio analysis
PEU_U03 is able to use different cost analysis methods and make decisions based on the rsults
PEU_U03 can calculate Future and Present value, also for annuities and solve simple calculation problems
PEU_U04 is able to perform discounted cash flow analysis and draw conclusions based on the results
PEU_U05 is able to carry out sensitivity analysis and scenario analysis using a financial model of an investment
PEU_U06 is able to work out basic project documentation and initiate a project
PEU_U07 is able to use basic methods of project management, monitoring and project risk management
PEU_U08 is able to implement basic conflict management methods in a project group
PEU_U09 is able to use basic group management methods, can undertake and shape the leadership position

relating to social competences:

PEU_K01 is able to think and act in a systematic, creative and entrepreneurial way
PEU_K02 has an established attitude of economic operation and decision-making based on available financial information and forecasts

PROGRAMME CONTENT		
Lecture		**Number of hours**
Lec.1	Supply and demand, equilibrium price, changes in demand and supply. Stock and commodity markets used by mineral industries	2
Lec.2	Costs in economics and in accounting. Cost and money outflow. Relevant cost, incremental cost, marginal cost, alternative cost. Short-term decision making.	2
Lec.3	Costs as the subject of cost accounting, different systems of cost accounting Different methods of cost data presentation (by types, divided into direct and indirect costs). Cost allocation	2
Lec.4	Variable and fixed costs. Break even point. Cost-volume –profit analysis.	1
Lec.5	Basics of financial accounting. Income statement and cash flow statement. Balance sheet. Working capital. Examples of financial statements of mining companies	2
Lec.6	Financial ratio analysis. Liquidity, profitability, activity and debt ratios. Financial and operating leverage.	2
Lec.7	The concept of time value of money. Computation of future and present value of money by means of spreadsheet functions. Basics of capital budgeting. Evaluation of different methods.	2
Lec.8	The concept of risk and return. Quantification of risk. Risk analysis in project evaluation: sensitivity analysis, scenario analysis, other methods.	2
	Total hours	15

Project		**Number of hours**
Pr 1	Issues of understanding communication: Definitions Models (Schramm model, Berlo's SMCR (source, message, channel, receiver) model, McCroskey model, Reusch and Bateson model, Westley-MacLean model)	3
Pr 2	Conflict Sources of conflicts Kilmann and Thomas classification of conflict Kilmann and Thomas test Different styles of conflict solving Roles of conflict in group development.	3
Pr3	Team roles Team roles Belbin perspective Discussion group roles Effective managerial behaviour in the context of team roles	3
Pr4	Leadership Hersey and Blanchard theory Black and Mouton approach to leadership Fiedler theory and his Least Preferred Coworker Scale Situational leadership self-assessment	3
Pr5	Summary;	3

	Effective managerial behaviour from the different contexts.	
	Total hours	15

Laboratory		Number of hours
Part A		
La1	Supply and Demand curves. Elasticity of demand.	2
La2	Economic costs. Cost curves. Profit maximization cases.	2
La3	Managerial cost accounting. Decision making cases.	2
La4	Basic financial accounting. Creation of simple Balance Sheet, Profit and Loss Statement and Cash Flow Statement	2
La5	Ratio analysis based on financial statements of companies	2
La6	Time value of money and capital budgeting – calculation by means of Excel functions	2
La7	Financial model of an investment. Sensitivity and Scenario analysis.	3
Part B		
La8	Basic concepts (process, project, project management, management by projects, critical factors for project success, competences). Preparing and initiation of the project. Project analysis (project environment, stakeholders, project objectives).	3
La9	Planning and estimating of the project. Project phases and life cycle	3
La10	Project organization. Project scope management. Planning of activities, resources and costs.	3
La11	Project risk management. Project monitoring. Project management methodologies.	3
La12	Quality management. Change control. Project closing.	3
	Suma godzin	**30**

TEACHING TOOLS USED

N1. Interactive lecture with the use of multimedia and discussion
N2. Laboratory classes: individual problem solving with the use of Excel spreadsheet
N3. Laboratory classes part B and project classes: case studies solving in groups and individually. Project presentations, discussion
N4. Consultation
N5. Self-study: solving assigned problems, literature studies

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01-W08 PEU_K01-K02	Assesment of student class activity
F2	PEU_U01-U10 PEU_K01-K02	Evaluation of student's assignements
P1	PEU_W01-W08 PEU_U01-U10 PEU_K01-K02	Written test

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: 1. Erhardt M., Brigham E.: Financial Management Theory and Practice. South-Western Cengage Learning, USA 2. Brigham E., Glapenski L.: Financial Management, 1997 3. Johnson H.: Making Capital Budgeting Decisions – Maximising the Value of the Firm. Financial Times/Prentice Hall (April 15, 1999) 4. Jonson H.: Strategic Capital Budgeting: Developing and Implementing the Corporate Capital Allocation Program, January 1994. 5. Lock Dennis, Project Management, Published April 11, 2013 by Routledge **SECONDARY LITERATURE:** 1. Jonson H.: Determining Cost of Capital: The Key to Firm Value. Apr 1999. 2. A Guide to Project Management Body of Knowledge (PMBOK®Guide Fourth Edition), Project Management Institute, 2008 (2004). wydanie polskie, MT&DC Warszawa, 2009 (2006) 3. Johnson H.: Global Financial Institutions and Markets. December 1999
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr inż. Gabriela Paszkowska, Gabriela.paszkowska@pwr.wroc.pl

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: ***Zasady i zastosowania InSAR oraz GIS w górnictwie***
Name in English: ***Principles and Application of InSAR and GIS in mining***
Main field of study: Mining and geology
Specialization: Geomatics for Mineral Resources Management
……………………….Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3007
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	Examination		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		
including number of ECTS points for practical (P) classes			3		
Including number of ECTS points for direct teacher-student contact (BU) classes	1,4		2,0		

*niepotrzebne skreślić

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of C ++ and Python programming language.
2. Basic knowledge of GIS functions and spatial data acquisition techniques
3. Ability to use GIS software package
4. Basic knowledge of databases

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SUBJECT OBJECTIVES

C1 Presentation of knowledge of satellite radar interferometry, as well as the possibility of using it in the ground deformation measurements.
C2 Acquiring the ability to determine surface displacements based on satellite radar data.
C3 Presentation of information on the use of GIS in advanced analysis of objects, phenomena and processes occurring in space.
C4 Acquiring the ability to formulate and solve tasks using GIS analytical functions.
C5 Acquiring skills to use spatial data and services in accordance with the INSPIRE Directive

SUBJECT EDUCATIONAL EFFECTS

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

PEK_W01 Has expanded knowledge in the field of using geoinformation systems to collect and process data used in modeling of both natural and anthropogenic phenomena and processes

PEK_W02 Knows the principles of construction and functioning of geoinformation systems in the mining industry and public administration

relating to skills:

PEK_U01 has the ability to use advanced GIS tools in mining, studies of natural phenomena, the impact of mining on the environment and space development,

PEK_U02 has the ability to formulate and solve spatial tasks in the GIS environment

PEK_U03 has the ability to interpret the results obtained and draw conclusions

relating to social competences:

PEU_K01 has the ability to formulate and transfer knowledge on the use of geoinformation systems in spatial analysis and presentation of their results

PROGRAMME CONTENT		
	Lecture	**Number of hours**
Lec 1	Discussion of syllabus, requirements for passing the course, literature	2
Lec 2	Introduction to Microwave Signals for Earth Observation	2
Lec 3	Principles and Applications of Passive and Active Microwave Remote Sensing	2
Lec 4	Acquisition and processing of SAR data	2
Lec 5	SAR image theory (geometric properties, polarization)	2
Lec 6	Basics of SAR data calculation using the DInSAR and SBAS methods	2
Lec 7	Principlesand Applicationsof Interferometric SAR (monitoring surface activity, natural and anthropogenic phenomena)	2
Lec 8	Fundamental concepts of geographical information systems	2
Lec 9	Data modelling in GIS. Representation of spatial data. Spatial databases. Current status and development trends	2
Lec 10	Methods of spatial analysis in GIS	2
Lec 11	Spatial data interpolation	2
Lec 12	Map algebra. Surface analysis, local and zonal functions	2
Lec 13	Basics of spatial statistics	2
Lec 14	Spatial Information Infrastructure. Inspire Directive. Open Data	2
Lec 15	Examples of applications of geoinformation systems in mining and environmental protection	2
	Total hours	**30**

Laboratory		Number of hours
La1	Configuration of the environment for SAR calculations	3
La2-3	Introduction to radar data calculations - calculation tasks	6
La4	Acquiring radar data and calculating the interferogram - DInSAR method	3
La5	Unwrapping of the interferometric phase - calculations	3
La6-7	Presentation of results in the GMT environment	6
La8	Discrete data interpolation. Preparation of input data for analysis (e.g. deformation measurements in the mining area)	3
La9	Discrete data interpolation. Development mining area terrain deformation maps with various interpolation methods.	3
La10	Discrete data interpolation. Analysis and assessment of the quality and uncertainty of interpolation. Prediction map. Development of maps of changes between two periods using a raster calculator.	3
La11	Spatial analysis - assessment of the suitability of the area for the location	3
La12	of mining operation. Construction of a database of spatial location criteria	3
La13	Spatial analysis - assessment of the suitability of the area for the location	3
La14	of mining operation. Selection of analytical procedures and conducting analytical operations.	3
La15	Spatial analysis - assessment of the suitability of the area for the location	3
	Total hours	**45**

TEACHING TOOLS USED
N1. Lectures N2. Multimedia presentations N3. Preparation of individual written term paper on a given topic N4. Multimedia materials (MOOC) N5. Laboratory instructions N6. Reports from laboratory exercises N7. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F1 Final mark for the written examination F2 Mark for the written report, P Final mark for the lecture (weighted average of F1 and F2, where F1 – 80% and F2 - 20%)
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F3 Mark for the written assignment reports F4 Mark from written tests, P2 Final mark for the laboratory (weighted average of F3 and F4, where F3 – 80% and F4 - 20%)

PRIMARY AND SECONDARY LITERATURE
<u>**PRIMARY LITERATURE:**</u> [1] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. 2015: Geographic Information Science and Systems, 4th Edition, John Wiley & Sons; [2] Maguire D., Batty M., Goodchild M., 2005. GIS Spatial Analysis and Modelling. ESRI Press [3] Berry J., 2007-2013. Beyond Mapping IV — GIS Modelling [4] Satellite InSAR Data: Reservoir Monitoring from Space, A. Ferretti, EAGE; 1st edition, 2014 [5] GMTSAR: An InSAR Processing System Based on Generic Mapping Tools (Second Edition), D. Sandwell i in., Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, 2016 [6] InSAR Principles - Guidelines for SAR Interferometry Processing and Interpretation, ESA Publications, 2008 <u>**SECONDARY LITERATURE:**</u> [1] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) [2] Kennedy M., 2009: Introducing Geographic Information Systems with ArcGIS: A Workbook Approach to Learning GIS, Second Edition, John Wiley and Sons; [3] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. W., 2006. GIS. Teoria i praktyka. Wydawnictwo Naukowe PWN, Warszawa [4] Urbański J., 2010. GIS w badaniach przyrodniczych, Wydawnictwo Uniwersytetu Gdańskiego [5] Dokumentacja środowiska GMT (Generic Mapping Tools) - http://gmt.soest.hawaii.edu/projects/gmt/wiki/Documentation
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Wojciech Milczarek, wojciech.milczarek@pwr.edu.pl Jan Blachowski, jan.blachowski@pwr.edu.pl

Semester 4
WUST

<table>
<tr><td>Course title</td><td colspan="3">Applied field exploration</td></tr>
<tr><td>European Credits (ECTS)</td><td>3</td><td>Time (hours) given to the students</td><td>45</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td>Lectures: , Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: , Seminar classes: , Fieldwork: 3</td><td>Student whole working time (hours)</td><td>75</td></tr>
<tr><td>Description of content</td><td colspan="3">The goal of the course is that students should acquire a hands-on understanding of different field exploration methodologies, and how they can be integrated for targeting VMS deposits.
Geological, geophysical and geochemical exploration methods in VMS exploration. Practical field mapping exercises in structural geology, stratigraphy, hydrothermal alteration. Practical geophysical surveying using UAV technology. GIS-based data synthesis for exploration target selection. Drill core logging and assaying.</td></tr>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="3">Knowledge: when passed the student is expected to have:
-knowledge about different field methods and their use during an exploration program.
-knowledge about drilling and sampling methods.
-knowledge about different methods for field mapping.
Skills: when passed the student is expected to have the ability to
- acquire in-depth structural, volcanological and alteration data from outcrops in the field
- contextualize field observations in relation to ore genetic model for VMS deposits.
- synthesize different types of geological and geophysical data for targeting a VMS deposit.
Competences: ,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3">Exercises U G# 1.20
Project work G U 3 4 5 1.80
The course is mainly presented via practicals in the field, but also with complementary lectures and excercises, in addition to project work.</td></tr>
<tr><td>Recommended readings</td><td colspan="3">Online compendium in Canvas room</td></tr>
<tr><td>TU Coordinator</td><td colspan="3">Nils Jansson, Nils.Jansson@ltu.se</td></tr>
</table>

Contribution to EIT's Overarching Learning Outcomes (tick relevant box/es)*	**OLO 1 Entrepreneurship**	**OLO2 Innovation**	**OLO3 Creativity**	**OLO4 Intercultural**	**OLO5 Value judgments / Sustainability**	**OLO6 Leadership**

Justification for OLO contribution	

Course title	**SOC Internship**		
European Credits (ECTS)	2	**Time (hours) given to the students**	30
Type (Lecture, internship, exercise etc.)	Lectures:, Auditorium classes: , Lab. Classes: , Project classes: 2 , Practical classes:, Seminar classes: , Fieldwork: x	**Student whole working time (hours)**	50
Description of content	The aim of the course is to enable students to work in socially responsible workplaces, and apply their skills and knowledge to promote social good. While this develops them to become work-ready professionals, it also nurtures them to become advocates who help build a better world. EDUCATIONAL GOALS: 1. To actively participate in the affairs of the community and in concrete actions on the ground that aim to promote the public interest, equality and solidarity. 2. To reflect on social license to operate issues 3. To work in direct contact with the beneficiaries of the civic activities undertaken e.g.: reception, facilitation, support, social assistance, etc. EXAMPLES OF SOCIAL AND CIVIC ISSUES IN MINERALS INDUSTRIES: • Depletion of natural capital (degradation of air, land and water quality), land use conflicts, health impacts • Digitalization and automation generate particular challenges for well-being in mining regions. Limited job opportunities for local workforce and skills mismatches. • High and continuous transparency and accountability standards of the industry, effective methods of information sharing and dialogue • A more equitable value-sharing, Corporate Social Responsibility issues • Facilitation of environmental awareness • Preservation and restoring of historic sites,		
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: to understand that social responsibility incorporates an ethical, social and environmentally-friendly perspective to our personal and professional activities Skills: To be able to engage in an informal professional discussion and business communication Competences: To cope with complexity, uncertainty and change in global contexts		

<table>
<tr><td>Assessment methods and criteria</td><td colspan="6">Criterion:
Submission of a project report</td></tr>
<tr><td>Recommended readings</td><td colspan="6"></td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Supervisors of the student’s Master thesis</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td>Students will be engaged in professional discussion and business communication</td><td></td><td></td><td></td><td>Students will be able to understand that social responsibility incorporates an ethical, social and environmentally-friendly perspective to our personal and professional activities</td><td></td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

<table>
<tr><td>Course title</td><td colspan="3">Exploration entrepreneurship</td></tr>
<tr><td>European Credits (ECTS)</td><td>4</td><td>Time (hours) given to the students</td><td>60</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td>Lectures: 1, Auditorium classes: , Lab. Classes: , Project classes: 1, Practical classes: 3, Seminar classes: 2, Fieldwork:</td><td>Student whole working time (hours)</td><td>100</td></tr>
<tr><td>Description of content</td><td colspan="3">To equip students with the professional skills to increase their employability and entrepreneurship skills to meet the current market demands. The EFGeoMentoring scheme aims at improving international networking and supporting the life-long learning and CPD requirements of experienced geology professionals. In addition, it allows students to benefit from insider knowledge about international work perspectives in different sectors of geological profession and countries.
Mentoring within the course is a process during which an experienced professional with and EurGeol title (mentor) accompanies the student in a targeted way. Mentoring contributes to developing personal, entrepreneurial, networking, social and professional skills regarding the mineral prospecting and exploration activity. It allows learning from professional experiences that can only be acquired through practice and can't be found in any textbook. Mentoring improves the opportunities of career beginners by providing career-enhancing contacts and involvement in professional networks.
At the beginning of the mentoring cooperation, students formulate clear goals and communicate them to their mentor. In consultation with the mentor, concrete topics and the respective roles within the mentoring process will be defined. Since the student is at the centre of the process, it is their task to become aware of their own plans and their support needs.
OBJECTIVES OF THE MODULE:
Intensify international networking among geologists all across Europe and beyond
Provide young professionals with contacts helping them to think through, plan and access their short, medium or long-term career development
Contribute on internship positions
Improve gender balance and increase diversity in leadership positions by providing targeted support to women and under-represented minorities
Facilitate life-long learning and Continuing Professional Development (CPD)
The EFG mentors are professionals who have acquired a high level of industrial and/or academic experience and work in industrial practice, business, academia, education or administration.
Coaching: The mentor actively guides and encourages the student to develop essential skills and attitudes for the future ("How do I assert myself? How do I behave in negotiations? What do I do in challenging work contexts?")
Advice: The mentor advises the student in concrete situations, in current questions and difficulties. Mentors support students in solving problems and assist them in making tough decisions.</td></tr>
</table>

	• **Help:** The mentor can help open otherwise locked doors that allow the student to pursue their goals. • **Support:** The mentor supports the student in essential decisions without deciding. Mentors assist in the development of professional strategies, as well as in career planning and review of possible obstacles. • **Inform:** The mentor informs the student about (informal) rules and processes applied in organisations or professional life in general. According to the student's background, mentors can also inform about seminars or conferences that they consider helpful. • **Participation:** Mentors allow students to participate in parts of their professional career, experiences and strategic decisions. They allow students to share their professional life and invite them, for instance, to participate in meetings or appointments. • **Give feedback:** Mentor and student provide each other with constructive feedback about their appearance and public perception. • **Networking:** Mentors give the students hints on maintaining and using contacts. They introduce the students into active networks and provide professional contacts. The mentor provides the student with the chance to create a successful CV and take a chance on social networks such as LinkedIn.
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: to provide background training to support the learning process; make students aware of broad professional issues; provide business and entrepreneurship skills to develop an awareness of business management and commercial practices regarding mineral prospecting and exploration. Skills: Develop relationships with other persons and maintain them. Can talk frankly about his ideas, fears and weaknesses. Identifying investment opportunities in the mineral resources sector. Competences: To define professional targets, wants to succeed and is actively committed to implementing these targets. Not afraid of making mistakes and experimenting with new ideas. Willing to question himself critically, accept external advice, and implement it.
Assessment methods and criteria	Practical mark At the end of the mentoring process, students will a) reflect their mentoring experience on a two-page report highlighting benefits and potential gaps for future implementation b) prepare a small business plan for an identified innovative idea of their own. Slack channel will allow for student-mentor exchange and networking within the whole cohort of participants. Mentoring is a one-to-one relationship between a mentor and a student. • Mentoring takes place beyond a dependent relationship (e.g. supervisor-subordinate or professor-student relationships). • During the mentoring process, learning and experimentation occur in a protected environment. • An integral part of mentoring is the development of professional skills and competencies. Mentoring is a reciprocal process of "give and take". Both sides learn from each

<table>
<tr><td></td><td colspan="6">other because even the mentor will have the opportunity to critically question his professional perspective and discover new perspectives, software and applications, and previously unperceived situations.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">Mentoring Mindset, Skills and Tools 4th Edition: Make it easy for mentors and students, 2020, Synergetic People Development Pty Ltd, 252 pages, ISBN 0980356458

The Mentoring Guide: Helping Mentors and Students Succeed, 2019, Michigan Publishing Services, ISBN: 1607855399.

Wang, J., Shibayama, S., 2022. Mentorship and creativity: Effects of mentor creativity and mentoring style. Research Policy 51, 104451. doi:10.1016/j.respol.2021.104451

Entrepreneurship: A Guide To Success For Entrepreneurs And Aspiring Entrepreneurs, 2018, ISBN 978-1720221654
Entrepreneurship: Successfully Launching New Ventures, Global Edition, 2018, Pearson, ISBN: 9781292255330</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Pavlos Tyrologou, pavlos.tyrologou@gmail.com</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td>XX</td><td></td><td>X</td><td>XX</td><td>XX</td><td>XX</td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

COURSE DESCRIPTIONS/
KARTY PRZEDMIOTÓW

second-level studies/ studia II stopnia
main field of study/ kierunek studiów:
Mining and Geology/ Górnictwo I Geologia

specjalność/specialisation:
Mineral Resources Exploration
- Track UNI MISKOLC-WUST

Semester 1 and 2
UNI MISKOLC

Course descriptions – Earth Science Engineering MSc

Contents

Core part

Numerical methods and optimization

Course Title: Numerical methods and optimization	**ECTS: 2**
Type of course (C/E):	Course code: **GEMAK712MA**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **P** Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)	
Position in Curriculum (which semester): **1.**	Pre-requisites *(if any)*: -
Course Description:	

Objectives of the course:
Upon completing the course, students shall understand the relation between engineering and mathematics; comprehend important concept of solution methods using both analytical and numerical techniques when the problems can be formulated using differential equations, system of linear equations and system of nonlinear equations. In addition, students shall be able to apply the optimization techniques to various engineering problems.

Course content:
1. Extrema of functions.
2. Unconstrained and constrained optimization.
3. Convex optimization.
4. Minimization of functions with one variable (golden section, parabola method).
5. Minimization of multivariable functions (Nelder-Mead, Newton, modified Newton, quasi-Newton, minimization with line search).
6. Methods of penalty functions.
7. Multiaided and multicriteria decision problems (Pareto efficient solutions).
8. Linear programming.
9. About Soft Computing (SC) methods: fuzzy systems
10. About Soft Computing (SC) methods: genetic algorithms
11. About Soft Computing (SC) methods: neural network
12. Numerical solutions of ordinary differential equations and system of equations: Runge-Kutta,
13. Numerical solutions of ordinary differential equations and system of equations: predictor-corrector
14. Numerical solutions of ordinary differential equations and system of equations: finite differences.

Teaching methodologies:

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Égertné, M. É., Kálovics, F., Mészáros, G.: Numerical Analysis I.-II. (Lecture notes), Miskolci Egyetemi Kiadó (1992), 1-175.

R. Fletcher: Practical Methods of Optimization, John Wiley &Sons, 2000.
P. E. Gill, W. Murray, M. H. Wright: Practical Optimization, Academic Press, 1981.
J. Nocedal, S. J. Wright: Numerical Optimization, Springer, 2000.
Galántai Aurél-Jeney András: Numerikus Módszerek; Miskolci Egyetemi Kiadó, 1997.
Galántai Aurél: Optimalizálási módszerek; Miskolci Egyetemi Kiadó, 2004.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T11
Skills: K4, K5, K6, K7, K8, K9, K10, K11
Attitudes:
Autonomy and responsibility: F1, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course gives the theory beckground for calculations applying numerical methods which are essential to solve different statistical and geophysical tasks.

Demonstration of coherence between teaching methodologies and the learning outcomes:
The course focuses on theory, which is supplemented by the course Computer sciences for engineers, providing the practical applications and exercises.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Körei Attila matka@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Engineering physics

Course Title: Engineering physics	ECTS: 4
Type of course (C/E):	Course code: **MFGFT7100011**

Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**

The degree of theoretical or practical nature of the course: (in ECTS%)

Type of Assessment (exam. / pr. mark. / other): **E**
Attendance at lectures is regulated by the university code of education and examination. Writing two tests at least satisfactory level, respectively during the semester is the requirement of signature

Grading scale:

% value	Grade
85 -100%	5 (excellent)
70 – 84%	4 (good)
60 - 69%	3 (satisfactory)
46 - 59%	2 (pass)
0 - 45%	1 (failed)

Position in Curriculum (which semester): **1.** | Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
Within the framework of the Earth Science Engineering MSc program, the students gain the deepening knowledge in those fields of the continuum physics, which are necessary to understand the geological processes and geophysical methods.

Course content:
The principles of continuum physics. The relationship between the micro- and macroscopic descriptions, averaging in time and space. The kinematical principles of deformable continuum, deformation tensor. Volume and surface forces, stress tensor. Basic equations of continuum mechanics, continuity theories. The equation of motion of elastic continuum, integral and differential forms. Law of conservation of mass, continuity equation. Extensive and intensive quantities, the 0th law of thermodynamics. General forms of law of conservation of mass. Material equations, Curie's law. Perfectly elastic body, linearly elastic body. Equation of motion of Hooke body. Fluid models, ideal fluids, viscous fluids. Newton body, Navier-Stokes body. Rheological models, Kelvin-Voight model, Maxwell model, Poynting-Thomson's law for material and motion equation of standard body. Wave propagation in linearly elastic medium. Solutions of wave equation. Wave propagation in different rocks, dispersion, absorption. Disperse waves.

Teaching methodologies:
Attendance at lectures is regulated by the university code of education and examination. Writing two tests at least satisfactory level, respectively during the semester is the requirement of signature

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
1.Dobróka M., Somogyiné M. J. 2014: An introduction to continuum mechanics and elastic wave propagation Lecture notes. University of Miskolc.
2.K. Aki and P. Richards. Quantitative seismology. vol. 1: Theory and Methods. W H Freeman & Co (1980)
3.K. Aki and P. G. Richards. Quantitative seismology. vol. 2: Theory and Methods. W H Freeman & Co (1980)
4. Hudson J.A.1980. The excitation and propagation of seismic waves. Cambridge University Press

5. Schön J. 1998. Physical properties of Rocks. In. Seismic Exploration vol. 18.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2
Skills:
Attitudes: A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
This is primarily a theoretical course, giving strong background for later geophysical courses in order to understand and interpret the physical processes that are used in geophysical prospecting and exploration works.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the theoretical part, the students complete different exercises in continuum mechanics.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Dobróka Mihály dobroka@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Physical geology

<table>
<tr><td colspan="2">Course Title: Physical geology</td><td>ECTS: 4</td></tr>
<tr><td>Type of course (C/E):</td><td colspan="2">Course code: MFFTT710001</td></tr>
<tr><td colspan="3">Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: 2 lectures, 1 seminars</td></tr>
<tr><td colspan="3">The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)</td></tr>
<tr><td colspan="3">Type of Assessment (exam. / pr. mark. / other): E
During the semester the following tasks should be completed: students have to complete two field programmes: 1) studying sedimentary rocks, reporting in ppt presentations (15%), 2) studying magmatic rocks,

Grading scale:
% value – Grade
80 -100% – 5 (excellent)
70 – 79% – 4 (good)
60 - 69% – 3 (satisfactory)
50 - 59% – 2 (pass)
0 - 49% – 1 (failed)</td></tr>
<tr><td>Position in Curriculum (which semester): 1.</td><td colspan="2">Pre-requisites (if any): -</td></tr>
<tr><td colspan="3">Course Description:</td></tr>
<tr><td colspan="3"><u>Objectives of the course</u>:
The main objectives of the course are deepening the students' abilities for geological interpretation, making them familiar with the reconstruction of rock-forming processes, introducing them to facial analysis and the stratigraphic methods.

<u>Course content</u>:
Fieldtrip, analysis of sedimentary formations
The formation and the inner structure of the Earth
Plate tectonic background of the geological processes
The role of physical geology in the geological exploration. Magmatic processes, their interpretation on field
Sedimentary processes, their interpretation on field
Fieldtrip, studying magmatic rocks
Metamorphic processes, their interpretation on field
Principles of stratigraphy, stratigraphic nomenclature
Stratotype, lito-, bio- and chronostratigraphy
Magneto-, chemo-, seismic, sequence, and cycle stratigraphy
Reconstruction of continental sedimentary environments
Reconstruction of marine sedimentary environments
Defining the succession of rock-forming processes and tectonic events

<u>Teaching methodologies</u>:
During the semester the following tasks should be completed: students have to complete two field programmes: 1) studying sedimentary rocks, reporting in ppt presentations (15%), 2) studying magmatic rocks,</td></tr>
<tr><td colspan="3">The 3-5 most important compulsory, or recommended literature (textbook, book) resources:
Sam J. Boggs: Principles of Sedimentology and Stratigraphy, Prentice Hall Publishing, 2011
Angela L. Coe: Field techniques. Wiley-Blackwell 2010
Gary Nichols: Sedimentology and Stratigraphy. Wiley-Blackwell, 2009</td></tr>
</table>

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K9, K11, K12, K13
Attitudes:
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course gives the fundamentals to later specific geological courses. It introduces the basic concepts and skills necessary for interpreation of different geological processes.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by classworks as well as field works

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Hartai Éva foldshe@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Mineralogy and geochemistry

Course Title: Mineralogy and geochemistry	**ECTS: 4**
Type of course (C/E):	Course code: **MFFAT710005**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** The final grade will consist of two part. During the semester two midterm tests are written. The average of them will be the 50% of the final grade. The rest 50% is for the final exam. Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)	
Position in Curriculum (which semester): **1.**	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
Students will get the knowledge of the principals of the distribution of chemical element in the Earth. They will also know the most important thermodynamic processes concerning solid materials, the geochemical classification of elements, the geochemical aspects of the genesis of the most important minerals and mineral assemblages. The geochemistry of isotopes, which explores the chemical evolution of the Earth will also be introduced, as well as the geochemical characteristics of water, organic matter, magmatic, sedimentary and metamorphic rocks by which we can describe the mineral-and rock-forming processes in the crust and mantle.

Course content:
Introduction; Hydrogen and alkaline metals
Alkaline earth metals
Boron, aluminium, carbon and silicon
Rare earth elements, titanium and zirconium
Uranium, thorium, vanadium, niobium and tantalum
Chromium, molybdenium and tungsten
Midterm test (1st); Manganese, iron, cobalt and nickel
Copper, gold, silver and platina group elements
Zinc, cadmium, mercury, gallium, indium and thallium
Tin, lead, arsenic, antimony and bismuth
Nitrogen, phosphorus and oxygen
Sulphur, selenium, tellurium, haloids and noble gases

Teaching methodologies:
The final grade will consist of two part. During the semester two midterm tests are written. The average of them will be the 50% of the final grade. The rest 50% is for the final exam.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Dill H.G. (2010): The „chessboard” classification schene of mineral deposits. Elsevier, 2010.
White, W. M. (2013): Geochemistry. Wiley-Blackwell.

Nordstrom D.K., Blowes D.W., Ptacek C.J. (2015): Hydrogeochemistry and microbiology of mine drainage: An update. Applied Geochemistry, Elsevier.
Albared, F. (2005): Geochemistry. An introduction. Cambridge Univ. Press.
Sarkar D., Datta R., Hanningan R.(2007): Concepts, and applications in environmental geochemistry, Elsevier.
John W. Anthony, Richard A. Bideaux, Kenneth W. Bladh, and Monte C. Nichols, Eds. (2003): Handbook of Mineralogy. Mineralogical Society of America.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T7
Skills: K1, K2
Attitudes: A1, A2, A9
Autonomy and responsibility: F2, F5

Demonstration of coherence of course content and unit's objectives:
This is a fundamental course, discussing systematic mineralogy and geochemical baskground of mineral formation processes

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by mineralogy laboratory work and geochemical modeling exercises

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Zajzon Norbert askzn@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*): **Móricz Ferenc**

Geodesy, spatial informatics

Course Title: Geodesy, spatial informatics	**ECTS: 4**
Type of course (C/E):	Course code: **MFGGT710002**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **E** Students will be assessed with using the following elements. Attendance15 %Short quizzes10 %Midterm exam40 %Final exam 35 % Grading scale: % value — Grade 85 -100% — 5 (excellent) 70 – 84% — 4 (good) 55 - 69% — 3 (satisfactory) 40 - 54% — 2 (pass) 0 - 39% — 1 (failed)	
Position in Curriculum (which semester): **1.**	Pre-requisites *(if any)*: -
Course Description:	

Objectives of the course:
The students will acquire the principles of modern geomatics, its measuring methods and the application of IT in the subject. They will be prepared to apply the modern measuring techniques, the remote data-acquiring methods and use them to solve practical problems. They will learn the application fields of geo-informatics and GIS programs. The students will be competent in the application of modern geodetic technology and geo-informatics in their field. The students enable to process their professional data and organize them into geo-information databases.

Course content:
Coordinate Systems in geodesy. Geometric shape and gravitational field of Earth. Projections and mapping. Hungarian projections and mapping. Modern measuring techniques in Geodesy: Photogrammetry, Remote Sensing, GPS, Inertial Measurements, SAR technology for promoting surveying tasks in the related special fields. Geo-objects and geo-models. Raster and vector models. Data-storing techniques. Database-modelling in geo-informatics. Thematical data and their storage problems. GIS packages. Digitalization, analytical problems, knowledge based systems in GIS environment. Practical work: self-made solutions of simple case-study problems.

Teaching methodologies:
Students will be assessed with using the following elements. Attendance15 %Short quizzes10 %Midterm exam40 %Final exam 35 %

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Quest: GeodesyTutorial;
Vanicek,P.:Geodesy;
Burkard,R.K.: GeodesyfortheLayman;
Gábor Bartha: Geoinformation Master Course. University of Miskolc, 2014.
István Havasi -Gábor Bartha: Introduction to GIS, Introduction to Geoinformatics (pp. 10.5) (Gábor Bartha), Satellite Global Positioning Systems (pp. 67) (István Havasi). angol nyelvű digitális

tankönyv: http://digitalisegyetem.uni-miskolc.hu, Miskolci Egyetem. TÁMOP 4.1.2.-08/1/A-2009-0033 projekt, 2011; Short,N.: The RemoteSensingTutorial
Competencies to evolve (relevant Learning outcomes, Appendix 1): Knowledge: T7 Skills: K2 Attitudes: A2 Autonomy and responsibility: F6 **Demonstration of coherence of course content and unit's objectives:** The course contributes to skills of students which should be applied for different geological and geophysical prospecting and exploration tasks in field as well as presenting and handling spatial data. **Demonstration of coherence between teaching methodologies and the learning outcomes:** Theoretical part is complemented by exercises
Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Bartha Gábor iitgabor@uni-miskolc.hu**
Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Computer science for engineers

Course Title: Computer science for engineers	**ECTS: 2**
Type of course (C/E):	Course code: **GEMAK713MA**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **0 lectures, 2 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **P** Grading scale: % value — Grade 90 -100% — 5 (excellent) 80 – 89% — 4 (good) 70 - 79% — 3 (satisfactory) 60 - 69% — 2 (pass) 0 - 59% — 1 (failed)	
Position in Curriculum (which semester): **1**.	Pre-requisites *(if any)*: -

Course Description:

<u>Objectives of the course</u>:
Programming and using of MATLAB environment (desktop): opration with matrices, elements of linear algebra, plot of one, two or three dimensional functions, printing, control statements, handle graphics and user interface.

<u>Course content</u>:
Object-oriented programming. Design of programming. Computer aided solution plan for chosen problems. Numerical kernel: numerical methods, input-output. Using of files. User interface with karakters and graphics. Writing, testing an documentation for programs. Online and printed description of programs. Help and demo in programs. Printability for the results. Basic concepts, objects of Maple programming language: definition and using of assign, variable, set, array, function. The Maple as programming language: using of array, conditional and loop statement. Definition and application of procedure. Main algorithm in Maple. Graphics of Maple: plot and plot3d, animation statements. Using of files, applications.

<u>Teaching methodologies</u>:

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
H. Moore: MATLAB for Engineers, Prentice Hall, 2011
P. E. Gill, W. Murray, M. H. Wright: Practical Optimization, Academic Press, 1981.
J. Nocedal, S. J. Wright: Numerical Optimization, Springer, 2000.
Stoyan G. (szerk.): MATLAB, Typotex, 2005.
The MATH WORKS Inc., Release 13 Product Family Documentation Set, 2002.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T2, T7
Skills:
Attitudes:
Autonomy and responsibility:

Demonstration of coherence of course content and unit's objectives:
The course provides practical skills to solve technical tasks by applying numerical methods

Demonstration of coherence between teaching methodologies and the learning outcomes: This is a learning by doing course where students shall complete calculations using numerical methods with application of MATLAB
Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Körei Attila matka@uni-miskolc.hu**
Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geophysical exploration methods I.

<table>
<tr><td colspan="2">Course Title: Geophysical exploration methods I.</td><td>ECTS: 4</td></tr>
<tr><td>Type of course (C/E):</td><td colspan="2">Course code: MFGFT7100021</td></tr>
<tr><td colspan="3">Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: 2 lectures, 1 seminars</td></tr>
<tr><td colspan="3">The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)</td></tr>
<tr><td colspan="3">Type of Assessment (exam. / pr. mark. / other): E
Attendance at lectures is regulated by the university code of education and examination. Three writing tests with satisfactory results, and two assignments during the semester is the requirement of signature.

Grading scale:
% value — Grade
86 -100% — 5 (excellent)
70 – 85% — 4 (good)
60 - 69% — 3 (satisfactory)
46 - 59% — 2 (pass)
0 - 45% — 1 (failed)</td></tr>
<tr><td>Position in Curriculum (which semester): 1.</td><td colspan="2">Pre-requisites (if any): -</td></tr>
<tr><td colspan="3">Course Description:</td></tr>
</table>

<u>Objectives of the course</u>:
Understanding the surface geophysical methods and the geophysical methods used in boreholes for the purpose that students can design and execute geophysical research and evaluate data.

<u>Course content</u>:
Classification of applied geophysics methods. Gravity methods: measured quantities, basic corrections and data processing methods. Filtering gravity maps.
Evaluation of measurement data for causative bodies with simple geometries. Geological and environmental geological applications. Magnetic methods: measured quantities, basic corrections and data processing methods.
Reducing magnetic data to the pole. Evaluation of measurement data for magnetizable bodies with simple geometries. Geological and environmental geological applications. The specific resistivity of rocks, the concept of apparent resistivity. Direct current geoelectric methods. VES and multi-electrode measurement methods. Introduction of electromagnetic methods.
Induced Polarization (IP) in the time domain (TDIP) and the frequency domain (FDIP). Types of electric polarizations creating the IP signal and their geological background. Frequency domain electromagnetic methods (FDEM): MT and VLF methods, artificial source frequency sounding methods: measurement systems, zones around the transmitter, characteristics of the apparent resistivity and phase curves.
Time-domain electromagnetic methods (TDEM): transient, IP and ground radar methods. The transient EM measurement system and the zones around the transmitter. In the case of electrical and electromagnetic methods, the possibilities of controlling the depth of penetration.
The development of seismic reflected waves. The travel-time curve and its characteristic parameters. Dynamic and static corrections. The common mid-point (CMP) gather. Features of seismic (TWT) sections.
Interpretation of seismic (2D and 3D) sections. Isochronal maps. Seismic stratigraphy. Vertical and horizontal resolution. Acoustic impedance, reflection and transmission coefficients. Possibilities of detecting gas reservoirs by seismic method. The bright spot.
The development of seismic refracted waves. The travel-time curve and its characteristic parameters. Processing and evaluation of refraction data. Near-surface applications. The relationship between the petrophysical properties of rocks and parameters measured by well logging methods.

Introduction to petrophysics. Reservoir modeling. The basics of nuclear well logging methods. Determination of lithology and porosity. Presentation of main application areas.
The basics of acoustic well logging methods. Determination of sonic porosity and permeability. Presentation of main application areas.
The basics of electric well logging methods. The relation between resistivity and water saturation. Presentation of main application areas.
Possibilities for joint processing of open-hole well logging data. Crossplot techniques. Statistical and depth-by-depth inversion methods.
Principle of engineering geophysical sounding measurements. Determination of petrophysical and geotechnical properties of soils/rocks.

Teaching methodologies:
Attendance at lectures is regulated by the university code of education and examination. Three writing tests with satisfactory results, and two assignments during the semester is the requirement of signature.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Telford W. M., Geldart L. P., Sheriff R. E., 1990. Applied geophysics. Second edition. Cambridge University Press.
Kearey P., Brooks M., Hill I., 2002. An Introduction to Geophysical Exploration. Third edition. Blackwell Science Ltd.
Serra O. & L., 2004. Well logging data acquisition and application, Editions Technip.
Szabó N. P., 2015. Geophysical exploration methods I. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/education.html
Szabó N. P., 2016. Well-logging methods. Electronic textbook. http://www.uni-miskolc.hu/~geofiz/education.htmlScientific papers selected from geophysical journals, e.g., First Break, Near Surface Geophysics, Geophysics, Journal of Applied Geophysics etc.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K9, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course intruduces the principal theoretical background and practical skills to plan and perform geophysical explorations for different geological environments and deposit types

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the theoretical part, the students are introduced to different geophysical prospecting and exploration methods in practice.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Szabó Norbert Péter gfnmail@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Data and information processing

Course Title: Data and information processing	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT7100031**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **P** Attendance at lectures is regulated by the university code of education and examination. Writing two tests at least satisfactory level, respectively during the semester is the requirement of signature. Grading scale: % value — Grade 86 -100% — 5 (excellent) 70 – 85% — 4 (good) 60 - 69% — 3 (satisfactory) 46 - 59% — 2 (pass) 0 - 45% — 1 (failed)	
Position in Curriculum (which semester): **1**.	Pre-requisites *(if any)*: -
Course Description:	

Objectives of the course:
Understanding the basics of inversion method-based geoinformation processing

Course content:
Introduction to the vector analysis. Multidimensional Euclidean spaces: N-dimensional dataspace, M-dimensional model parameter space. The parameters of inversion-based data and information processing. Classification of geophysical problems: direct problem, inverse problem. Explicit and implicit forms of direct problems. The linearization of the nonlinear direct problems, introduction of the Jacobi-matrix. The linear inverse problems. Solution of the overdetermined linear inverse problems: Gaussian Least Squares method (LSQ). Normal equation, stability, condition number. Definition of the generalized linear inverse problem. Solution of the underdetermined linear inverse problem by Lagrange multiplicators, generalized inverse problem. The principle of the simple solution. The principles of information theory. The theory of signals. The principles of data and information processing by means of inversion methods. Modeling, model types. Theoretical and measured characteristics. Error characteristic parameters in the data and the model space. The purport of local and global inversion methods. Spectral transformations (Fourier integral transformation, DFT, FFT, Z-transformation). Convolution, discrete convolution. Correlation functions, discrete correlation functions. Deterministic filtering. Image processing filters.

Teaching methodologies:
Attendance at lectures is regulated by the university code of education and examination. Writing two tests at least satisfactory level, respectively during the semester is the requirement of signature.

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Dobróka M., 2001: The Methods of Geophysical Inversion. University textbook, University of Miskolc.
W. Menke, 1984: Geophysical Data Analysis: Discrete Inverse Theory. Academic Press Inc.
Mrinal Sen and Paul L. Stoffa: Seismic Exploration - Global Optimization: Methods In Geophysical Inversion. Software, Elsevier Science Ltd. 1997.

Szabó N.P., Dobróka M.: Float-encoded genetic algorithm used for the inversion processing of well-logging data Global Optimization: Theory, Developments and Applications: Mathematics Research Developments, Computational Mathematics and Analysis Series. New York: Nova Science Publishers Inc., 2013. pp. 79-104.
P.J.M. van Laarhoven, E.H.L. Aarts, 1987: Simulated Annealing: Theory and Applications. D. Reidel Publishing Company, ISBN 90-277-2513-6

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T6, T9
Skills: K2, K6, K7
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
Theoretical background and application of data processing tasks are princial for completion of geophysical measurements and interpretation works. The course provides both theory and practice in this topic.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the theoretical part, the students complete data management and processing exercises.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Dobróka Mihály dobroka@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Graduate research seminar

Course Title: Graduate research seminar		**ECTS: 2**
Type of course (C/E):	Course code: **MFFAT710006**	
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **0 lectures, 2 seminars**		
The degree of theoretical or practical nature of the course: (in ECTS%)		
Type of Assessment (exam. / pr. mark. / other): **P** During the semester the following tasks should be completed: short presentation of the selected topic, outline and references (20%), elaboration of the concept map of the article (20%), submission of first draft (15%), submission of the final text (20%), Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)		
Position in Curriculum (which semester): **1**.	Pre-requisites *(if any)*: -	

Course Description:

Objectives of the course:
To introduce the methods of information gathering and evaluation, formal and ethic requirements of scientific communication, rules for preparation of oral and poster presentations. During the course these general requirements are actualized to the field of earth science and engineering. Examples and excercises will use English publications and text materials.

Course content:
Editorial and formal requirements of scientific publications. Planning of the concept and structure of a scientific publication, making an outline, development of a concept map. Usage of references, reference styles. Etics of scientific writing: how to avoid plagiarism, usage of citations. Information sources provided by the Central Library: hard copy, catalogue search, electronic resources. Usage of electronic information resources: search options, simple and combined search, electronic libraries. Data visualization: graphs, figures, tables. The art of presentation: preparation for an oral contribution. The art of presentation: preparation of a poster.

Teaching methodologies:
During the semester the following tasks should be completed: short presentation of the selected topic, outline and references (20%), elaboration of the concept map of the article (20%), submission of first draft (15%), submission of the final text (20%),

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
L. C. Perelman, J. Paradis, and E. Barrett: The Mayfield Handbook of Technical and Scientific Writing (McGraw-Hill, 2001).
G. J. Alred, C. T. Brusaw, and W. E. Oliu: Handbook of Technical Writing, (St. Martin's, New York, 2003).
Hagan P; Mort P: Report writing guideline for mining entógineers. Mining Education Australia, 2014.
Chun-houh Chen, Wolfgang Härdle, Antony Unwin (eds.) Handbook of Data Visualization (Springer, 2008).

MEA Report writing guide. https://www.engineering.unsw.edu.au/mining-engineering/sites/mine/files/publications/MEA_ReportWritingGuide_eBook_2018ed.pdf
ISO 690-2: Information and documentation - Bibliographic references.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T5, T8, T12
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K10, K11
Attitudes: A2, A3, A4, A5, A6, A7, A8, A9
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
Students are introduced to the information sources available paper-based and electronically. They are also introduced to best practices on scientific writing, referencing and presentation techniques.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Completing a small research article and a presentation the students improve their knowledge in scientific communication. This is a learning by doing course, where one of the most important goals is to learn the proper way of scientific writing and referen

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Mádai Ferenc askmf@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Structural geology

<table>
<tr><td colspan="2">Course Title: Structural geology</td><td>ECTS: 4</td></tr>
<tr><td>Type of course (C/E):</td><td colspan="2">Course code: MFFAT720020</td></tr>
<tr><td colspan="3">Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: 1 lectures, 2 seminars</td></tr>
<tr><td colspan="3">The degree of <u>theoretical </u>or practical nature of the course: (in ECTS%)</td></tr>
<tr><td colspan="3">Type of Assessment (exam. / pr. mark. / other): E
Attendance at lectures is regulated by the university code of education and examination. Writing a test and constructing a geological profile at least on satisfactory level, respectively during the semester is the requirement of signature. The exam is ora

Grading scale:
% value — Grade
86 -100% — 5 (excellent)
70 – 85% — 4 (good)
60 - 69% — 3 (satisfactory)
46 - 59% — 2 (pass)
0 - 45% — 1 (failed)</td></tr>
<tr><td>Position in Curriculum (which semester): 2.</td><td colspan="2">Pre-requisites (if any): -</td></tr>
<tr><td colspan="3">Course Description:</td></tr>
<tr><td colspan="3"><u>Objectives of the course</u>:
The course provides a background in the fundamentals of structural geology. It introduces the methods of interpreting structural observations and determining the 3-D distribution of the lithological units, the physical properties controlling the development of fractures, folds and other structural features. The course also introduces the students to building up, constructing and analysing spatial models.

<u>Course content</u>:
Theoretical backgrounds: basic terms of structural geology and tectonics. Techniques of data acquisition, recording and visualization. Stress and strain, deformation mechanisms, rheological models. Brittle and ductile features, their style and origin. Syngenetic structures and their role in further structural evolution. Plate tectonics and large scale structures. Characteristics of tectonic regimes. Practical exercises: use of tools to measure, demonstrate and analyze the structural data. Basics for constructing maps and cross sections.
Lecture: Basic terms; information on the interior of the Earth.
Practice: Use of geological maps; rules and geometrical basis of construction of cross sections.
Lecture: Structural features of the rocks, deformation, description of movements.
Practice: construction of cross sections.
Lecture: Stresses, mechanics.
Practice: construction of cross sections.
Lecture: Rheology and failure envelopes.
Practice: construction of cross sections.
Lecture: Mechanisms and features of brittle deformation. Practice: construction of cross sections with drill logs
Lecture: Mechanisms and features of ductile deformation
Practice: construction of cross sections with drill logs.
Field exercise: structural orientation measurements on folded and faulted rocks.
(The exercise is organised by exchange with the contact hours of another course, in 6 hours)
Practice: working with orientation data, stereograms.
Practice: working with orientation data, stereograms.
Practice: construction exercises.</td></tr>
</table>

Practice: construction exercises.

Teaching methodologies:
Attendance at lectures is regulated by the university code of education and examination. Writing a test and constructing a geological profile at least on satisfactory level, respectively during the semester is the requirement of signature. The exam is ora

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Twiss, R. J. & Moores, E. M: Structural Geology. Freeman & Co., New York, 1992, 532 p.
Ramsay, J. G. & Huber, M. I: The techniques of modern structural geology. Vol. 1: Strain Analysis. Academic Press, London, 1983, 1-308 p.
Ramsay, J. G. & Huber, M. I: The techniques of modern structural geology. Vol. 2: Folds and Fractures. Academic Press, London, 1987, 309-700 p.
Ramsay, J. G. & Lisle, R. J: The techniques of modern structural geology. Vol. 3: Applications of continuum mechanics in structural geology. Academic Press, London, 2000, 701-1062 p.
Twiss, R. J. & Moores, E. M: Tectonics. Freeman & Co., New York, 1995, 415 p.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K9, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
In the limited timeframes of the semester, the thematics includes all topics which belong to the structural geology on introductory level. It also provides a possibility to go deeper in some topics for those who have the appropriate basic knowledge alread

Demonstration of coherence between teaching methodologies and the learning outcomes:
The program is arranged with giving the theoretical and practical basics first and then going to the application of these basics by making field observations, measurements and then working with these data. The students have to be able to interpret the obs

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Németh Norbert foldnn@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Mineral deposits

<table>
<tr><td colspan="2">Course Title: Mineral deposits</td><td>ECTS: 4</td></tr>
<tr><td>Type of course (C/E):</td><td colspan="2">Course code: MFFTT720021</td></tr>
<tr><td colspan="3">Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: 2 lectures, 1 seminars</td></tr>
<tr><td colspan="3">The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)</td></tr>
<tr><td colspan="3">Type of Assessment (exam. / pr. mark. / other): E
Test about recognizing the different hand specimens of ores, raw materials (35%); Written test about the classification of ores with examples (65%).

Grading scale:
% value — Grade
80 -100% — 5 (excellent)
70 – 79% — 4 (good)
60 - 69% — 3 (satisfactory)
50 - 59% — 2 (pass)
0 - 49% — 1 (failed)</td></tr>
<tr><td>Position in Curriculum (which semester): 2.</td><td colspan="2">Pre-requisites (if any): -</td></tr>
<tr><td colspan="3">Course Description:</td></tr>
<tr><td colspan="3"><u>Objectives of the course</u>:
The key target of the course is to introduce the geology of raw material deposits, their spatial distribution, their quantity and quality for the different commodities.

<u>Course content</u>:
During the introduction the students get familiar with the different groups of commodities – ores, industrial minerals, solid fossil energy minerals, construction materials and their use and history. In the next period, the students will learn the ore forming geological processes and their appearances, which creates the different deposits. Also they will learn the genetic classification of the deposits with national and international examples. It prepares the students to be able to recognize the geological features of mineralizations, alterations and tectonic preformation. It covers all the important mines and ore districts in Europe and worldwide. During the laboratory classes the students can learn the natural occurrences of the ores, non-ores and industrial minerals. They will learn the physical and chemical properties, and texture of the different raw material types, and how to identify and distinguish them. To the proper use of geological maps and sections in 3D, the students will do exercises to develop their capabilities. During the related field trips the students will examine real deposits in the field.

<u>Teaching methodologies</u>:
Test about recognizing the different hand specimens of ores, raw materials (35%); Written test about the classification of ores with examples (65%).</td></tr>
<tr><td colspan="3">The 3-5 most important compulsory, or recommended literature (textbook, book) resources:
Robb, L., (2005): Introduction to Ore-Forming Processes: Blackwell Publishing Co., 373 p. (ISBN 0-632-06378-5).
EVANS, A. M. 1993: Ore Geology and Industrial Minerals – An Introduction. Blackwell Publishing, ISBN 978-0632-02953-2
CRAIG, J. R. & Vaughan, D. J. 1994: Ore Microscopy & Ore Petrography. John Wiley and Sons Inc. ISBN 10158-0012
Dill H.G. (2010): The „chessboard” classification scheme of mineral deposits. Elsevier, 2010.</td></tr>
</table>

Cox, D.P. Singer D.E. (1992): Mineral Deposit Models, U.S.G.S. Bulletin 1993.
Competencies to evolve (relevant Learning outcomes, Appendix 1): Knowledge: T1, T2, T3, T4, T7, T8, T9 Skills: K1, K2, K3, K5, K11, K12, K13 Attitudes: A1, A2, A3, A4, A5, A7 Autonomy and responsibility: F1, F2, F3, F4, F5 **Demonstration of coherence of course content and unit's objectives:** Students get familiar with the different groups of commodities – ores, industrial minerals, solid fossil energy minerals, construction materials and their use and history, as well as the ore forming geological processes and their appearances, genetic clas **Demonstration of coherence between teaching methodologies and the learning outcomes:** Theoretical part is complemented by laboratory classes where students analyze specimens from different deposit types. learn the natural occurrences of the ores, non-ores and industrial minerals. They will learn the physical and chemical properties, and te
Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Zajzon Norbert askzn@uni-miskolc.hu**
Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*): **Leskó Máté**

Engineering geology and hydrogeology

<table>
<tr><td colspan="2">Course Title: Engineering geology and hydrogeology</td><td>ECTS: 4</td></tr>
<tr><td>Type of course (C/E):</td><td colspan="2">Course code: MFKHT720020</td></tr>
<tr><td colspan="3">Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: 2 lectures, 1 seminars</td></tr>
<tr><td colspan="3">The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)</td></tr>
<tr><td colspan="3">Type of Assessment (exam. / pr. mark. / other): E
Participation in presentation lectures and practical classes is mandatory. Field trips and classroom calculations. The successful completion of the course is based on the successful completion of the semester test and the successful completion of the exam

Grading scale:
% value — Grade
85 -100% — 5 (excellent)
75 – 84% — 4 (good)
63 - 74% — 3 (satisfactory)
50 - 62% — 2 (pass)
0 - 49% — 1 (failed)</td></tr>
<tr><td>Position in Curriculum (which semester): 2.</td><td colspan="2">Pre-requisites (if any): -</td></tr>
<tr><td colspan="3">Course Description:</td></tr>
<tr><td colspan="3"><u>Objectives of the course</u>:
It introduces students to the key concepts of engineering geology, modern hydrogeology, and field hydrogeology, soil formation, soil classification methods, laboratory and field soil tests, water-to-rock underwater stress, and groundwater flow patterns.

<u>Course content</u>:
Introduction to the examination of soil characteristics
Determination of shear strength parameters of soils
Soil consolidation
Shallow and deep foundation, the basics of EC7 design
The most important basics, problems and relationships of hydrogeology
Hydrogeological pools, flow systems, sustainability, artificial replenishment
Hydrogeochemistry, transport processes
Water management issues, particularly in cross-border areas
Hydrogeology of the Carpathian Basin
Isotope hydrogeology, use of stable isotopes to understand groundwater
Groundwater recharge and their interpretation
Well hydraulics calculations
Isotope hydrogeology, use of radioactive isotopes to understand groundwater

<u>Teaching methodologies</u>:
Participation in presentation lectures and practical classes is mandatory. Field trips and classroom calculations. The successful completion of the course is based on the successful completion of the semester test and the successful completion of the exam</td></tr>
<tr><td colspan="3">The 3-5 most important compulsory, or recommended literature (textbook, book) resources:
David Daming: Introduction to Hydrogeology, McGraw-Hill Higher Education, 2002.
F. G. Bell: Engineering Geology, Oxford, Blackwell Scientific Publications, 1992</td></tr>
</table>

Dr. Juhász József: Hidrogeológia. Akadémiai kiadó, Budapest, 2002. Dr. Juhász József: Mérnökgeológia I-III. Miskolci Egyetemi Kiadó, 1999; 2002; 2003 Dr. Kleb Béla: Mérnökgeológia Budapest, 1980 David Daming: Introduction to Hydrogeology, McGraw-Hill Higher Education, 2002. F. G. Bell: Engineering Geology, Oxford, Blackwell Scientific Publications, 1992 S. E. Ingebritsen, W. E. Sanford: Groundwater in Geologic Processes. Cabridge University Press, 1998. Kruseman G.P. and Ridder N.A: Analysis and Evaluation of Pumping Test Data, ILRI publication, Wageningen, Netherlamds, 1990, pp. 1-377. Neven Kresic: Quantitative Solutions in Hydrogeology and Groundwater Modeling. Lewis Publishers, 1997. Barnes, C. W. (1988): Earth, Time and Life. John Wiley and Sons, New York Brookfield, M. (2006): Principles of Stratigraphy. Blackwell Publishing, New York

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K6, K7, K8, K9, K10, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The course provides the theory and practical skills to understand the hydrogeological and engineering geological background for interpretation of different geological and geotechnical processes.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Theoretical part is complemented by laboratory classes where students perform calculations and modeling exercises of hydrogeological systems and geotechnical characterization of soils.

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Szűcs Péter hgszucs@ui-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Analytical technics in mineralogy and petrology

Course Title: Analytical technics in mineralogy and petrology	**ECTS: 2**
Type of course (C/E):	Course code: **MFFAT720025**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **P** There are two written tests about the theoretical part (50% of the final grade). Both must be written to minimum 50%. Two laboratory report must be written about the individual work (50% of the final grade). Missing, or not passed tests can be completed a Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	

Objectives of the course:
The key target of the course is to introduce the different analytical methods used in mineralogy and geology for the students. There are laboratory classes with individual work about the learned methods nearby the theoretical classes. Thru these exercises the students learn what is the best available method to answer certain geological questions.

Course content:
Description of the work, formulating analytical pairs, work and lab safety teaching
Physical properties (hardness, magnetic, solubility, density), density measurements
X-ray diffraction lecture I.
X-ray diffraction lecture II.
X-ray diffraction practice
DTA lecture
DTA quantitative calculations
Scanning electron microscopy lecture I.
Scanning electron microscopy lecture II.
Scanning electron microscopy practice
Formula calculations

Teaching methodologies:
There are two written tests about the theoretical part (50% of the final grade). Both must be written to minimum 50%. Two laboratory report must be written about the individual work (50% of the final grade). Missing, or not passed tests can be completed a

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
Reed SJB (2005): Electron Microprobe Analysis and Scanning Electron Microscopy in Geology. Cambridge University Press.
O'Donoghue M (2006): Gems: Their sources, descriptions and identification. Elsevier.
Pracejus B (2008): The ore minerals under the microscope: an optical guide. Elsevier.

Goldstein J et al. (2003): Scanning Electron Microscopy and X-ray Microanalysis. Kluwer Academic/Plenum Publishers.
King M. et al. (1993): Mineral Powder Diffraction File Search- and Databook. ICDD, USA.

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T7, T8, T9
Skills: K1, K2, K3, K5, K11, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
Lectures cover the theoretical fundamentals for different methods of analysis of minerals, which is essential basics for geological exploration tasks.

Demonstration of coherence between teaching methodologies and the learning outcomes:
Following the introduction of different analytical methods, this is a learning by doing course where students go through the preparation, analysis and interpretation steps for various analytical techniques (XRPD, EPMA, SEM)

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Zajzon Norbert askzn@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geopphysical engineering specialisation

Geophysical measurements

Course Title: Geophysical measurements	**ECTS: 4**
Type of course (C/E):	Course code: **MFGFT720012**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Grading scale: % value Grade 90 -100% 5 (excellent) 80 – 89% 4 (good) 65 - 79% 3 (satisfactory) 60 - 64% 2 (pass) 0 - 49% 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	

<u>Objectives of the course</u>:
Within the frame of this subject the students specialized in geophysical engineering study the application of geophysical methods in the different exploration phases, as well as the principles and aspects of planning geophysical surveys. An additional aim of the subject is to familiarize the students with the working principles and use of geophysical measurement devices.

<u>Course content</u>:
Lectures: General principles and main tasks of the raw-material exploration. Exploration phases. The principles of geophysical surveys. The role of geophysical methods in the exploration phases. Gravity data acquisition. Measuring devices and measured quantities of the gravity method. Gravity data processing and corrections. Magnetic data acquisition. Measuring devices and measured quantities of the magnetic method. Magnetic gradiometry. Magnetic data processing and corrections. The components and properties of geoelectrical data acquisition systems. Electrode configurations and setting up of electrode spreads. Main aspects of planning geoelectrical surveys. The components and properties of electromagnetic data acquisition systems. Survey configurations of different electromagnetic methods. Main aspects of planning electromagnetic surveys. Quality control of recorded data. The types and properties of seismic sources. The components and properties of seismic data acquisition systems. Main aspects of planning seismic surveys. Quality control of recorded seismic data. The field techniques of improving the signal-to-noise ratio. Basic steps of seismic data processing. Components and properties of data acquisition systems used for vertical seismic profiling (VSP). Basic steps of VSP data processing. Main properties and components of the techniques of borehole geophysical logging (wireline logging and measured while logging). Quality control a well logs. The constructions and properties of resistivity and induction logging tools. The constructions and properties of nuclear logging tools. The constructions and properties of sonic logging tools.
Seminar
Spreading systems of geophysical surveys. The steps and products of the workflow of geophysical surveys. The introduction of Scintrex CG-5 Autograv gravimeter. The introduction of GEM GSM-19 Ovehauser magnetometer. The introduction of geoelectrical data acquisition systems. The introduction of VLF measuring

devices and ground penetrating radar. The introduction of a gamma spectrometer. The main functions and properties of the components of a wireline logging system. The main aspects of planning a well logging program.

Teaching methodologies:

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:
P. Kearey, M. Brooks, I. Hill, 2002: An introduction to geophysical exploration, Blackwell Science Ltd., ISBN 0-632-04929-4
D. V. Ellis, J. M. Singer, 2007: Well logging for earth scientists. Springer, Dordrecht, The Netherlands, ISBN 978-1-4020-3738-2 (HB).
W. M. Telford, L. P. Geldart, R. E. Sheriff., 1990: Applied Geophysics. 2nd Edition. Cambridge University Press, ISBN: 0 521 32693 1
O. Serra, L. Serra, 2004: Data Acquisition and Applications, Editions Serralog, France, ISBN: 978295156125
Other educational materials and study aids on the web page of Geophysical Department: http://www.uni-miskolc.hu/~geofiz/segedlet.html
Operating manuals: https://scintrexltd.com/wp-content/uploads/2017/02/CG-5-Manual-Ver_8.pdf; https://userpage.fu-berlin.de/geodyn/instruments/Manual_GEM_GSM-19.pdf

Competencies to evolve (relevant Learning outcomes, Appendix 1):
Knowledge: T1, T2, T3, T4, T5, T7, T8, T9
Skills: K1, K2, K3, K9, K12, K13
Attitudes: A1, A2, A3, A4, A5, A7
Autonomy and responsibility: F1, F2, F3, F4, F5

Demonstration of coherence of course content and unit's objectives:
The syllabus elaborated for and applied to the education of the course strives to cover all the important parts of the specialities connected to the objectives. This well-considered construction of topics enables the lecturer to emphasize the essential re

Demonstration of coherence between teaching methodologies and the learning outcomes:
The applied teaching methodologies are aimed at communicating up-to-date knowledge, developing the students' capability to apply the introduced ideas and information, improving their ability to test these ideas and evidence, to generate own ideas and evid

Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Vass Péter, private professor gfvassp@uni-miskolc.hu**

Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*): **Dr. Gombár László, Dr. Turai Endre, Dr. Szabó Norbert Péter**

Geophysical Exploration Methods II

<table>
<tr><td colspan="2">Course Title: Geophysical Exploration Methods II</td><td>ECTS: 4</td></tr>
<tr><td>Type of course (C/E):</td><td colspan="2">Course code: MFGFT720015</td></tr>
<tr><td colspan="3">Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: 2 lectures, 1 seminars</td></tr>
<tr><td colspan="3">The degree of <u>theoretical</u> or practical nature of the course: (in ECTS%)</td></tr>
<tr><td colspan="3">Type of Assessment (exam. / pr. mark. / other): exam

Grading scale:
% value — Grade
86 -100% — 5 (excellent)
71 – 85% — 4 (good)
61 - 70% — 3 (satisfactory)
46 - 60% — 2 (pass)
0 - 45% — 1 (failed)</td></tr>
<tr><td>Position in Curriculum (which semester): 2.</td><td colspan="2">Pre-requisites (if any): -</td></tr>
<tr><td colspan="3">Course Description:</td></tr>
<tr><td colspan="3"><u>Objectives of the course</u>:
The main objective of the subject is to familiarize the students specialized in geophysical engineering with the details of different geophysical methods used in the fields of raw-material exploration and environmental investigations.

<u>Course content</u>:
Physical basics of seismic methods. Reflexion seismic method. Refraction seismic method. Vertical seismic profile (VSP). Geophysical inversion of magnetic data. Magnetic forward problem of arbitrary shaped source. The problem of ambiguity. 3D underdetermined problems of magnetic data. Geological applications. Physical basics of geoelectrical methods. Self-potential method. Charged-body method. Direct current resistivity methods. Induced polarization method. Physical basics of electromagnetic (EM) methods. Magnetotelluric method. Frequency-domain (FD) electromagnetic methods. Transient electromagnetic method (TEM). Very-low-frequency electromagnetic method (VLF-EM). Main features and essentials of borehole geophysics. Classification of well logging methods. Formation density logging. Photoelectric factor logging. Neutron logging methods. Well log interpretation techniques. Quick-Look Interpretation. Crossplots and overlays. Formation evaluation in shaly sands.

<u>Teaching methodologies</u>:</td></tr>
<tr><td colspan="3">The 3-5 most important compulsory, or recommended literature (textbook, book) resources:
W. M. Telford, L. P. Geldart, R. E. Sheriff., 1990: Applied Geophysics. 2nd Edition. Cambridge University Press, ISBN: 0 521 32693 1
UBC Geophysical Inversion Facility – Inversion manuals (GRAV3D and MAG3D). http://gif.eos.ubc.ca/documentation
P. Kearey, M. Brooks, I. Hill, 2002: An introduction to geophysical exploration, Blackwell Science Ltd., ISBN 0-632-04929-4
D. V. Ellis, J. M. Singer, 2007: Well logging for earth scientists. Springer, Dordrecht, The Netherlands, ISBN 978-1-4020-3738-2 (HB).
O. Serra, L. Serra, 2004: Data Acquisition and Applications, Editions Serralog, France, ISBN: 978295156125</td></tr>
</table>

Other educational materials and study aids on the web page of Geophysical Department: http://www.uni-miskolc.hu/~geofiz/segedlet.html
Competencies to evolve (relevant Learning outcomes, Appendix 1): Knowledge: T1, T2, T3, T4, T5, T6, T7, T8, T9 Skills: K1, K2, K3, K12, K13 Attitudes: A1, A2, A3, A4, A5, A7 Autonomy and responsibility: F1, F2, F3, F4, F5 **Demonstration of coherence of course content and unit's objectives:** The syllabus elaborated for and applied to the education of the course strives to cover all the important parts of the specialities connected to the objectives. This well-considered construction of topics enables the lecturer to emphasize the essential re **Demonstration of coherence between teaching methodologies and the learning outcomes:** The applied teaching methodologies are aimed at communicating up-to-date knowledge, developing the students' capability to apply the introduced ideas and information, improving their ability to test these ideas and evidence, to generate own ideas and evid
Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Vass Péter, gfvassp@uni-miskolc.hu**
Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*): **Dr. Gombár László, Dr. Turai Endre, Dr. Szabó Norbert Péter**

Geological engineering specialisation

Historical geology

Course Title: Historical geology	**ECTS: 4**
Type of course (C/E):	Course code: **MFFTT720028**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **2 lectures, 1 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **exam** Completion of inter-semester test with at least satisfactory result (see below). It can be repeated once. Practical requirements: obligatory participation in the field-trips, ppt-presentation for one of them Grading scale: % value — Grade 80 -100% — 5 (excellent) 70 – 79% — 4 (good) 60 - 69% — 3 (satisfactory) 50 - 59% — 2 (pass) 0 - 49% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -

Course Description:

Objectives of the course:
The aim of the subject is to give knowledge (1) on the role of time in the geological processes, (2) on the different methods of age-determination, (3) on the structural evolution of the Earth and (4) on the history of life in the Earth with special emphasis on the utility of all these in prospecting raw materials) and how to reconstruct paleoenvironments in geology as basic information for raw material exploration

Course content:
Principles of stratigraphy. Basic principles of stratigraphy, litho-, bio- and chronostratigraphy. Different methods of stratigraphical correlation and their significance in raw material prospecting. Age-determining methods: biostratigraphy, radiometry, magnetostratigraphy, chemostratigraphy, event stratigraphy, sequence stratigraphy. Reconstruction of different palaeoenvironments and their application in raw materail prospecting. Different magmatic, metamorphic and sedimentary facies types. The geological time scale, the structural, climatological and biological evolution of the Earth during the Precambrian, the Paleozoic, the Mesozoic and the Cenozoic. The evolution of Homoidea.

Teaching methodologies:
Completion of inter-semester test with at least satisfactory result (see below). It can be repeated once. Practical requirements: obligatory participation in the field-trips, ppt-presentation for one of them

The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**:

Levin, H.L. (2006) – The Earth Through Time, 8th Ed., 616 p., Wiley
Barnes, C.W. (1988): Earth, Time and Life. John Wiley and Sons, New York
Brookfield, M. (2006): Principles of Stratigraphy. Blackwell Publishing, New York

Competencies to evolve (relevant Learning outcomes, Appendix 1): Knowledge: T1, T2, T3, T4, T5, T7, T8, T9 Skills: K1, K2, K3, K5, K6, K7, K9, K11, K12, K13 Attitudes: A1, A2, A3, A4, A5, A7 Autonomy and responsibility: F1, F2, F3, F4, F5 **Demonstration of coherence of course content and unit's objectives:** This is a fundamental course to understand the principles of stratigraphy, its applicability to solve complex geological problems and tasks. **Demonstration of coherence between teaching methodologies and the learning outcomes:** The lectures of the course introduce in detail the methods included in the curriculum, while practical skills are developed by field trips and case studies.
Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Less György, full professor foldlgy@uni-miskolc.hu**
Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

Geological mapping

Course Title: Geological mapping	**ECTS: 4**
Type of course (C/E):	Course code: **MFFTT720029**
Type (lec./sem./lab./consult.) and Number of Contact Hours per Week: **1 lectures, 2 seminars**	
The degree of theoretical or practical nature of the course: (in ECTS%)	
Type of Assessment (exam. / pr. mark. / other): **practical mark** Criterion for signature: Preparation of two geological cross-sections based on real Carpathian geological maps (from Slovakia and Romania); Preparation of covered and uncovered (without Quaternary deposits) geological map of an about 2 sq. km territory (i Grading scale: % value — Grade 90 -100% — 5 (excellent) 75 – 89% — 4 (good) 60 - 74% — 3 (satisfactory) 45 - 59% — 2 (pass) 0 - 44% — 1 (failed)	
Position in Curriculum (which semester): **2**.	Pre-requisites *(if any)*: -
Course Description:	
Objectives of the course: The subject gives knowledge on the figuration of geological phenomena on topographic maps, on preparing geological maps, cross-sections, their legend and on assembling explanatory report **Course content**: The aim of preparing geological maps. The geological map and its additional parts (geological cross-sections, stratigraphical columns and legend). Geological phenomena figured in the geological maps: lithostratigraphical units, structural chacteristics. Different types of geological boundaries and their recognition on the field. Orientation on the field with topographical map and with GPS. Documentation of field observations in the field booklet and on the topographical map. Preparation of geological cross-sections. Preparation of covered and uncovered (without Quaternary deposits) geological maps with stratigraphical column and legend. Assembly of explanatory reports **Teaching methodologies**: Criterion for signature: Preparation of two geological cross-sections based on real Carpathian geological maps (from Slovakia and Romania); Preparation of covered and uncovered (without Quaternary deposits) geological map of an about 2 sq. km territory (i	
The 3-5 most important compulsory, or recommended **literature** (textbook, book) **resources**: Tearprock, D.J. & Bischke, R.E. (2002): Applied Subsurface Geological Mapping with Structural Methods 2nd Edition, 846 p., Prentice Hall Hamilton, D.E. & Jones, T.A.: Computer modeling of geological surfaces and volumes. – AAPG Computer applications in geology. No.1., 589 p. Tulsa, Oklahoma McClay, K. (1995): The mapping of Geological Structures. Geolog. Soc. of London Handbook. John Wiley Sons, Chichester, New York, Brisbane, Toronto, Singapore. SURFER 8.0 Tutorial and User's Guide. - Golden Software. P512 . Denver	
Competencies to evolve (relevant Learning outcomes, Appendix 1):	

Knowledge: T1, T2, T3, T4, T5, T7, T8, T9 Skills: K1, K2, K3, K5, K6, K7, K9, K11, K12, K13 Attitudes: A1, A2, A3, A4, A5, A7 Autonomy and responsibility: F1, F2, F3, F4, F5 **Demonstration of coherence of course content and unit's objectives:** Theoretical part and laboratory exercisis givesan overview to the students about methodology and tools of geological mapping works. **Demonstration of coherence between teaching methodologies and the learning outcomes:** After giving the theoretical basis of mapping methodology, this is a learning by doing course, where the students should compete geological mapping work in the Bükk mountains
Responsible Academic staff member and lecturing load (*name, position, scientific degree):* **Dr. Less György, full professor foldlgy@uni-miskolc.hu**
Other Academic Staff Involved in Teaching, if any and lecturing load (*name, position, scientific degree*):

List of competences

a) Knowledge

T1 - Understands the processes described by the general and specific theories required for the practicising of the fields of earth science engineering (geologist-engineering, geophysical-engineering, geoinformatics-engineering), understands the internal connections between geological processes, and knows the planning and interpretation procedures based on the processes.
T2 - Has a solid technical and scientific knowledge required for the high-level progress in earth sciences engineering disciplines, among others in numerical methods, technical physics and their contexts.
T3 - Based on his/her knowledge, understands the structure of the raw material extraction sector, the technologies used for the extraction and preparation of mineral raw materials, as well as the scope of geo-environmental tasks, their external socio-economic environment and regulatory system.
T4 - Has a thorough knowledge and understanding of the best practices applied to earth science engineering tasks and the long-term development directions that can be expected in this field in the medium term.
T5 - Knows the problem-solving (research-planning and management) techniques of best available practices in earth sciences.
T6 - At the application level, knows the GIS methods of computer design and analysis and the geoinformatics systems.
T7 - Knows in detail the geological and geophysical methods suitable for exploring natural resources.
T8 - Has a well-established knowledge of the methods of exploring mineral deposits.
T9 - Has detailed knowledge and sound application practice on the methods of knowledge acquisition and data collection in the technical earth sciences, and on their instrumental measurement and IT data processing procedures.
T10 - Has a well-established knowledge of the legal, economic, administrative, safety, work and fire protection, information technology and environmental protection fields related to the fields of earth science engineering.

b) Skills

K1- Able to apply general and specific basic and applied scientific theories within the technical earth sciences, able to systematize them, to solve independent engineering tasks (mainly complex geological prospecting, final report summarizing exploration results, geological-geophysical parts of environmental impact assessments).
K2 - Able to convey knowledge authentically by preparing presentations and written documents in Hungarian or in a foreign language.
K3 - Able to perform complex planning, construction, inspection and official licensing tasks (geological-geophysical exploration plans of natural resources, acquisition of environmental geology) with the innovative application of theories and terminology describing technical earth science knowledge.
K4 - Able to review legal and economic knowledge and activities related to technical earth science tasks, to optimize connections.
K5 - Able to actively cooperate with, organize, manage, and supervise larger and more complex activities based on or incorporating technical earth science tasks (especially mining, environmental technology investments, operations).
K6 - Uses modern information acquisition and data collection methods.
K7 - Able to solve technical problems requiring innovative skills in theory and practice (especially field, surface, underground data collection, measurements, and their processing and interpretation requiring innovative skills).
K8 - Able to process raw material exploration and production data and organize it into geoinformatics databases (systems).
K9 - Able to prospect and explore geological structures, to plan these research phases.
K10 - Able to take quantitative and qualitative assessment of mineral resources, to evaluate their economics, to compile concession tenders and to give opinions on this type of report.
K11- Able to contribute to the solution of geological-geophysical tasks arising during the extraction of mineral raw materials (planning, investment, operation, closure) and to analyze the solution possibilities.

K12 - Able to review the structure of the raw materials extraction sector, the technologies used for the extraction and processing of mineral raw materials, as well as the scope of geo-environmental tasks, their external socio-economic environment and regulatory system.
K13 - Able to organize cooperation with related disciplines and manage the (working) group within the framework of larger and more complex activities based on or incorporating technical earth science tasks.

c) Competence in terms of attitude

A1 - Open and receptive to the knowledge and acceptance of professional and technological methodological developments in the fields of technical earth sciences, to the acquisition of their management, and to the participation in their development.
A2 - Actively applies innovative skills and knowledge in solving professional problems in the fields of earth science engineering.
A3 - Commits and convincingly demonstrates to knowing and adhering to the professional and ethical values.
A4 - Professionalism and professional solidarity have deepened.
A5 - Respects and follows the ethical principles and written rules of work and professional culture in activities, and is able to follow them even when managing small workgroups.
A6 - In the course of professional work, observes and adheres to the requirements of safety, health, environmental protection and quality assurance and control (SHE and QA / QC).
A7 - Has a sufficient motivation to carry out activities in often changing working, geographical and cultural circumstances.

(d) Competence in terms of autonomy and responsibility

F1 - With the in-depth knowledge of the received strategic guidelines and external environmental requirements, is able to plan the work independently, and is also suitable to lead workgroups.
F2 - Takes responsibility and is accountable for the work processes carried out under his / her control, for the employees working in them.
F3 - Makes decisions carefully, in consultation with representatives of other disciplines (primarily legal, economic, and environmental), independently, takes responsibility for decisions.
F4 - In addition to constructive teamwork, is an autonomous specialist capable of making professional decisions in the field of operation entrusted to him/her.
F5 - Committed to the practice of sustainable natural resource management, occupational health and safety

Semester 3
WUST

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish … Geofizyka inżynierska
Name of subject in English Engineering Geophysics
Main field of study: Mining and geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
………………………. Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code ………… W06GIG-SM3004….
Group of courses NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			50	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	1			2	
including number of ECTS points for practical classes (P)				2	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,8			0,9	

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. has knowledge of fundamentals of applied geophysics, physics and geology.
2. knows fundamentals of soil and rock mechanics.
3. is able to use MS Office software.
4. is able to work in a team.

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SUBJECT OBJECTIVES

C1 familiarize with physical phenomena in geosphere of the Earth
C2 familiarize with engineering problems solved by means of geophysical surveying
C3 familiarize with various geophysical surveys.
C4 acquisition of skills to plan geophysical field surveying and to interpret its results.
C5 development of skills to work in a group.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:
PEU_W01 recognizes, names and explains engineering problems in different fields.
PEU_W02 identifies, describes and chooses geophysical surveying methods.
PEU_W03 analyses and assesses case studies from solving the engineering problems.

relating to skills:
PEU_U01 is able to coordinate team work, create field research plans and manage the work progress.
PEU_U02 is able to independently create solutions for complex practical problems in engineering and geoengineering applying knowledge about geophysical surveying, mining geophysics, utilizing modern methods in geophysical data acquisition and interpretation.
PEU_U03 is able to critically assess, process and interpreted results of the geophysical surveying and provide recommendations related to engineering problems in mining, civil engineering, engineering geology, municipal waste site, archeology, engineering properties of soil and rocks, hydrogeology, monitoring seepage in river dykes or dams.
PEU_U04 is able to solve geophysical problems.
PEU_U05 is able to conduct auto-didactical education related to detailed handling of typical software.
relating to social competences:
PEU_K01 understands the need to create and transfer to the society – among others by mass media- information and opinions related to mining engineering achievements and other activities of mining engineer; tries to transfer the information in commonly understood way, presenting different points of view; is aware of the quality and need to shape the work safety culture in mining and the responsibility for the health and life of other employees.

PROGRAMME CONTENT

Lecture		Number of hours
Lec 1	Physical properties of rocks. Inter-relationships between the various subdisciplines of applied geophysics. Overview of geophysical methods, their physical principles and applications. Methodology of geophysical surveying.	1
Lec 2	Engineering problems solved with geophysical surveying. Case studies.	2
Lec 3	Electrical resistivity methods. Tomography and VSE. IP method. Physical principles. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
Lec 4	Electromagnetic methods. FDEM and TDEM methods. Magnetotelluric methods. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Lec 5	GPR surveying. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Lec 6	Seismic tomography. Seismic interferometry. Physical principles. Applications. Case studies.	2
Lec 7	Mine geophysics. Seismology. Seismic methods. Active and passive seismic tomography. Microgravimetry. Case studies.	2
Lec 8	Gravity and magnetic surveying. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
	Total hours	15

Project	Number of hours

Proj 1	One selected geophysical technique. Fundamentals and equipment. Field surveying	4
Proj 2	Processing and interpretation of field data.	3
Proj 3	Solving the geophysical problems.	8
	Total hours	15

TEACHING TOOLS USED

N1. N1.Lecture aided by presentation.
N2.Demonstration.
N3.Discussion and consultations
N3Calculations
N5Practical field surveying

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
P1	W01-W03	Test related to lecture content. Final grade.
F1	U01-U02, U05	Test. Project 1. Report on Project 1
F2	U03, U05	Test. Project 2. Report on Project 2
F3	U04, U05	Test. Solving geophysical problems
F1-F3, P2	U01-U05 K02	Grades are given for each of three project tasks including tests and reports. The final grade P2 for the project course is the weighted average grade of F1-F3.

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Aki, K., Richards P.G., 1980. Quantitative Seismology: Theory and Methods. W.H. Freeman Co.. San Francisco.
[2] Burger, H.R., Sheehan, A.F., Jones, C.H., 2006. Introduction to Applied Geophysics: Exploring the Shallow Subsurface. W.W. Norton & Company, Inc.
[3] Mendecki, A.J. (ed.), 1997. Seismic Monitoring in Mines. Chapman & Hall.
[4] Reynolds, J.M., 2011. An Introduction to Applied and Environmental Geophysics. Wiley – Blackwell. John Wiley & Sons.
[5] Sharma, Prem V., 2002. Environmental and engineering geophysics. Cambridge University Press.
[6] Torge, W., 1989. Gravimetry. Water de Gruyter. Berlin. New York.
[7] Selected Journal Publications (for example journals: Progress in Geophysics, Engineering Geophysics Journal, Environmental and Engineering Geophysics, Journal of Geophysics and Engineering, Pure and Applied Geophysics).

SECONDARY LITERATURE:

[1] Lowrie, W., 2007. Fundamentals of Geophysics. Cambridge University Press.
[2] Milsom, J., 2003. Field Geophysics. John Wiley & Sons Ltd.
[3] Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990. Applied Geophysics. Cambridge University Press.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

ANNA BARBARA GOGOLEWSKA, anna.gogolewska@pwr.edu.pl

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish Wspomagane komputerowo modelowanie geologiczne i geostatystyka.)
Name of subject in English: Computer Aided Geological Modelling and Geostatistics
Main field of study (if applicable): Górnictwo i geologia.
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Mineral Resource Exploration
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W06GIG-SM3002
Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	crediting with grade	Examination / crediting with grade*	crediting with grade	Examination / crediting with grade*	Examination / crediting with grade*
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		
including number of ECTS points for practical classes (P)			3		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,8		1,9		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Mathematical Statistics,
2. Fundamentals of Geology and Mineral Deposits

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SUBJECT OBJECTIVES

C1 Developing basic skills in computer modelling of 3-D objects.
C2 Introduction of the principles of digital modelling of typical geological structures.
C3 Introduction to the methods of deposit parameters estimation and resources evaluation.

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 Estimation methods, principles of geostatistics, kriging estimators PEU_W02 Geostatistical modelling of the selected deposit parameters (domain analysis, variogram modelling, PEU_W03 Creating and validating 3-D models of various geological structures in the comprehensive dedicated software environment. relating to skills: PEU_U01 Application of relevant estimation methods for quality modelling of a deposit PEU_U02 Evaluating 3-D objects against structural and quality block models (volumes, tonnages, grades) PEU_U03 Describing the interpretation and applied approach, creating models, evaluation results, recommendations for possible enhancements relating to social competences: PEK_K01 The student can think and act in a creative and enterprising way

PROGRAMME CONTENT		
Lecture		Number of hours
Lec 1	Introduction to the course. Geological database and validation of the geological data.	2
Lec 2	Geology of the seam.	2
Lec 3	Structural model of the stratified deposit. Methods of the prediction of the surface layer parameters.	2
Lec 4	Spatial distribution of samples values. Regionalized variable.	2
Lec 5	BLUE Estimator of the mean value: Kriging.	2
Lec 6	Quality model of the deposit – block model of the parameter layers. Estimation and evaluation of the block model.	2
Lec 7	Reserves modelling and evaluation.	2
Lec 8	Mineral resources. International reporting. The JORC Code	1
	Total hours	**15**

Laboratory		Number of hours
La1	Determining the rules of work at the laboratory.	3
La2	Assignment of the individual dataset for the exercises and creating initial data files.	3
La3	Data validation and creating initial geological database.	3
La4	Construction of the structural wireframe model of stratigraphy layers.	3
La5	Construction of the block model of the deposit and overburden layers. Thickness and stripping ratio analysis.	3
La6	Data preparation to geostatistical analysis. Compositing of the samples.	3
La7	Domain analysis with the use of the statistical methods.	3
La8	Determination of the empirical variogram. Anisotropy analysis.	3
La9	Variogram modelling.	3
La10	Kriging Neighborhood Analysis - defining optimal parameters of the	3

	estimation procedure.	
La11	Estimation of quality parameters in block model of the deposit layers. Validation of the estimation quality.	3
La12	Validation of the quality model and classification of the resources. Balance resources evaluation.	3
La13	Preparation of data for continuous surface mining ultimate pit design. Ultimate pit outlines generation	3
La14	Wireframe and block modelling of the ultimate pit	3
La15	Reserves evaluation, visualization and interrogation of created models	3
	Total hours	45

TEACHING TOOLS USED

N1. Form of lectures - traditional, multimedia presentations using specialized software and demonstrations of its application "live", individual development of specialist topics covered during the lecture,
N2. individual development of project tasks within the laboratories frames, individual development of electronic reports concerning project tasks within the laboratories frames,
N3. evaluation of laboratory tasks reports with multipoint grade of student's work, group analysis of the results obtained during laboratory tasks; preparation of conclusions concerning data dependencies and constraints of mining projects, skill control tests, duty hours in laboratory.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01, PEU_W02	Lecture grade on the basis of the written examination
F2	PEU_W03,	Laboratory task assessment: "structural modelling assessment
F3	PEU_U01	Laboratory task assessment: "geostatistical modelling"
F4	PEU_U02, PEU_U03	Laboratory task assessment: "reserves evaluation".
P average of F1, F2, F3, F4		

PRIMARY AND SECONDARY LITERATURE
<u>PRIMARY LITERATURE:</u> [1] M. Armstrong, Basic Linear Geostatistics, Springer Verlag, 1998. [2] P. Goovaerts: "Geostatistics for Natural Resource Evaluation", Oxford University Press, 1997. [3] R. H. Grishong, Jr., 3-D Structural Geology, Springer Verlag, 2008 [4] K. Hefferan, J. O'Brien, Earth materials, Willey-Blacwell, Chichester U.K., 2010 [5] W. Hustrulid, M. Kuchta, Open pit mine planning and design. Chapter 3. Orebody description, Taylor&Francis, 2013. [6] A. G. Journel, and C.J. Huijbregts, Mining Geostatistics, Academic Press, 1978. [7] Ch.C. Plummer, D.H. Carlson, L. Hammersley, Physical geology, McGraw-Hill I.E. N.Y. 2010 [8] D.R. Prothero, R.H. Dott Jr., Evolution of the Earth, McGraw-Hill I.E. N.Y., 2010 [9] M.W. Rossi, C.V. Deutsch, Mineral Resources Estimation, Springer Verlag 2014. **<u>SECONDARY LITERATURE:</u>** [10] Handouts, tutorials.
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Dr inż. Krzysztof Hołodnik **Dr inż. Witold Kawalec**

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Cyfrowa kopalnia
Name in English: Digital Mine…………………….
Main field of study: Mining and geology
Specialization: Mining Engineering,
Geotechnical and Environmental Engineering,
………………………. Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3006
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		15		
Number of hours of total student workload (CNPS)	25		25		
Form of crediting	crediting with grade		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**1**		1		
including number of ECTS points for practical (P) classes			1		
Including number of ECTS points for direct teacher-student contact (BK) classes	0,8		0,8		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Computer literacy skills
2. Basic knowledge related to Mining Engineering and Mineral Processing
3. Programming

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SUBJECT OBJECTIVES

C1. Acquisition of the ability to create utility applications in the C / C ++ and LabVIEW environment
C2. Providing students with knowledge about embedded systems, their construction, selection of components, designing, programming and their exploitation.
C3. Familiarizing with the advances of technology & methods of future mining operations.
C4. Acquisition and consolidation of social competencies including emotional intelligence skills involving the cooperation in the group of students aiming to effectively solve problems. Responsibility, honesty and fairness in the proceedings; observance force in academia and society

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 A student has knowledge related to automation systems, control systems and measurement systems in various aspects of the mining industry. PEU_W02 The student has knowledge of the importance of automation and robotics systems in modern mining. **relating to skills:** PEU_U01 A student is able to select and integrate elements of a specialized measuring and control system including: control unit, executive system, measuring system as well as peripheral and communication modules PEU_U02 A student can design improvements in the existing design solutions for automation and robotics components and systems **relating to social competences:** PEU_K01 A student is aware of the need for a professional approach to technical issues, meticulous reading of documentation and knows environmental conditions in which devices and their components can function PEU_K02 The student has knowledge concerning the benefits of creation and implementation new solutions&technologies into mining industry

PROGRAMME CONTENT		
	Form of classes - lecture	**Number of hours**
Lec 1	Terminology (process, automation, robots, measurement devices, control systems). Definition of digital mine	2
Lec 2	Aims, benefits, drawbacks of automation. Industrial revolutions. Definition of industry 4.0. Overview of components of the 4th industrial revolution. Industry 4.0 and mining	2
Lec 3	Elements of technological process in mining. Automation of cyclic processes Measuring technologies in industry 4.0. Sensors systems. Data transmission and data storage technologies. Analytics in industry 4.0. Industrial BigData, Cloud Computing	2
Lec 4	Industrial Internet of Things. M2M communication, anti-collision systems, location of people underground	2
Lec 5	Virtual and augmented realities for industry. Simulators. Digital Twin. Digital models of processes and objects. Management information creation systems, reporting	2
Lec 6	Case study: Automation in open pit lignite mining (KTZ, Autonomous haulage (use case from Australia))	1
Lec 7	Case study: underground mine (Rock Vader – Sandvik project, other use cases from Sandvik, Epiroc, MineMaster, Zanam, AOT from ZGPS KGHM, KIC project on shaft inspection, …etc)	2
Lec 8	Case study: mineral processing (ConVis, FlowVis) in KGHM, OPMO project	2
	Total hours	**15**

Form of classes - laboratory		Number of hours
Lab1	Scope of the course, teaching purpose, crediting conditions, literature, data. Introduction to ARDUINO	3
Lab2	Basic sensors for physical parameters measurements	3
Lab3	Measurements in Labview	3
Lab4	Analysis and Visualization in Labview	3
Lab5	Control in labview	3
	Total hours	**15**

TEACHING TOOLS USED
N1. Type of lectures - traditional, illustrated with multimedia presentations with the usage of audio- visual equipment. N2. Discussion concerning lectures and laboratory. N3 Configuration on laboratory classes measuring systems (hardware and software), performing of measurements, teamwork N4. Projects defence - oral and written form. N5. Duty hours.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at the end of semester)	Educational effect number	Way of evaluating educational effect achievement
F1, P1	PEK_U02-PEK_U04	F1.1 Grade from laboratory work's performance and its merits F.1.2 Grade from laboratory work's oral or written defence P1.Final grade (weighted average of F1.1 - 60% and F1.2 - 40%).
F2, P2	PEK_U02-PEK_U04	F2.1 Grade from activity during the lecture (questions, discussions etc) F.2.2 Grade from written exam P2.Final grade (weighted average of F2.1 - 20% and F2.2 - 80%).

LITERATURE
PRIMARY LITERATURE: [1] LabVIEWTM Getting Started with LabVIEW http://www.ni.com/pdf/manuals/373427j.pdf [2] Monk Simon: Arduino dla początkujących. Podstawy i szkice, Anderson R., Cervo D., Helion, 2018 [3] Monk Simon: Arduino dla początkujących. Kolejny krok, Anderson R., Cervo D., Helion, 2015 **ONLINE LITERATURE:** [1] LabVIEW Tutorial [2] ARDUINO Tutorial [3] Materials prepared by Tutor [4] Internet websites
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Prof. dr hab. inż. Radosław Zimroz, radoslaw.zimroz@pwr.edu.pl **dr inż. Anna.Nowak-Szpak**

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name of subject in Polish Bezpieczeństwo i higiena pracy
Name of subject in English: Occupational Health and Safety
Main field of study (if applicable): Górnictwo i geologia.
Specialization (if applicable): Mining Engineering,
Geotechnical and Environmental Engineering,
Mineral Resource Exploration
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W06GIG-SM3005
Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15			15	
Number of hours of total student workload (CNPS)	25			25	
Form of crediting	crediting with grade			crediting with grade	
For group of courses mark (X) final course					
Number of ECTS points	**1**			1	
including number of ECTS points for practical classes (P)				1	
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	0,7			0,8	

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Possesses basic knowledge of technologies used in open-pit mines and underground mines.
2. Is able to use Microsoft Office environment to prepare documents in Word, multimedia presentations in Power Point and work with Excel spreadsheets.
3. Is able to identify harmful, dangerous and nuisance factors in the workplace environment.

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SUBJECT OBJECTIVES

C1. To introduce the principles of occupational risk assessment in accordance with relevant standards
C2 To present the principles of occupational risk assessment and the determination of admissibility with the use of STER software and the RISC SCORE method.

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEU_W01 Possesses general knowledge of rules of occupational risk assessment formulation PEU_W02 – Possesses knowledge of evaluating and determining the admissibility of occupational risk. PEU _W0 3 – Possesses general knowledge of corrective and preventive actions regarding hazards of typical work posts in the mining industry.… relating to skills: PEU_U01 Is able to identify hazards of harmful, dangerous and nuisance factors of typical work posts in the mining industry PEU_U02 Is able to estimate and determine risk acceptability with methods according to STER software and the RISC SCORE method. PEU_U03 - Is able to plan corrective and preventive actions for hazards of typical work posts in the mining industry.… relating to social competences: PEU_K01 - Is able to work in a team and together complete occupational risk assessment and develop its results and the required documentation in the form of a team report

PROGRAMME CONTENT		
	Lecture	**Number of hours**
Lec 1	Definition of occupational risk. Legal basics of occupational risk assessment. Risk assessment methods. Course of occupational risk assessment. Information necessary for occupational risk assessment. Identification of harmful, dangerous and nuisance factors in the work environment.	3
Lec 2	Estimation of occupational risk assessment and determination of admissibility. Corrective and preventive actions. Familiarising employees with the results of occupational risk assessment. Implementation of agreed corrective and preventive actions. Monitoring the effectiveness of implemented actions. Periodic occupational risk assessment. Harmful factors – identification and assessment of risks.	3
Lec 3	Dangerous factors - identification and assessment of risks.	3
Lec 4	Nuisance factors in occupational risk assessment: psychological burden, static burden, monotype.	3
Lec 5	Methods of occupational risk assessment: STER software, the RISC SCORE method, written test	3
	Total hours	**15**

	Project	Number of hours
Pr1	Occupational risk assessment with the use of STER software for two work posts – description of work post, identification of hazards. Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of harmful factors (dust, noise)	3
Pr2	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of	3

	harmful factors (vibration, chemical agents)	
Pr3	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of dangerous factors (slippery or uneven surfaces, falling elements, moving parts, moving machinery and transported bimi items)	3
Pr4	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility for nuisance factors (psychological burden, static burden, monotype)	3
Pr 5	Occupational risk assessment for a selected work post with the use of the RISC SCORE method, presentation of executed exercises, test	3
	Suma godzin	**15**

TEACHING TOOLS USED
N1. Informative lecture with elements of problematic lectures. N2 Multimedia presentations. N3 Didactic discussions during lectures. N4 Didactic discussions during laboratory classes. N5Computer presentation of executed occupational risk assessments. N6Consultation.

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1	PEU_W01-W03	grade from a test
F2	PEU_W01-W03 PEU_U01- U03	grade from a presentation
P2	PEU_W01-W03 PEU_U01- U03	final grade from project classes (arithmetic average of F1 and F2)

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Occupational Safety and Health in Mining. Anthology on the situation in 16 mining countries. Ed.: Kaj Elgstrand and Eva Vingård. University of Gothenburg nr 2013;47(2) (gupea.ub.gu.se › bitstream › gupea_2077_32882_1)

[2] Boyle, Tony: Health and safety: Risk management. IOSH, 2001. (http://www.iosh.co.uk/index.cfm?go=publications.main)

[3] Encyclopaedia of occupational health and safety. Fourth edition Stellman, Jeanne M. (ed.). International Labour Organization, 1998 (http://www.ilo.org/public/english/support/publ/xtextre.htm#b103) http://www.ilo.org/public/english/support/publ/encyc/)

[4] McKeown, Céline; Twiss, Michael: Workplace ergonomics: A practical guide, IOSH, 2001, 160 p. http://www.iosh.co.uk/index.cfm?go=publications.main

<u>SECONDARY LITERATURE:</u> Handouts, articles
OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)
Dr inż. Żaklina Konopacka

Zał. nr 5 do ZW 78/2023
Attachment no. 4. to the Program of Studies

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: ***Zasady i zastosowania InSAR oraz GIS w górnictwie***
Name in English: ***Principles and Application of InSAR and GIS in mining***
Main field of study: Mining and geology
Specialization: Geomatics for Mineral Resources Management
……………………….Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code: W06GIG-SM3007
Group of courses: No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		45		
Number of hours of total student workload (CNPS)	50		75		
Form of crediting	Examination		crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	**2**		3		
including number of ECTS points for practical (P) classes			3		
Including number of ECTS points for direct teacher-student contact (BU) classes	1,4		2,0		

*niepotrzebne skreślić

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Basic knowledge of C ++ and Python programming language.
2. Basic knowledge of GIS functions and spatial data acquisition techniques
3. Ability to use GIS software package
4. Basic knowledge of databases

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SUBJECT OBJECTIVES

C1 Presentation of knowledge of satellite radar interferometry, as well as the possibility of using it in the ground deformation measurements.
C2 Acquiring the ability to determine surface displacements based on satellite radar data.
C3 Presentation of information on the use of GIS in advanced analysis of objects, phenomena and processes occurring in space.
C4 Acquiring the ability to formulate and solve tasks using GIS analytical functions.
C5 Acquiring skills to use spatial data and services in accordance with the INSPIRE Directive

SUBJECT EDUCATIONAL EFFECTS
relating to knowledge: PEK_W01 Has expanded knowledge in the field of using geoinformation systems to collect and process data used in modeling of both natural and anthropogenic phenomena and processes PEK_W02 Knows the principles of construction and functioning of geoinformation systems in the mining industry and public administration relating to skills: PEK_U01 has the ability to use advanced GIS tools in mining, studies of natural phenomena, the impact of mining on the environment and space development, PEK_U02 has the ability to formulate and solve spatial tasks in the GIS environment PEK_U03 has the ability to interpret the results obtained and draw conclusions relating to social competences: PEU_K01 has the ability to formulate and transfer knowledge on the use of geoinformation systems in spatial analysis and presentation of their results

PROGRAMME CONTENT		
	Lecture	**Number of hours**
Lec 1	Discussion of syllabus, requirements for passing the course, literature	2
Lec 2	Introduction to Microwave Signals for Earth Observation	2
Lec 3	Principles and Applications of Passive and Active Microwave Remote Sensing	2
Lec 4	Acquisition and processing of SAR data	2
Lec 5	SAR image theory (geometric properties, polarization)	2
Lec 6	Basics of SAR data calculation using the DInSAR and SBAS methods	2
Lec 7	Principlesand Applicationsof Interferometric SAR (monitoring surface activity, natural and anthropogenic phenomena)	2
Lec 8	Fundamental concepts of geographical information systems	2
Lec 9	Data modelling in GIS. Representation of spatial data. Spatial databases. Current status and development trends	2
Lec 10	Methods of spatial analysis in GIS	2
Lec 11	Spatial data interpolation	2
Lec 12	Map algebra. Surface analysis, local and zonal functions	2
Lec 13	Basics of spatial statistics	2
Lec 14	Spatial Information Infrastructure. Inspire Directive. Open Data	2
Lec 15	Examples of applications of geoinformation systems in mining and environmental protection	2
	Total hours	**30**

Laboratory		Number of hours
La1	Configuration of the environment for SAR calculations	3
La2-3	Introduction to radar data calculations - calculation tasks	6
La4	Acquiring radar data and calculating the interferogram - DInSAR method	3
La5	Unwrapping of the interferometric phase - calculations	3
La6-7	Presentation of results in the GMT environment	6
La8	Discrete data interpolation. Preparation of input data for analysis (e.g. deformation measurements in the mining area)	3
La9	Discrete data interpolation. Development mining area terrain deformation maps with various interpolation methods.	3
La10	Discrete data interpolation. Analysis and assessment of the quality and uncertainty of interpolation. Prediction map. Development of maps of changes between two periods using a raster calculator.	3
La11	Spatial analysis - assessment of the suitability of the area for the location	3
La12	of mining operation. Construction of a database of spatial location criteria	3
La13	Spatial analysis - assessment of the suitability of the area for the location	3
La14	of mining operation. Selection of analytical procedures and conducting analytical operations.	3
La15	Spatial analysis - assessment of the suitability of the area for the location	3
	Total hours	**45**

TEACHING TOOLS USED
N1. Lectures N2. Multimedia presentations N3. Preparation of individual written term paper on a given topic N4. Multimedia materials (MOOC) N5. Laboratory instructions N6. Reports from laboratory exercises N7. Consultations

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F1 Final mark for the written examination F2 Mark for the written report, P Final mark for the lecture (weighted average of F1 and F2, where F1 – 80% and F2 - 20%)
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F3 Mark for the written assignment reports F4 Mark from written tests, P2 Final mark for the laboratory (weighted average of F3 and F4, where F3 – 80% and F4 - 20%)

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. 2015: Geographic Information Science and Systems, 4th Edition, John Wiley & Sons; [2] Maguire D., Batty M., Goodchild M., 2005. GIS Spatial Analysis and Modelling. ESRI Press [3] Berry J., 2007-2013. Beyond Mapping IV — GIS Modelling [4] Satellite InSAR Data: Reservoir Monitoring from Space, A. Ferretti, EAGE; 1st edition, 2014 [5] GMTSAR: An InSAR Processing System Based on Generic Mapping Tools (Second Edition), D. Sandwell i in., Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, 2016 [6] InSAR Principles - Guidelines for SAR Interferometry Processing and Interpretation, ESA Publications, 2008 **SECONDARY LITERATURE:** [1] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) [2] Kennedy M., 2009: Introducing Geographic Information Systems with ArcGIS: A Workbook Approach to Learning GIS, Second Edition, John Wiley and Sons; [3] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. W., 2006. GIS. Teoria i praktyka. Wydawnictwo Naukowe PWN, Warszawa [4] Urbański J., 2010. GIS w badaniach przyrodniczych, Wydawnictwo Uniwersytetu Gdańskiego [5] Dokumentacja środowiska GMT (Generic Mapping Tools) - http://gmt.soest.hawaii.edu/projects/gmt/wiki/Documentation
SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
Wojciech Milczarek, wojciech.milczarek@pwr.edu.pl Jan Blachowski, jan.blachowski@pwr.edu.pl

FACULTY OF GEOENGINEERING, MINING AND GEOLOGY

SUBJECT CARD

Name in Polish: Geochemia
Name in English: Geochemistry
Faculty of studies (if applicable): Mining and Geology
Specialisation (if applicable): Mining Engineering
Mineral Resource Exploration
Level and form of studies: 2nd level, full-time
Subject Type: Obligatory
Subject code: W06GIG- SM3055W
Group of courses: NO

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in the University (ZZU)	**30**				
Number of hours of total student workload (CNPS)	**50**				
Form of crediting	**Crediting with grade**				
For a group of courses mark (X) for the final course					
Number of ECTS points	**2**				
including number of ECTS points for practical (P) classes					
including number of ECTS points for direct teacher-student contact (BK) classes	**1,4**				

* delete as applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Possesses basic knowledge in the area of general chemistry (inorganic and organic) and physics.
2. Possesses basic knowledge in the area of mineralogy and petrology.
3. Possesses basic knowledge and skills in the area of hydrogeology.
4. Is familiar with basic concepts of deposit and mining geology.

SUBJECT OBJECTIVES

C1 Aim of the subject is to familiarize students with fundamental physicochemical principles and processes which occur in the Earth's crust and their theoretical foundations and implications.

SUBJECT LEARNING OUTCOMES

relating to knowledge:

PEU_W01 Possesses knowledge relating to the thermodynamic and geochemical principles and processes which occur in the Earth's crust.

PEU_W02 Possesses basic knowledge in the area of rock formation and the determination of the age of rocks.

relating to skills:

PEU_ U01 Is able to search for information on geochemical processes and carry out their critical evaluation and analysis.

relating to social competencies:

PEU_K01 Is able to formulate and impart knowledge regarding processes occurring in the Earth's crust and their impact on the environment.

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Lec.1	Introduction. History, present time and future of the Universe. Construction of the Earth and the structure of outer zones	3
Lec.2	The basics of thermodynamic geological processes (parameters and functions of state)	3
Lec.3	Geochemical calculations (solutions, reactions, pH, Eh, dissolution, phase diagrams, stability, rule of contradiction)	3
Lec.4	Geochemical calculations (chemical equilibria diagrams)	3
Lec.5	Global geochemical cycles	3
Lec.6	Geochemistry of elements	3
Lec.7	Geochemistry of organic compounds	3
Lec.8	Earth and life	3
Lec.9	Applied Geochemistry	3
Lec.10	Determination of the absolute age of rocks. Mineral thermometry and barometry	3
Lec.11	Mineral facies indicators	3
Lec.12	Natural non-isotope markers	3
Lec.13	Natural isotope markers	3
Lec.14	Artificial non-isotope markers	3
Lec.15	Paleomagnetism and dendrochronology	3
	Total hours	**45**

Form of classes - seminar		Number of hours
Se1		
Se2		
	Total hours	

Form of classes - laboratory		Number of hours
La1-		
La2-		
	Total hours	

TEACHING TOOLS USED

N1. Traditional lecture supplemented with multimedia presentations and discussions.

EVALUATION OF SUBJECT EDUCATIONAL OUTCOME ACHIEVEMENTS

Evaluation F – forming (during semester), P – concluding (at semester end)	Educational outcome number	Method of evaluating educational outcome achievement
P	PEU_W01-W02 PEU_U01 PEU_K01	Written test
F, P		
F, P		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE

[1] Albarède F., 2009 – Geochemistry. An introduction. Cambridge University Press, Cambridge, UK.

[2] Allègre C. J., 2008 – Isotope geology. Cambridge University Press, Cambridge, UK.

[3] Hefferan K., O'Brien J., 2010 – Earth materials. Wiley-Blackwell, Chichester, UK.

[4] Marshall C. P., Fairbridge R. W. (eds), 1999 – Encyklopedia of Geochemistry. Kluwer Academic Publishers, Dodrecht, Boston, London.

[5] McSween H. Y., Huss G. R., 2010 – Cosmochemistry. Cambridge University Press, Cambridge, UK

[6] Tolstikhin I. N., Kramers J. D., 2008 – The evolution of matter. From the Big Bang to the Present Day. Cambridge University Press, Cambridge, UK

SECONDARY LITERATURE

[1] Appelo C.A.J., Postma D., 2005 - Geochemistry, groundwater and pollution. Balkema.

[2] Merkel B. , Planer-Friedrich 8.,2005 - Groundwater geochemistry. Springer

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

Prof. dr hab. inż. Tadeusz Przylibski

dr inż. Danuta Szyszka, dr inż. Katarzyna Łuszczek, dr inż. Agata Kowalska

Semester 4
WUST

<table>
<tr><td>Course title</td><td colspan="6">Applied field exploration</td></tr>
<tr><td>European Credits (ECTS)</td><td colspan="2">3</td><td colspan="2">Time (hours) given to the students</td><td colspan="2">45</td></tr>
<tr><td>Type (Lecture, internship, exercise etc.)</td><td colspan="2">Lectures: , Auditorium classes: , Lab. Classes: , Project classes: , Practical classes: , Seminar classes: , Fieldwork: 3</td><td colspan="2">Student whole working time (hours)</td><td colspan="2">75</td></tr>
<tr><td>Description of content</td><td colspan="6">The goal of the course is that students should acquire a hands-on understanding of different field exploration methodologies, and how they can be integrated for targeting VMS deposits.
Geological, geophysical and geochemical exploration methods in VMS exploration. Practical field mapping exercises in structural geology, stratigraphy, hydrothermal alteration. Practical geophysical surveying using UAV technology. GIS-based data synthesis for exploration target selection. Drill core logging and assaying.</td></tr>
<tr><td>Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)</td><td colspan="6">Knowledge: when passed the student is expected to have:
-knowledge about different field methods and their use during an exploration program.
-knowledge about drilling and sampling methods.
-knowledge about different methods for field mapping.
Skills: when passed the student is expected to have the ability to
- acquire in-depth structural, volcanological and alteration data from outcrops in the field
- contextualize field observations in relation to ore genetic model for VMS deposits.
- synthesize different types of geological and geophysical data for targeting a VMS deposit.
Competences: ,</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="6">Exercises U G# 1.20
Project work G U 3 4 5 1.80
The course is mainly presented via practicals in the field, but also with complementary lectures and excercises, in addition to project work.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">Online compendium in Canvas room</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Nils Jansson, Nils.Jansson@ltu.se</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Justification for OLO contribution	

Course title	**SOC Internship**		
European Credits (ECTS)	2	**Time (hours) given to the students**	30
Type (Lecture, internship, exercise etc.)	Lectures:, Auditorium classes: , Lab. Classes: , Project classes: 2 , Practical classes:, Seminar classes: , Fieldwork: x	**Student whole working time (hours)**	50
Description of content	The aim of the course is to enable students to work in socially responsible workplaces, and apply their skills and knowledge to promote social good. While this develops them to become work-ready professionals, it also nurtures them to become advocates who help build a better world. EDUCATIONAL GOALS: 1. To actively participate in the affairs of the community and in concrete actions on the ground that aim to promote the public interest, equality and solidarity. 2. To reflect on social license to operate issues 3. To work in direct contact with the beneficiaries of the civic activities undertaken e.g.: reception, facilitation, support, social assistance, etc. EXAMPLES OF SOCIAL AND CIVIC ISSUES IN MINERALS INDUSTRIES: • Depletion of natural capital (degradation of air, land and water quality), land use conflicts, health impacts • Digitalization and automation generate particular challenges for well-being in mining regions. Limited job opportunities for local workforce and skills mismatches. • High and continuous transparency and accountability standards of the industry, effective methods of information sharing and dialogue • A more equitable value-sharing, Corporate Social Responsibility issues • Facilitation of environmental awareness • Preservation and restoring of historic sites,		
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: to understand that social responsibility incorporates an ethical, social and environmentally-friendly perspective to our personal and professional activities Skills: To be able to engage in an informal professional discussion and business communication Competences: To cope with complexity, uncertainty and change in global contexts		

<table>
<tr><td>Assessment methods and criteria</td><td colspan="6">Criterion:
Submission of a project report</td></tr>
<tr><td>Recommended readings</td><td colspan="6"></td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Supervisors of the student’s Master thesis</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td>Students will be engaged in professional discussion and business communication</td><td></td><td></td><td></td><td>Students will be able to understand that social responsibility incorporates an ethical, social and environmentally-friendly perspective to our personal and professional activities</td><td></td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

Course title	**Exploration entrepreneurship**		
European Credits (ECTS)	4	**Time (hours) given to the students**	60
Type (Lecture, internship, exercise etc.)	Lectures: 1, Auditorium classes: , Lab. Classes: , Project classes: 1, Practical classes: 3, Seminar classes: 2, Fieldwork:	**Student whole working time (hours)**	100
Description of content	To equip students with the professional skills to increase their employability and entrepreneurship skills to meet the current market demands. The EFGeoMentoring scheme aims at improving international networking and supporting the life-long learning and CPD requirements of experienced geology professionals. In addition, it allows students to benefit from insider knowledge about international work perspectives in different sectors of geological profession and countries. Mentoring within the course is a process during which an experienced professional with and EurGeol title (mentor) accompanies the student in a targeted way. Mentoring contributes to developing personal, entrepreneurial, networking, social and professional skills regarding the mineral prospecting and exploration activity. It allows learning from professional experiences that can only be acquired through practice and can't be found in any textbook. Mentoring improves the opportunities of career beginners by providing career-enhancing contacts and involvement in professional networks. At the beginning of the mentoring cooperation, students formulate clear goals and communicate them to their mentor. In consultation with the mentor, concrete topics and the respective roles within the mentoring process will be defined. Since the student is at the centre of the process, it is their task to become aware of their own plans and their support needs. OBJECTIVES OF THE MODULE: • Intensify international networking among geologists all across Europe and beyond • Provide young professionals with contacts helping them to think through, plan and access their short, medium or long-term career development • Contribute on internship positions • Improve gender balance and increase diversity in leadership positions by providing targeted support to women and under-represented minorities • Facilitate life-long learning and Continuing Professional Development (CPD) The EFG mentors are professionals who have acquired a high level of industrial and/or academic experience and work in industrial practice, business, academia, education or administration. • **Coaching:** The mentor actively guides and encourages the student to develop essential skills and attitudes for the future ("How do I assert myself? How do I behave in negotiations? What do I do in challenging work contexts?") • **Advice:** The mentor advises the student in concrete situations, in current questions and difficulties. Mentors support students in solving problems and assist them in making tough decisions.		

	Help: The mentor can help open otherwise locked doors that allow the student to pursue their goals. **Support:** The mentor supports the student in essential decisions without deciding. Mentors assist in the development of professional strategies, as well as in career planning and review of possible obstacles. **Inform:** The mentor informs the student about (informal) rules and processes applied in organisations or professional life in general. According to the student's background, mentors can also inform about seminars or conferences that they consider helpful. **Participation:** Mentors allow students to participate in parts of their professional career, experiences and strategic decisions. They allow students to share their professional life and invite them, for instance, to participate in meetings or appointments. **Give feedback:** Mentor and student provide each other with constructive feedback about their appearance and public perception. **Networking:** Mentors give the students hints on maintaining and using contacts. They introduce the students into active networks and provide professional contacts. The mentor provides the student with the chance to create a successful CV and take a chance on social networks such as LinkedIn.
Learning outcomes of the curricular unit (knowledge, skills and competences to be developed by the students)	Knowledge: to provide background training to support the learning process; make students aware of broad professional issues; provide business and entrepreneurship skills to develop an awareness of business management and commercial practices regarding mineral prospecting and exploration. Skills: Develop relationships with other persons and maintain them. Can talk frankly about his ideas, fears and weaknesses. Identifying investment opportunities in the mineral resources sector. Competences: To define professional targets, wants to succeed and is actively committed to implementing these targets. Not afraid of making mistakes and experimenting with new ideas. Willing to question himself critically, accept external advice, and implement it.
Assessment methods and criteria	Practical mark At the end of the mentoring process, students will a) reflect their mentoring experience on a two-page report highlighting benefits and potential gaps for future implementation b) prepare a small business plan for an identified innovative idea of their own. Slack channel will allow for student-mentor exchange and networking within the whole cohort of participants. Mentoring is a one-to-one relationship between a mentor and a student. - Mentoring takes place beyond a dependent relationship (e.g. supervisor-subordinate or professor-student relationships). - During the mentoring process, learning and experimentation occur in a protected environment. - An integral part of mentoring is the development of professional skills and competencies. Mentoring is a reciprocal process of "give and take". Both sides learn from each

<table>
<tr><td></td><td colspan="6">other because even the mentor will have the opportunity to critically question his professional perspective and discover new perspectives, software and applications, and previously unperceived situations.</td></tr>
<tr><td>Recommended readings</td><td colspan="6">Mentoring Mindset, Skills and Tools 4th Edition: Make it easy for mentors and students, 2020, Synergetic People Development Pty Ltd, 252 pages, ISBN 0980356458

The Mentoring Guide: Helping Mentors and Students Succeed, 2019, Michigan Publishing Services, ISBN: 1607855399.

Wang, J., Shibayama, S., 2022. Mentorship and creativity: Effects of mentor creativity and mentoring style. Research Policy 51, 104451. doi:10.1016/j.respol.2021.104451

Entrepreneurship: A Guide To Success For Entrepreneurs And Aspiring Entrepreneurs, 2018, ISBN 978-1720221654
Entrepreneurship: Successfully Launching New Ventures, Global Edition, 2018, Pearson, ISBN: 9781292255330</td></tr>
<tr><td>TU Coordinator</td><td colspan="6">Pavlos Tyrologou, pavlos.tyrologou@gmail.com</td></tr>
<tr><td rowspan="2">Contribution to EIT’s Overarching Learning Outcomes (tick relevant box/es)*</td><td>OLO 1 Entrepreneurship</td><td>OLO2 Innovation</td><td>OLO3 Creativity</td><td>OLO4 Intercultural</td><td>OLO5 Value judgments / Sustainability</td><td>OLO6 Leadership</td></tr>
<tr><td>XX</td><td></td><td>X</td><td>XX</td><td>XX</td><td>XX</td></tr>
<tr><td>Justification for OLO contribution</td><td colspan="6"></td></tr>
</table>

COURSE DESCRIPTIONS/
KARTY PRZEDMIOTÓW

second-level studies/ studia II stopnia
main field of study/ kierunek studiów:
Mining and Geology/ Górnictwo I Geologia

specialisation/specjalność:
GEOMATICS FOR MINERAL RESOURCE MANAGEMENT

ścieżka studiów/study track: FREIBERG

1-st Semester

Semestr 1

Zał. nr 5 do ZW 8/2020
Załącznik nr … do programu studiów

WYDZIAŁ **Geoinżynierii, Górnictwa i Geologii**

KARTA PRZEDMIOTU

Nazwa przedmiotu w języku polskim Wspomagane komputerowo modelowanie geologiczne i geostatystyka. ….(zajęcia są prowadzone w języku angielskim)
Nazwa przedmiotu w języku angielskim Computer Aided Geological Modelling and Geostatistics……………………………………………….
Kierunek studiów (jeśli dotyczy): Górnictwo i geologia.
Specjalność (jeśli dotyczy): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Poziom i forma studiów: II stopień, stacjonarna
Rodzaj przedmiotu: obowiązkowy *
Kod przedmiotu W06GIG-SM0038
Grupa kursów NIE*

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	15		45		
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	30		120		
Forma zaliczenia	~~Egzamin /~~ zaliczenie na ocenę*	Egzamin / zaliczenie na ocenę*	~~Egzamin /~~ zaliczenie na ocenę*	Egzamin / zaliczenie na ocenę*	Egzamin / zaliczenie na ocenę*
Dla grupy kursów zaznaczyć kurs końcowy (X)					
Liczba punktów ECTS	**1**		4		
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)			4		
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego udziału nauczycieli lub innych osób prowadzących zajęcia (BU)	1		2		

*niepotrzebne skreślić

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I KOMPETENCJI SPOŁECZNYCH

1. Mathematical Statistics,
2. Fundamentals of Geology and Mineral Deposits

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CELE PRZEDMIOTU

C1 Developing basic skills in computer modelling of 3-D objects.
C2 Introduction of the principles of digital modelling of typical geological structures.
C3 Introduction to the methods of deposit parameters estimation and resources evaluation.

PRZEDMIOTOWE EFEKTY UCZENIA SIĘ

Z zakresu wiedzy:
PEU_W01 Estimation methods, principles of geostatistics, kriging estimators
PEU_W02 Geostatistical modelling of the selected deposit parameters (domain analysis, variogram modelling,
PEU_W03 Creating and validating 3-D models of various geological structures in the comprehensive dedicated software environment.

Z zakresu umiejętności:
PEU_U01 Application of relevant estimation methods for quality modelling of a deposit
PEU_U02 Evaluating 3-D objects against structural and quality block models (volumes, tonnages, grades)
PEU_U03 Describing the interpretation and applied approach, creating models, evaluation results, recommendations for possible enhancements

Z zakresu kompetencji społecznych:
PEK_K01 The student can think and act in a creative and enterprising way

TREŚCI PROGRAMOWE		
Forma zajęć - wykład		**Liczba godzin**
Wy1	Introduction to the course. Geological database and validation of the geological data.	2
Wy2	Geology of the seam.	2
Wy3	Structural model of the stratified deposit. Methods of the prediction of the surface layer parameters.	2
Wy4	Spatial distribution of samples values. Regionalized variable.	2
Wy5	BLUE Estimator of the mean value: Kriging.	2
Wy6	Quality model of the deposit – block model of the parameter layers. Estimation and evaluation of the block model.	2
Wy7	Reserves modelling and evaluation.	2
Wy8	Mineral resources. International reporting. The JORC Code	1
	Suma godzin	**15**

Forma zajęć - ćwiczenia		**Liczba godzin**
Ćw1		
Ćw2		
Ćw3		
Ćw4		
..		
	Suma godzin	0

Forma zajęć - laboratorium	**Liczba godzin**

La1	Determining the rules of work at the laboratory.	3
La2	Assignment of the individual dataset for the exercises and creating initial data files.	3
La3	Data validation and creating initial geological database.	3
La4	Construction of the structural wireframe model of stratigraphy layers.	3
La5	Construction of the block model of the deposit and overburden layers. Thickness and stripping ratio analysis.	3
La6	Data preparation to geostatistical analysis. Compositing of the samples.	3
La7	Domain analysis with the use of the statistical methods.	3
La8	Determination of the empirical variogram. Anisotropy analysis.	3
La9	Variogram modelling.	3
La10	Kriging Neighborhood Analysis - defining optimal parameters of the estimation procedure.	3
La11	Estimation of quality parameters in block model of the deposit layers. Validation of the estimation quality.	3
La12	Validation of the quality model and classification of the resources. Balance resources evaluation.	3
La13	Preparation of data for continuous surface mining ultimate pit design. Ultimate pit outlines generation	3
La14	Wireframe and block modelling of the ultimate pit	3
La15	Reserves evaluation, visualization and interrogation of created models	3
	Suma godzin	45

Forma zajęć - projekt		Liczba godzin
Pr1		
Pr2		
Pr3		
Pr4		
…		
	Suma godzin	0

Forma zajęć - seminarium		Liczba godzin
Se1		
Se2		
Se3		
…		
	Suma godzin	0

STOSOWANE NARZĘDZIA DYDAKTYCZNE
N1. Form of lectures - traditional, multimedia presentations using specialized software and demonstrations of its application "live", individual development of specialist topics covered during the lecture, N2. individual development of project tasks within the laboratories frames, individual development of electronic reports concerning project tasks within the laboratories frames, N3. evaluation of laboratory tasks reports with multipoint grade of student's work, group analysis of the results obtained during laboratory tasks; preparation of conclusions concerning data dependencies and constraints of mining projects, skill control tests, duty hours in laboratory.

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW UCZENIA SIĘ

Oceny (F – formująca (w trakcie semestru), P – podsumowująca (na koniec semestru)	Numer efektu uczenia się	Sposób oceny osiągnięcia efektu uczenia się
F1	PEU_W01, PEU_W02	Lecture grade on the basis of the written examination
F2	PEU_W03,	Laboratory task assessment: “structural modelling assessment
F3	PEU_U01	Laboratory task assessment: “geostatistical modelling”
F4	PEU_U02, PEU_U03	Laboratory task assessment: “reserves evaluation”.
P average of F1, F2, F3, F4		

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA

LITERATURA PODSTAWOWA:

[1] M. Armstrong, Basic Linear Geostatistics, Springer Verlag, 1998.
[2] P. Goovaerts: “Geostatistics for Natural Resource Evaluation“, Oxford University Press, 1997.
[3] R. H. Grishong, Jr., 3-D Structural Geology, Springer Verlag, 2008
[4] K. Hefferan, J. O’Brien, Earth materials, Willey-Blacwell, Chichester U.K., 2010
[5] W. Hustrulid, M. Kuchta, Open pit mine planning and design. Chapter 3. Orebody description, Taylor&Francis, 2013.
[6] A. G. Journel, and C.J. Huijbregts, Mining Geostatistics, Academic Press, 1978.
[7] Ch.C. Plummer, D.H. Carlson, L. Hammersley, Physical geology, McGraw-Hill I.E. N.Y. 2010
[8] D.R. Prothero, R.H. Dott Jr., Evolution of the Earth, McGraw-Hill I.E. N.Y., 2010
[9] M.W. Rossi, C.V. Deutsch, Mineral Resources Estimation, Springer Verlag 2014.

LITERATURA UZUPEŁNIAJĄCA:

[10] Handouts, tutorials.

OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)

Dr inż. Krzysztof Hołodnik
Dr inż. Witold Kawalec, Dr Paweł Zagożdżon

Zał. nr 5 do ZW 8/2020
Załącznik nr … do programu studiów

WYDZIAŁ GEOINŻYNIERII, GÓRNICTWA i GEOLOGII

KARTA PRZEDMIOTU

Nazwa przedmiotu w języku polskim Geofizyka inżynierska
….(zajęcia są prowadzone w języku angielskim)
Nazwa przedmiotu w języku angielskim Engineering Geophysics
Kierunek studiów (jeśli dotyczy): górnictwo i geologia
Specjalność (jeśli dotyczy): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Poziom i forma studiów: **~~I~~ / II stopień / ~~jednolite studia magisterskie~~*, stacjonarna / ~~niestacjonarna~~***
Rodzaj przedmiotu: **~~obowiązkowy~~ / wybieralny / ~~ogólnouczelniany~~ ***
Kod przedmiotu **W06GIG-SM0040**
Grupa kursów **~~TAK~~ / NIE***

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	15			15	
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	40			50	
Forma zaliczenia	~~Egzamin~~ / zaliczenie na ocenę*			~~Egzamin~~ / zaliczenie na ocenę*	
Dla grupy kursów zaznaczyć kurs końcowy (X)					
Liczba punktów ECTS	1			2	
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)				2	
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego udziału nauczycieli lub innych osób prowadzących zajęcia (BU)				2	

*niepotrzebne skreślić

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I KOMPETENCJI SPOŁECZNYCH

1. has knowledge of fundamentals of applied geophysics, physics and geology.
2. knows fundamentals of soil and rock mechanics.
3. is able to use MS Office software.
4. is able to work in a team.

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CELE PRZEDMIOTU

C1 familiarize with physical phenomena in geosphere of the Earth
C2 familiarize with engineering problems solved by means of geophysical surveying
C3 familiarize with various geophysical surveys.

C4 acquisition of skills to plan geophysical field surveying and to interpret its results. C5 development of skills to work in a group.

PRZEDMIOTOWE EFEKTY UCZENIA SIĘ Z zakresu wiedzy: PEU_W01 recognizes, names and explains engineering problems in different fields. PEU_W02 identifies, describes and chooses geophysical surveying methods. PEU_W03 analyses and assesses case studies from solving the engineering problems. Z zakresu umiejętności: PEU_U01 is able to coordinate team work, create field research plans and manage the work progress. PEU_U02 is able to independently create solutions for complex practical problems in engineering and geoengineering applying knowledge about geophysical surveying, mining geophysics, utilizing modern methods in geophysical data acquisition and interpretation. PEU_U03 is able to critically assess, process and interpreted results of the geophysical surveying and provide recommendations related to engineering problems in mining, civil engineering, engineering geology, municipal waste site, archeology, engineering properties of soil and rocks, hydrogeology, monitoring seepage in river dykes or dams. PEU_U04 is able to solve geophysical problems. PEU_U05 is able to conduct auto-didactical education related to detailed handling of typical software. Z zakresu kompetencji społecznych: PEU_K02 understands the need to create and transfer to the society – among others by mass media- information and opinions related to mining engineering achievements and other activities of mining engineer; tries to transfer the information in commonly understood way, presenting different points of view; is aware of the quality and need to shape the work safety culture in mining and the responsibility for the health and life of other employees.

TREŚCI PROGRAMOWE		
Forma zajęć - wykład		**Liczba godzin**
Wy1	Physical properties of rocks. Inter-relationships between the various subdisciplines of applied geophysics. Overview of geophysical methods, their physical principles and applications. Methodology of geophysical surveying.	1
Wy2	Engineering problems solved with geophysical surveying. Case studies.	2
Wy3	Electrical resistivity methods. Tomography and VSE. IP method. Physical principles. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
Wy4	Electromagnetic methods. FDEM and TDEM methods. Magnetotelluric methods. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Wy5	GPR surveying. Physical principles. Methods of field surveying.	2

	Equipment. Interpretation and application. Case studies.	
Wy6	Seismic tomography. Seismic interferometry. Physical principles. Applications. Case studies.	2
Wy7	Mine geophysics. Seismology. Seismic methods. Active and passive seismic tomography. Microgravimetry. Case studies.	2
Wy8	Gravity and magnetic surveying. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
	Suma godzin	**15**

Forma zajęć - projekt		**Liczba godzin**
Pr1	One selected geophysical technique. Fundamentals and equipment. Field surveying	4
Pr2	Processing and interpretation of field data.	3
Pr3	Solving the geophysical problems.	8
	Suma godzin	**15**

STOSOWANE NARZĘDZIA DYDAKTYCZNE
N1.Lecture aided by presentation. N2.Demonstration. N3.Discussion and consultations N3Calculations N5Practical field surveying

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW UCZENIA SIĘ

Oceny (F – formująca (w trakcie semestru), P – podsumowująca (na koniec semestru)	Numer efektu uczenia się	Sposób oceny osiągnięcia efektu uczenia się
P1	W01-W03	Test related to lecture content. Final grade.
F1	U01-U02, U05	Test. Project 1. Report on Project 1
F2	U03, U05	Test. Project 2. Report on Project 2
F3	U04, U05	Test. Solving geophysical problems
F1-F3, P2	U01-U05 K02	Grades are given for each of three project tasks including tests and reports. The final grade P2 for the project course is the weighted average grade of F1-F3.

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA

LITERATURA PODSTAWOWA:

[1] Aki, K., Richards P.G., 1980. Quantitative Seismology: Theory and Methods. W.H. Freeman Co.. San Francisco.
[2] Burger, H.R., Sheehan, A.F., Jones, C.H., 2006. Introduction to Applied Geophysics: Exploring the Shallow Subsurface. W.W. Norton & Company, Inc.
[3] Mendecki, A.J. (ed.), 1997. Seismic Monitoring in Mines. Chapman & Hall.
[4] Reynolds, J.M., 2011. An Introduction to Applied and Environmental Geophysics. Wiley – Blackwell. John Wiley & Sons.

[5] Sharma, Prem V., 2002. Environmental and engineering geophysics. Cambridge University Press.
[6] Torge, W., 1989. Gravimetry. Water de Gruyter. Berlin. New York.
[7] Selected Journal Publications (for example journals: Progress in Geophysics, Engineering Geophysics Journal, Environmental and Engineering Geophysics, Journal of Geophysics and Engineering, Pure and Applied Geophysics).

LITERATURA UZUPEŁNIAJĄCA:

[1] Lowrie, W., 2007. Fundamentals of Geophysics. Cambridge University Press.
[2] Milsom, J., 2003. Field Geophysics. John Wiley & Sons Ltd.
[3] Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990. Applied Geophysics. Cambridge University Press.

OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)

ANNA BARBARA GOGOLEWSKA, anna.gogolewska@pwr.edu.pl

Zał. nr 5 do ZW 8/2020
Załącznik nr … do programu studiów

WYDZIAŁ GEOINŻYNIERII, GÓRNICTWA I GEOLOGII

KARTA PRZEDMIOTU

Nazwa przedmiotu w języku polskim: Zintegrowana analiza deformacji w geomechanice…….(zajęcia są prowadzone w języku angielskim)
Nazwa przedmiotu w języku angielskim: Integrated Analysis of Deformations in Geomechanical Engineering
Kierunek studiów (jeśli dotyczy): górnictwo i geologia
Specjalność (jeśli dotyczy): Geomatics for Mineral Resources Management
Poziom i forma studiów: ~~I~~ / II stopień / ~~jednolite studia magisterskie~~*, stacjonarna / ~~niestacjonarna*~~
Rodzaj przedmiotu: ~~obowiązkowy~~ / wybieralny ~~/ ogólnouczelniany~~ *
Kod przedmiotu W06GIG-SM0041G
Grupa kursów ~~TAK~~ / NIE*

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	30		30		
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	90		60		
Forma zaliczenia	Egzamin / ~~zaliczenie na ocenę*~~		~~Egzamin~~ / zaliczenie na ocenę*		
Dla grupy kursów zaznaczyć kurs końcowy (X)					
Liczba punktów ECTS	5				
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)	3		2		
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego udziału nauczycieli lub innych osób prowadzących zajęcia (BU)	2,5		1,5		

*niepotrzebne skreślić

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I KOMPETENCJI SPOŁECZNYCH

1. Podstawowa wiedza z zakresu goemechaniki
2. Podstawową wiedza dotycząca eksploatacji górniczej
3. Podstawowa wiedza monitorowania zmian górotworu

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CELE PRZEDMIOTU

C1 Przedstawienie roli monitorowania w górnictwie zrównoważonym
C2 Przygotowanie i przeprowadzenie analizy deformacji górotworu spowodowanych działalnością górniczą

C3 Przygotowanie i przeprowadzenie analizy deformacji zapór i usypisk ziemnych
C4 Nauczenie zasad modelowania MES
C5 Nabycie umiejętności wykorzystania analizy zintegrowanej wykorzystując modelowanie deterministyczne MES i wyniki pomiarów geodezyjnych i geotechnicznych

PRZEDMIOTOWE EFEKTY UCZENIA SIĘ

Z zakresu wiedzy:

PEU_W01 Potrafi rozróżnić i opisać zastosowania technik monitorowania deformacji w sPEUtrum dyscyplin inżynieryjnych takich jak górnictwo i inżynieria budowlana

PEU_W02 Potrafi scharakteryzować górotwór i metody górnicze

PEU_W03 . Posiada wiedzę z zakresu analiz: empirycznych i deterministycznych z zastosowaniem FEM deformacji górotworu,

PEU_W04 . Posiada wiedzę podstaw i zastosowań analizy zintegrowanej metody deterministycznej z wynikami pomiarów geodezyjnych

PEU_W05 . Potrafi wyznaczyć główne założenia pomiaru geodezyjnego deformacji wywołanych eksploatacja górniczą

PEU_W06 Ma znajomość przygotowania modelu MES

Z zakresu umiejętności:

Z zakresu kompetencji społecznych:

PEU_K01 Potrafi ocenić rolę monitorowania i predykcji w górnictwie zrównoważonym w całym jego cyklu

TREŚCI PROGRAMOWE		
Forma zajęć - wykład		**Liczba godzin**
Wy1	Syllabus, warunki zaliczenia, literatura,	2
Wy2	Wstęp do zintegrowanej analizy deformacji	2
Wy3	Rola monitorowania w górnictwie zrównoważonym	2
Wy4	Opis zjawisk fizycznych: statyka- dynamika , rozchodzenie się ciepła, przepływ cieczy, zmiany siły grawitacji, zastosowania	2
Wy5	Metody analizy deformacji: stosując analizę systemów i mechaniki ciała stałego	2
Wy6	Ogólna klasyfikacja metod monitorowania: absolutne i względne pomiary deformacji,	**2**
Wy7	zalety i wady metod geodezyjnych i geotechniczno-strukturalnych, koncepcja pomiarów zintegrowanych	**2**

Wy8	Mechanika ciała stałego, Problem warunków brzegowych	**2**
Wy9	Rozwiązanie systemu kratownicy - relacja do MES MES	**2**
Wy10	Empiryczne metody wyznaczania deformacji powierzchni wywołanych eksploatacją podziemną (gaz i nafta) i eksploatacją odkrywkową, zastosowanie MES, Kategoria terenu	**2**
Wy11	Przykłady zastosowania integracji : stabilności zboczy w kopalniach odkrywkowych, Chiquqimata, Chile, NevadaUSA	**2**
Wy12	Przykłady zastosowania integracji : deformacja górotworu na terenach podziemnej eksploatacji górniczej w kopalni soli w Kanadzie,	**2**
Wy13	Problemy wydobycia gazu naturalnego i nafty	**2**
Wy14	Podsumowanie	**2**
Wy15	Kolokwium	**2**
	Suma godzin	**30**

Forma zajęć - ćwiczenia		Liczba godzin
Ćw1		
Ćw2		
Ćw3		
Ćw4		
..		
	Suma godzin	

Forma zajęć - laboratorium		Liczba godzin
La1	Przedstawienie zakresu ćwiczeń, warunków zaliczenia oraz literatury.	2
La2	Analiza wpływu obciążenia na górotwór –zastosowanie programu GeoStudio 2007	2
La3	Analiza naprężeń in-situ górotworu i górotworu obciążonego	2
La4	Zaprojektowanie pomiaru geodezyjnego na terenie górniczym prowadzenia podziemnej eksploatacji na podstawie wyników MES. Dyskusja projektu pomiarów.	2
La5	Wyznaczenie kategorii terenu górniczego Dyskusja wyników projektu	2
La6	Zaprojektowanie pomiaru geodezyjnego na terenie kopalni odkrywkowej na podstawie modelu MES . Dyskusja projektu pomiarów.	2
La7	Zaprojektowanie pomiaru geodezyjnego ziemnej zapory wodnej na podstawie modelu MES. Dyskusja analizy	2
La8	Podsumowanie	1
	Suma godzin	15

Forma zajęć - projekt		Liczba godzin
Pr1	Wyznaczenie MES deformacji górotworu spowodowanych eksploatacją podziemną, wyznaczenie kategorii terenu. Analiza sprężysta i nieliniowa . Omowienie monitorowania	6
Pr2	Podsumowanie	1
Pr3	Wyznaczenie MES deformacji usypiska/zapory ziemnej w warunkach zmiennego poziomu wody. Wyznaczenie wspolczynnika bezpieczeństwa stosując oprogramowanie Geostudio. Omowienie monitorowania	6
Pr4	Podsumowanie	2
…		
	Suma godzin	**15**

Forma zajęć - seminarium		Liczba godzin
Se1		
Se2		
Se3		
…		
	Suma godzin	

STOSOWANE NARZĘDZIA DYDAKTYCZNE
N1. Wykład, film N2. N3.

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW UCZENIA SIĘ

Oceny (F – formująca (w trakcie semestru), P – podsumowująca (na koniec semestru)	Numer efektu uczenia się	Sposób oceny osiągnięcia efektu uczenia się
F1	PEK_U01 – PEK_U06	Oceny z Lab 2-7, projekt 1 i 2.
F2		
F3		
P P PEU_W01 – PEU_W06, Kolokwium , Ocena końcowa z wykładu PEU_U01 – PEU_U06 Ocena końcowa z laboratorium . Średnia ze sprawozdań i projektu		

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA
<u>LITERATURA PODSTAWOWA:</u> [1] Szostak-Chrzanowski, A., A. Chrzanowski,(2010), „INTEGETED ANALYSIS OF DEFORMATIONS IN GEOMECHANICS “, UNB, Fredericton, N.B., 220p. **<u>LITERATURA UZUPEŁNIAJĄCA:</u>** 1 Szostak-Chrzanowski, A., A. Chrzanowski, M. Massiera (2005) “Use of deformation monit results in solving geomechanical problems – case studies “, *Engineering Geology,* vol. 7 Issues 1-2, pp. 3-12. 2 Chrzanowski,A. (1993):"Modern Surveying Techniques for Mining and Civil Engineering 33 in: *Comprehensive Rock Engineering,* Pergamon Press,Vol.3.Chapter 33, pp.773-809.
OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)
Anna Chrzanowska anna.chrzanowska@pwr.edu.pl

Zał. nr 5 do ZW 8/2020
Załącznik nr … do programu studiów

WYDZIAŁ **Geoinżynierii, Górnictwa i Geologii**

KARTA PRZEDMIOTU

Nazwa przedmiotu w języku polskim Bezpieczeństwo i higiena pracy ….(zajęcia są prowadzone w języku angielskim)
Nazwa przedmiotu w języku angielskim Occupational Health and Safety
Kierunek studiów (jeśli dotyczy): Górnictwo i geologia.
Specjalność (jeśli dotyczy): Mining Engineering
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Poziom i forma studiów: II stopień, stacjonarna
Rodzaj przedmiotu: obowiązkowy *
Kod przedmiotu W06GIG-SM0042
Grupa kursów NIE*

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	15			15	
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	30			30	
Forma zaliczenia	~~Egzamin /~~ zaliczenie na ocenę*	Egzamin / zaliczenie na ocenę*	Egzamin / zaliczenie na ocenę*	~~Egzamin~~ / zaliczenie na ocenę*	Egzamin / zaliczenie na ocenę*
Dla grupy kursów zaznaczyć kurs końcowy (X)					
Liczba punktów ECTS	**1**			1	
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)				1	
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego udziału nauczycieli lub innych osób prowadzących zajęcia (BU)	1			1	

*niepotrzebne skreślić

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I KOMPETENCJI SPOŁECZNYCH

1. Possesses basic knowledge of technologies used in open-pit mines and underground mines.
2. Is able to use Microsoft Office environment to prepare documents in Word, multimedia presentations in Power Point and work with Excel spreadsheets.
3. Is able to identify harmful, dangerous and nuisance factors in the workplace environment.

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CELE PRZEDMIOTU

C1. To introduce the principles of occupational risk assessment in accordance with relevant

standards C2 To present the principles of occupational risk assessment and the determination of admissibility with the use of STER software and the RISC SCORE method.

PRZEDMIOTOWE EFEKTY UCZENIA SIĘ
Z zakresu wiedzy: PEU_W01 Possesses general knowledge of rules of occupational risk assessment formulation PEU_W02 – Possesses knowledge of evaluating and determining the admissibility of occupational risk. PEU _W0 3 – Possesses general knowledge of corrective and preventive actions regarding hazards of typical work posts in the mining industry.… Z zakresu umiejętności: PEU_U01 Is able to identify hazards of harmful, dangerous and nuisance factors of typical work posts in the mining industry PEU_U02 Is able to estimate and determine risk acceptability with methods according to STER software and the RISC SCORE method. PEU_U03 - Is able to plan corrective and preventive actions for hazards of typical work posts in the mining industry.… Z zakresu kompetencji społecznych: PEU_K01 - Is able to work in a team and together complete occupational risk assessment and develop its results and the required documentation in the form of a team report

TREŚCI PROGRAMOWE		
Forma zajęć - wykład		**Liczba godzin**
Wy1	Definition of occupational risk. Legal basics of occupational risk assessment. Risk assessment methods. Course of occupational risk assessment. Information necessary for occupational risk assessment. Identification of harmful, dangerous and nuisance factors in the work environment.	3
Wy2	Estimation of occupational risk assessment and determination of admissibility. Corrective and preventive actions. Familiarising employees with the results of occupational risk assessment. Implementation of agreed corrective and preventive actions. Monitoring the effectiveness of implemented actions. Periodic occupational risk assessment. Harmful factors – identification and assessment of risks.	3
Wy3	Dangerous factors - identification and assessment of risks.	3
Wy4	Nuisance factors in occupational risk assessment: psychological burden, static burden, monotype.	3
Wy 5	Methods of occupational risk assessment: STER software, the RISC SCORE method, written test	3
	Suma godzin	**15**

Forma zajęć - ćwiczenia		**Liczba godzin**
Ćw1		
Ćw2		
Ćw3		

Ćw4		
..		
	Suma godzin	

Forma zajęć - laboratorium		Liczba godzin
La1		
La2		
La3		
La4		
La5		
…		
	Suma godzin	

Forma zajęć - projekt		Liczba godzin
Pr1	Occupational risk assessment with the use of STER software for two work posts – description of work post, identification of hazards. Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of harmful factors (dust, noise)	3
Pr2	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of harmful factors (vibration, chemical agents)	3
Pr3	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of dangerous factors (slippery or uneven surfaces, falling elements, moving parts, moving machinery and transported bimi items)	3
Pr4	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility for nuisance factors (psychological burden, static burden, monotype)	3
Pr 5	Occupational risk assessment for a selected work post with the use of the RISC SCORE method, presentation of executed exercises, test	3
	Suma godzin	**15**

Forma zajęć - seminarium		Liczba godzin
Se1		
Se2		
Se3		
…		
	Suma godzin	

STOSOWANE NARZĘDZIA DYDAKTYCZNE
N1. Informative lecture with elements of problematic lectures. N2 Multimedia presentations. N3 Didactic discussions during lectures. N4 Didactic discussions during laboratory classes. N5Computer presentation of executed occupational risk assessments. N6Consultation.

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW UCZENIA SIĘ

Oceny (F – formująca (w trakcie semestru), P – podsumowująca (na koniec semestru)	Numer efektu uczenia się	Sposób oceny osiągnięcia efektu uczenia się
F1	PEU_W01-W03	grade from a test
F2	PEU_W01-W03 PEU_U01- U03	grade from a presentation
P2	PEU_W01-W03 PEU_U01- U03	final grade from project classes (arithmetic average of F1 and F2)
P		

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA

LITERATURA PODSTAWOWA:

[1] Iwona Romanowska Słomka, Adam Słomka Zarządzanie ryzykiem zawodowym. Wydawnictwo TARBONUS, Krakow Tarnobrzeg, 2009

[2] Iwona Romanowska Słomka, Adam Słomka Ocena ryzyka zawodowego. Wydawnictwo TARBONUS, Krakow Tarnobrzeg, 2010

[3] Wiesława Horst Ryzyko zawodowe na stanowisku pracy. Część 1, Ergonomiczne czynniki ryzyka. Wydawnictwo Politechniki Poznańskiej, Poznan, 2004

LITERATURA UZUPEŁNIAJĄCA:

[1] PN-N-18002 Systemy zarządzania bezpieczeństwem i higieną pracy - Ogólne wytyczne do oceny ryzyka zawodowego

[2]

OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)

Dr inż. Żaklina Konopacka

Zał. nr 5 do ZW 8/2020
Załącznik nr … do programu studiów

WYDZIAŁ **Geoinżynierii, Górnictwa i Geologii**

KARTA PRZEDMIOTU

Nazwa przedmiotu w języku angielskim: Project Management, Appraisal and Risk Evaluation ….(zajęcia są prowadzone w języku angielskim)

Nazwa przedmiotu w języku polskim :Zarządzanie projektami, ocena ich opłacalności i ryzyka.
Kierunek studiów (jeśli dotyczy): Górnictwo i geologia
Specjalność (jeśli dotyczy): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Poziom i forma studiów: II stopień , stacjonarna
Rodzaj przedmiotu: obowiązkowy
Kod przedmiotu W06GIG-SM0039G
Grupa kursów TAK

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	15		30	15	
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	30		60	30	
Forma zaliczenia	Egzamin				
Dla grupy kursów zaznaczyć kurs końcowy (X)	X				
Liczba punktów ECTS	4				
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)	3				
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego udziału nauczycieli lub innych osób prowadzących zajęcia (BU)	3				

*niepotrzebne skreślić

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I KOMPETENCJI SPOŁECZNYCH

1. Knowledge of basic mathematical analysis, probability and statistical models
2. Skills in using Excel spreadsheets
3. Understanding of the need of lifelong learning and the importance of application of Economics, Management and Social Sciences in engineering.

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CELE PRZEDMIOTU

The course combines two groups of topics: basics of mineral economics and financial management and introduction to project management.
Part A: The purpose of the course is

C1 to introduce basic concepts of Microeconomics and financial management
C2 to introduce the concept of time value of money and present the methods used to evaluate investment projects. Different techniques are illustrated by examples and case studies. The range of application as well as the advantages and disadvantages of each method are discussed. The issues of inflation and risk analysis are included.

Part B:
C3 Introduction to project management basic concepts, methods and tools.
C4 Presentation of given project management areas: Project scope management, Project time management, Project cost management, Project risk management. Project planning, scheduling and control using Microsoft Project.
C5 Presentation of the issues of effective communication in project teams, group behaviour and leadership.

PRZEDMIOTOWE EFEKTY UCZENIA SIĘ

Z zakresu wiedzy:

PEU_W01 rozumie pojęcia podaży i popytu, elastyczności popytu i ich wpływ na rynki
PEU_W02 zna pojęcia kosztów w ekonomii i rachunkowości, rozumie różnice
PEU_W03 zna sposoby klasyfikacji kosztów w przedsiębiorstwach, zna i rozumie podstawowe pojęcia rachunku kosztów
PEU_W04 ma podstawową wiedzę o treści i wzajemnych relacjach bilansu, rachunku zysków i strat oraz rachunku przepływów pieniężnych, zna sposób prezentacji danych finansowych przedsiębiorstw w ustawowych sprawozdaniach finansowych i zna ich warianty.
PEU_W05 ma podstawową wiedzę na temat metody analizy wskaźnikowej sprawozdań finansowych
PEU_W06 zna pojęcia wartości przyszłej i wartości obecnej przepływów pieniężnych i rent rocznych
PEU_W07 zna podstawowe i zaawansowane metody oceny efektywności inwestycji (NPV, IRR, MIRR, DPBP, PBP) oraz zakresy ich stosowania
PEU_W08 ma podstawową wiedzę o metodach oceny ryzyka inwestycji

Z zakresu umiejętności:

PEU_U01 potrafi przeprowadzić analizę przyczyn i skutków zmiany popytu i podaży
PEU_U02 na podstawie krzywych kosztowych potrafi przeprowadzić optymalizację wielkości produkcji w różnych przypadkach.
PEU_U03 umie zinterpretować i korzystać z informacji zawartych w ustawowych sprawozdaniach finansowych. Umie przeprowadzić analizę wskaźnikową sprawozdań finansowych w podstawowym zakresie
PEU_U03 umie korzystać z danych kosztowych przedstawionych w różnych układach ewidencyjnych kosztów, umie stosować podstawowe metody rachunkowości zarządczej do podejmowania decyzji krótkoterminowych
PEU_U04 potrafi obliczyć wartość przyszłą i obecną pieniądza dla szeregu płatności oraz rozwiązać zadania rachunkowe z zakresu wartości pieniądza w czasie
PEU_U05 potrafi przeprowadzić ocenę opłacalności inwestycji poznanymi metodami
PEU_U06 potrafi przeprowadzić analizę wrażliwości i analizę scenariuszy z wykorzystaniem modelu finansowego inwestycji
PEU_U07 potrafi przygotować dokumentację projektową w podstawowym zakresie i

zainicjować projekt PEU_U08 potrafi zastosować podstawowe metody zarządzania projektami, monitorowania i zarządzania ryzykiem projektu PEU_U09 potrafi zastosować podstawowe metody zarządzania konfliktami w grupie PEU_U10 potrafi zastosować podstawowe metody zarządzania grupą i kreowania pozycji lidera, potrafi ocenić skuteczność zarządzania grupą <u>Z zakresu kompetencji społecznych:</u> PEU_K01 potrafi myśleć i działać w sposób systemowy, kreatywny i przedsiębiorczy PEU_K02 ma utrwaloną postawę ekonomicznego działania i podejmowania decyzji w oparciu o dostępne informacje finansowe i prognozy

TREŚCI PROGRAMOWE		
Forma zajęć - wykład		**Liczba godzin**
Wy1	Supply and demand, equilibrium price, changes in demand and supply. Stock and commodity markets used by mineral industries	2
Wy2	Costs in economics and in accounting. Cost and money outflow. Relevant cost, incremental cost, marginal cost, alternative cost. Short-term decision making.	2
Wy3	Costs as the subject of cost accounting, different systems of cost accounting Different methods of cost data presentation (by types, divided into direct and indirect costs). Cost allocation	2
Wy4	Variable and fixed costs. Break even point. Cost-volume –profit analysis.	1
Wy5	Basics of financial accounting. Income statement and cash flow statement. Balance sheet. Working capital. Examples of financial statements of mining companies	2
Wy6	Financial ratio analysis. Liquidity, profitability, activity and debt ratios. Financial and operating leverage.	2
Wy7	The concept of time value of money. Computation of future and present value of money by means of spreadsheet functions. Basics of capital budgeting. Evaluation of different methods.	2
Wy8	The concept of risk and return. Quantification of risk. Risk analysis in project evaluation: sensitivity analysis, scenario analysis, other methods.	2
	Suma godzin	15

Forma zajęć - projekt		**Liczba godzin**
Pr 1	Issues of understanding communication: Definitions Models (Schramm model, Berlo's SMCR (source, message, channel, receiver) model, McCroskey model, Reusch and Bateson model, Westley-MacLean model)	3
Pr 2	Conflict Sources of conflicts Kilmann and Thomas classification of conflict Kilmann and Thomas test Different styles of conflict solving Roles of conflict in group development.	3
Pr3	Team roles	3

	Team roles Belbin perspective Discussion group roles Effective managerial behaviour in the context of team roles	
Pr4	Leadership Hersey and Blanchard theory Black and Mouton approach to leadership Fiedler theory and his Least Preferred Coworker Scale Situational leadership self-assessment	3
Pr5	Summary; Effective managerial behaviour from the different contexts.	3
	Suma godzin	15

Forma zajęć - laboratorium		Liczba godzin
Part A		
La1	Supply and Demand curves. Elasticity of demand.	2
La2	Economic costs. Cost curves. Profit maximization cases.	2
La3	Managerial cost accounting. Decision making cases.	2
La4	Basic financial accounting. Creation of simple Balance Sheet, Profit and Loss Statement and Cash Flow Statement	2
La5	Ratio analysis based on financial statements of companies	2
La6	Time value of money and capital budgeting – calculation by means of Excel functions	2
La7	Financial model of an investment. Sensitivity and Scenario analysis.	3
Part B		
La8	Basic concepts (process, project, project management, management by projects, critical factors for project success, competences). Preparing and initiation of the project. Project analysis (project environment, stakeholders, project objectives).	3
La9	Planning and estimating of the project. Project phases and life cycle	3
La10	Project organization. Project scope management. Planning of activities, resources and costs.	3
La11	Project risk management. Project monitoring. Project management methodologies.	3
La12	Quality management. Change control. Project closing.	3
	Suma godzin	**30**

STOSOWANE NARZĘDZIA DYDAKTYCZNE

N1. Wykład interaktywny z pokazem slajdów i dyskusją
N2. Ćwiczenia laboratoryjne: indywidualne rozwiązywanie zadań z wykorzystaniem arkusza kalkulacyjnego.
N3. Ćwiczenialaboratoryjne: rozwiązywanie zadań w grupach. Prezentacja wyników. Dyskusja o otrzymanych wynikach
N4. Konsultacje
N5. Praca własna – rozwiązywanie zadań domowych
N6. Praca własna – samodzielne studia literaturowe

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW UCZENIA SIĘ

Oceny (F – formująca (w trakcie semestru), P	Numer efektu uczenia się	Sposób oceny osiągnięcia efektu uczenia się

– podsumowująca (na koniec semestru)		
F1	PEU_W01-W08 PEU_K01-K02	Dyskusja na zajęciach, ocena aktywności studentów na zajęciach laboratoryjnych i projektowych
F2	PEU_U01-U10 PEU_K01-K02	Ocena rozwiązań zadań uzyskanych przez studentów w trakcie zajęć laboratoryjnych i projektowych
P1	PEU_W01-W08 PEU_U01-U10 PEU_K01-K02	Egzamin pisemny
P2	PEU_W01-W08 PEU_U01-U10 PEU_K01-K02	Ocena indywidualnych rozwiązań zadań nadesłanych przez studentów po zajęciach

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA

LITERATURA PODSTAWOWA:

1. Erhardt M., Brigham E.: Financial Management Theory and Practice. South-Western Cengage Learning, USA
2. Brigham E.: Podstawy zarządzania finansami. Polskie Wydawnictwo Ekonomiczne, Warszawa 1997
3. Czekaj J., Dresler Z.: Podstawy zarządzania finansami firm. PWN Warszawa 1996
4. Jaruga A., Sobańska J., Kopczyńska L. Szychta A.: *Rachunkowość dla menedżerów*. Towarzystwo Gospodarcze RAFIB, Łódź 1996.
5. Jonson H.: Ocena projektów inwestycyjnych. Maksymalizacja wartości przedsiębiorstwa. Wyd. K.E. Liber, Warszawa 2000.
6. Nowak E.: Rachunek kosztów przedsiębiorstwa. Wydawnictwo Ekspert, Wrocław 2001
7. Sierpińska M., Jachna T.: Ocena przedsiębiorstwa według standardów światowych, PWN Warszawa 1994.
8. Świderska G. K.(red): Rachunkowość zarządcza. (praca zbiorowa) Wyd. Poltext, Warszawa 1997
9. Wysocki Robert K., McGary R., Efektywne zarządzanie projektami, OnePress, 2005
10. Lock Dennis, Podstawy zarządzania projektami, PWE, 2009

LITERATURA UZUPEŁNIAJĄCA:

1. Jajuga K., Jajuga T., 2006. Inwestycje. Instrumenty finansowe, aktywa niefinansowe, ryzyko finansowe, inżynieria finansowe, Wydawnictwo Naukowe PWN, Warszawa.
2. Jonson H.: Koszt kapitału. Klucz do wartości firmy. Wyd. K.E. Liber, Warszawa 2000
3. Turyna J., Pułaska-Turyna B.: Rachunek kosztów i wyników. Wyd. Finans-Servis, Warszawa 1997.
4. A Guide to Project Management Body of Knowledge (PMBOK®Guide Fourth Edition), Project Management Institute, 2008 (2004). wydanie polskie, MT&DC Warszawa, 2009 (2006)

OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)

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Zał. nr 5 do ZW 8/2020
Załącznik nr … do programu studiów

WYDZIAŁ GEOINZYNIERII, GÓRNICTWA I GEOLOGII

KARTA PRZEDMIOTU

Nazwa przedmiotu w języku polskim ***Zasady i zastosowania InSAR oraz GIS w górnictwie***
Nazwa przedmiotu w języku angielskim ***Principles and Application of InSAR and GIS in mining***
Kierunek studiów (jeśli dotyczy): Górnictwo i geologia
Specjalność (jeśli dotyczy): ***Geomatics for Mineral Resources Management (Geomatyka w zarządzaniu surowcami mineralnymi)***
Poziom i forma studiów: ~~I~~ / II stopień / ~~jednolite studia magisterskie~~*, stacjonarna / ~~niestacjonarna~~*
Rodzaj przedmiotu: obowiązkowy / ~~wybieralny~~ / ~~ogólnouczelniany~~ *
Kod przedmiotu W06GIG-SM0037
Grupa kursów ~~TAK~~ / NIE*

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	30		45		
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	60		90		
Forma zaliczenia	Egzamin / ~~zaliczenie na ocenę*~~		~~Egzamin~~ / zaliczenie na ocenę*		
Dla grupy kursów zaznaczyć kurs końcowy (X)					
Liczba punktów ECTS	2		3		
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)			3		
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego udziału nauczycieli lub innych osób prowadzących zajęcia (BU)	2		2		

*niepotrzebne skreślić

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I KOMPETENCJI SPOŁECZNYCH

1. Zna podstawy programowania w językach: C++ oraz Python.
2. Ma podstawową wiedzę z zakresu roli narzędzi geoinformacyjnych (GIS) oraz z zakresu technik pozyskiwania danych przestrzennych.
3. Potrafi posługiwać się pakietem oprogramowania GIS
4. Ma podstawową wiedzę z zakresu baz danych

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CELE PRZEDMIOTU

C1 Przedstawienie wiadomości z zakresu satelitarnej interferometrii radarowej, a także możliwości wykorzystania jej w pomiarach deformacji terenu.
C2 Nabycie umiejętności wyznaczania przemieszczeń powierzchni terenu w oparciu o satelitarne dane radarowe.

C3	Przedstawienie wiadomości dotyczących stosowania GIS w zaawansowanej analizie obiektów, zjawisk i procesów zachodzących w przestrzeni
C4	Nabycie umiejętności formułowania i rozwiązywania zadań z zastosowaniem funkcji analitycznych GIS
C4	Nabycie umiejętności korzystania z danych i usług danych przestrzennych zgodnie z dyrektywą INSPIRE

PRZEDMIOTOWE EFEKTY UCZENIA SIĘ

Z zakresu wiedzy:

PEU_W01 Posiada poszerzoną wiedzę w zakresie wykorzystywania systemów geoinformacyjnych do gromadzenia i przetwarzania danych wykorzystywanych w modelowaniu zjawisk i procesów zarówno naturalnych jak i antropogenicznych

PEU_W02 Zna zasady budowy i funkcjonowania systemów geoinformacyjnych w branży górniczej i administracji publicznej

Z zakresu umiejętności:

PEU_U01 Potrafi korzystać z zaawansowanych narzędzi GIS w górnictwie, badaniach zjawisk przyrodniczych, oddziaływaniu górnictwa na otoczenie i zagospodarowaniu przestrzeni,

PEU_U02 Potrafi formułować i rozwiązywać zadania przestrzenne w środowisku GIS

PEU_U03 Potrafi interpretować otrzymane wyniki oraz wyciągać wnioski

Z zakresu kompetencji społecznych:

PEU_K01 Potrafi formułować i przekazać wiedzę na temat wykorzystania systemów geoinformacyjnych w analizach przestrzennych i prezentacji ich wyników

TREŚCI PROGRAMOWE

Forma zajęć - wykład		Liczba godzin
Wy1	Omówienie syllabusu, warunków zaliczenia, literatury	2
Wy2	Wprowadzenie do teorii sygnałów mikrofalowych do obserwacji Ziemi	2
Wy3	Wykorzystanie pasywnej i aktywnej teledetekcji satelitarnej do wyznaczania przemieszczeń powierzchni terenu	2
Wy4	Akwizycja i przetwarzanie danych SAR	2
Wy5	Teoria obrazów SAR (geometryczne właściwości, polaryzacja)	2
Wy6	Podstawy obliczeń danych SAR metodami: DinSAR oraz SBAS	2
Wy7	Wykorzystanie danych SAR w monitorowaniu aktwyności powierzchni terenu (czynniki naturalne i antropogeniczne)	2
Wy8	Usystematyzowanie podstawowych pojęć z zakresu systemów informacji geograficznej	2
Wy9	Modelowanie danych w GIS. Reprezentacja danych przestrzennych. Bazy danych przestrzennych. Stan obecny i trendy rozwojowe	2
Wy10	Metody analiz przestrzennych w GIS	2
Wy11	Interpolacja danych przestrzennych	2
Wy12	Algebra mapy. Analizy powierzchni, funkcje lokalne, funkcje strefowe	2
Wy13	Podstawy statystyki przestrzennej	2
Wy14	Infrastruktury Informacji Przestrzennej. Dyrektywa Inspire. Open data	2
Wy15	Przykłady zastosowań systemów geoinformacyjnych w górnictwie i ochronie środowiska	2
	Suma godzin	**15**

Forma zajęć - laboratorium		Liczba godzin
La1	Konfiguracja środowiska do obliczeń SAR	3
La2	Wprowadzenie do obliczeń danych radarowych – zadania obliczeniowe	6
La3	Pozyskanie danych radarowych oraz obliczenia interferogramu – metoda DInSAR	3
La4	Rozwiniecie fazy interferometrycznej – obliczenia	3
La5	Prezentacja wyników obliczeń danych SAR w środowisku GMT	6
La6	Interpolacja danych dyskretnych. Przygotowanie danych wejściowych do analizy (np. pomiar przemieszczeń powierzchni terenu górniczego)	3
La7	Interpolacja danych dyskretnych. Opracowanie map rozkładu przestrzennego przemieszczeń różnymi metodami interpolacji.	3
La8	Interpolacja danych dyskretnych. Analiza i ocena jakości interpolacji. Mapa prognozy. Opracowanie map zmian zanieczyszczenia pomiędzy dwoma okresami z zastosowaniem kalkulatora rastrowego.	3
La9	Analizy przestrzenne – ocena przydatności terenu pod lokalizację wybranej inwestycji górniczej. Budowa bazy danych przestrzennych kryteriów lokalizacji	3
La10	Analizy przestrzenne – ocena przydatności terenu pod lokalizację Inwestycji górniczej. Wybór procedur i przeprowadzenie operacji analitycznych.	3
La11	Analizy przestrzenne – ocena przydatności terenu pod lokalizację inwestycji górniczej. Opracowanie modelu przetwarzania danych przestrzennych.	3
La12	Analizy przestrzenne – ocena przydatności terenu pod lokalizację inwestycji górniczej. Analiza i interpretacja wyników. Prezentacja graficzna i statystyczna wyników. Geowizualizacja	3
La13	GIS mobilny. Pozyskiwanie danych przestrzennych i atrybutowych w terenie.	3
	Suma godzin	**45**

STOSOWANE NARZĘDZIA DYDAKTYCZNE

N1. Wykład z elementami wykładu problemowego
N2. Prezentacje multimedialne
N3. Wykonanie indywidualnej pisemnej pracy semestralnej na zadany temat
N4. Materiały multimedialne (MOOC)
N5. Instrukcje laboratoryjne
N6. Wykonanie zadań laboratoryjnych i przygotowanie sprawozdań
N7. Konsultacje

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW UCZENIA SIĘ

Oceny (F – formująca (w trakcie semestru), P – podsumowująca (na koniec semestru)	Numer efektu uczenia się	Sposób oceny osiągnięcia efektu uczenia się
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F1 Ocena końcowa z egzaminu w formie pisemnej, F2 Ocena z pisemnej pracy semestralnej, P Ocena końcowa z wykładu (średnia ważona z F1 – 80% oraz F2 - 20%)
F, P	PEU_W01 – 02 PEU_U01 – 03	F3 Ocena z wykonanych zadań i sprawozdań Pisemnych,

	PEU_K01	F4 Ocena ze sprawdzianów pisemnych, P2 Ocena końcowa z laboratorium (średnia ważona z F3 – 80% oraz F4 - 20%)

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA

LITERATURA PODSTAWOWA:

[1] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. 2015: Geographic Information Science and Systems, 4th Edition, John Wiley & Sons;

[2] Maguire D., Batty M., Goodchild M., 2005. GIS Spatial Analysis and Modelling. ESRI Press

[3] Berry J., 2007-2013. Beyond Mapping IV — GIS Modelling

[4] Satellite InSAR Data: Reservoir Monitoring from Space, A. Ferretti, EAGE; 1st edition, 2014

[5] GMTSAR: An InSAR Processing System Based on Generic Mapping Tools (Second Edition), D. Sandwell i in., Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, 2016

[6] InSAR Principles - Guidelines for SAR Interferometry Processing and Interpretation, ESA Publications, 2008

LITERATURA UZUPEŁNIAJĄCA:

[1] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

[2] Kennedy M., 2009: Introducing Geographic Information Systems with ArcGIS: A Workbook Approach to Learning GIS, Second Edition, John Wiley and Sons;

[3] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. W., 2006. GIS. Teoria i praktyka. Wydawnictwo Naukowe PWN, Warszawa

[4] Urbański J., 2010. GIS w badaniach przyrodniczych, Wydawnictwo Uniwersytetu Gdańskiego

[5] Dokumentacja środowiska GMT (Generic Mapping Tools) - http://gmt.soest.hawaii.edu/projects/gmt/wiki/Documentation

OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)

Wojciech Milczarek, wojciech.milczarek@pwr.edu.pl

Jan Blachowski, jan.blachowski@pwr.edu.pl

Semestr 2

TU Bergakademie Freiberg

Data:	MGEOFER.MA.Nr.2013	Stand: 31.10.2017	Start: WiSe 2019
Module name:	Applied Remote Sensing in Geosciences		
Course coordinator:	Prof. Dr.-Ing. Jörg Benndorf		
Instructors:	John, Andre / Dr.-Ing.		
Department:	Department of Mine Surveying and Geodesy		
Duration:	1 Semester		
Study goals	After successful completion of the course students will be able to apply methods of remote sensing in the context of analysis of spatio-temporal processes in geosciences. This includes in particular, - the ability to choose suitable sensor technology based on knowledge about available sensors and related physical principles - processing of remote sensing data using typical software - application of multi-variate statistical methods to infer relevant information from sensor data, relevant to specific case studies - application of spatial modelling techniques for prediction of attributes at not samples location or times. - integration of before mentioned aspects in an efficient work flow.		
Content:	This module covers the introduction to and working on selected applications of remote sensing in geosciences by the means of selected case studies. Topics covered include - review of theoretical foundation of remote sensing - data acquisition techniques (terestrial , airborne, spaceborne) - spatio-temporal analysis of data - Geoscientific background related to the case studies. Practical exercises will be conducted applying multi-spectral and radar data for change detection of ground properties and ground deformations. Students will conduct individual project assignments and present their results.		
Typical literature:	Richards and Jia, Remote Sensing Digital Image Analysis, Springer Schowengerdt, Remote Sensing: Models and Methods for Image Processing, Academic Press		
Teaching mode:	S1 (WS): Lecture (1 SWS) S1 (WS): practical work (3 SWS)		
Prerequisites:	Pre-requisites are basic knowledge in geosciences, remote sensing and statistics.		
Term:	Winter Term		
Examination:	Project assignment and presentation		
ECTS (LP):	6		
Grade:	Assessment of the project assignment and presentation		
Study load:	Total estimated study lead is180h. It consists of 60h supervised lecture and practical time and 120 independent work including group work, practical, self-study and preparation for examination.		

Data:	Geomod. MA. Nr. 638 / Prüfungs-Nr.: 30105	Stand: 31.10.2017	Start: WiSe 2019
Module name:	Geomodelling – Geostatistics for natural resource modelling		
Course coordinator:	Prof. Dr.-Ing. Jörg Benndorf		
Instructors:	Prof. Dr.-Ing. Jörg Benndorf		
Department:	Department of Mine Surveying and Geodesy		
Duration:	1 Semester		
Study goals	After successful completion of the course, students are able to: - explain the theoretical foundation of spatial data analysis, geostatistical model building and estimation - apply geostatistical methods in the context of estimating natural resources/reserves - critically evaluate model assumptions of different estimation and simulation method and choose suitable methods for specific applications - discuss the critical character of the SMU-size to recoverable reserves - conduct a resource/reserve estimation in a simple case study		
Content:	Importance of Resource Modeling and Estimation in the Value Chain of Mining, uni-variate and multi-variate Explorative Data Analysis, Analysis of Spatial Continuity, the Spatial Random Function Model, Model Assumptions of Stationarity and Ergodicity, Inference of a Spatial Random Function using unbiased Estimators, Dealing with Preferential Sampling, Variography and Variogram Modeling, Simple Methods for Spatial Estimation including the Polygon Method, Triangulation, Inverse Distance Power and Polynomial Regression, Geostatistical Methods for Spatial Estimation including Simple Kriging, Ordinary Kriging and Universal Kriging, Integrating Secondary Information into Spatial Modeling using Techniques of Co-Kriging, other methods including Indicator Kriging and Block Kriging, Introduction in Modeling spatial Uncertainty using Conditional Simulation, the Method of Sequential Gaussian Simulation, Geostatistical Considerations in Estimating Reserves in Terms of Volume-Variance Relationship for defining Smallest Minable Units and Grade Tonnage Curves, Applications in Mining Cases, Introduction to CRIRSCO-based International Reporting standards (example JORC Code).		
Typical literature:	M. Armstrong: “Basic Linear Geostatistics”, Springer Verlag; H. Akin, H. Siemes: „Praktische Geostatistik“, Springer Verlag; A. G. Journel, and C.J. Huijbregts, 1978, Mining Geostatistics, Academic Press; P. Goovaerts: “Geostatistics for Natural Resource Evaluation“, Oxford University Press; T. Schafmeister: “Geostatistik für die hydrogeologische Praxis“, Springer Verlag		
Teaching mode:	S1 (WS): Lecture, language English (2 SWS) S1 (WS): practical work in groups (2 SWS)		
Prerequisites:	**Recommended:** Introduction to Statistics Calculus		
Term:	Winter Term.		

Examination:	Written Exam of 90 minutes Group Work Assignment For modules with multiple assessment methods, each of these must be passed with a minimum grade of "sufficient" (4.0).
ECTS (LP):	5
Grade:	Written Exam (weight 2) Set of assignment (weight 1)
Study load:	Total estimated study lead is150h. It consists of 60h presence time (lectures and practical), and 90 hours independent work including group work, practical, self-study and preparation for examination

Data:	GEOMON. BA. 128 / Prüfungs-Nr.: -	Stand: 31.10.2017	Start: WiSe 2019
Module name:	Geomonitoring		
Course coordinator:	Prof. Dr.-Ing. Jörg Benndorf		
Instructors:	Benndorf, Jörg/ Prof. Dr.-Ing. John, Andre / Dr.-Ing.		
Department:	Department of Mine Surveying and Geodesy		
Duration:	1 Semester		
Study goals	Students are able to build on their knowledge about geodetic and geotechnical measurement methods on the one hand and their understanding about the geogenic/ antropogenic process to monitor on the other hand to generate reliable and effective monitoring concepts for spatial, temporal and spatio-temporal processes. Students are able to critically analyze monitoring concepts and interpret monitoring results.		
Content:	The Lecture introduces to applications and to the methodological approach of Geomonitoring. Starting on the basis of measurement and data acquisition techniques it discusses monitoring design aspects and statistical and model based inference strategies. The aim is to infer an understanding of geo-processes and their relevant spatio-temporal dynamics, including change detection. Topical application in the context of resource extraction impact- and environmental impact monitoring on different scales in time and space will be discussed and analyzed.		
Typical literature:	Kavanagh, B.F. (2002): Geomatics. Pearson Education, Upper Saddle River; Jain, R. (2015). Environmental Impact of Mining and Mineral Processing: Management, Monitoring, and Auditing Strategies. Butterworth-Heinemann. Fischer-Stabel, P. (2005): Umweltinformationssysteme. Wichmann, Heidelberg. de Gruijter, J., Brus, D.J., Bierkens, M.F.P., Knotters, M.(2006). Sampling for Natural Resources. Springer.		
Teaching mode:	S1 (WS): Lecture (2 SWS) S1 (WS): practical work in groups (2 SWS)		
Prerequisites:	**Recommended:** Introduction to Remote Sensing Geodetic Surveying Introduction to GIS Engineering Surveying Geomodelling		
Term:	Winter Term		
Examination:	Oral Exam Set of Assignments		
ECTS (LP):	5		
Grade:	Oral Exam (weight 1) Assignment (weight 1)		
Study load:	Total estimated study lead is150h. It consists of 60h supervised lecture and practical time and 90 independent work including group work, practical, self-study and preparation for examination.		

Data:	MARVERM. BA. Nr. 641 / Prüfungs-Nr.:	Stand: 31.10.2017	Start: WiSe 2019
Module name:	Underground Mine Surveying		
Course coordinator:	Prof. Dr.-Ing. Jörg Benndorf		
Instructors:	Prof. Dr.-Ing. Jörg Benndorf		
Department:	Department of Mine Surveying and Geodesy		
Duration:	1 Semester		
Study goals	After successful completion of the course, students are able to: - apply the theory of error propagation in the context of planning and critical analysis of measurement results for underground surveying campaigns - optimize the case specific use of suitable surveying instrumentation, the measurement design and data processing method for campaigns related to the absolute spatial orientation of underground mining workings. - independently conduct typically underground mine surveying tasks and analyze results.		
Content:	- Legal regulations with respect to underground mine surveying (in particular German law: Verordnung über markscheiderische Arbeiten und Beobachtung der Oberfläche - Markscheider-Bergverordnung vom 19. Dezember 1986) - Application of the theory of error propagation and GUM - Guide to the Expression of Uncertainty in Measurement - Transfer of coordinates and directional angels from surface to underground (mechanical and optical shaft plumbing, gyroscopic measurements, application of inertial systems) - Alignment control in underground drifts and tunnels - Underground geodetic infrastructure and mine mapping - Drill hole surveying - Recent developments		
Typical literature:	Schulte, Löhr, Vosen: Markscheidekunde für das Studium und die betriebliche Praxis. Springer Verlag; Meixner, H. und Bukrinskij, A.: Markscheidewesen für Bergbaufachrichtungen. VEB Deutscher Verlag für Grundstoffindustrie, Leipzig 1985; Knufinke, P.: Allgemeine Vermessungs- und Markscheidekunde.; 1. Auflage, ISBN: 3-89653-530-7,; Deutscher Markscheiderverein e.V., Bochum, 1999; Ogundare, J. O. (2015). Precision surveying: the principles and geomatics practice. John Wiley & Sons. Zeitschriften: Markscheidewesen, AVN, VDV-Magazin		
Teaching mode:	S1 (WS): Lecture (2 SWS) S1 (WS): exercises and practical work in groups (3 SWS)		
Prerequisites:	Basic knowledge about surveying, surveying instrumentation and underground mining.		
Term:	Winter Term.		
Examination:	Oral Assessment (30 Minutes) Set of assignments		

	For modules with multiple assessment methods, each of these must be passed with a minimum grade of "sufficient" (4.0).
ECTS (LP):	5
Grade:	Oral assessment (weight 1)
Study load:	Total estimated study load is180h. It consists of 75h presence time (lectures and underground surveying practical), and 105 hours independent work including group work, practical, self-study and preparation for examination

Semestr 3

TU Bergakademie Freiberg

Data:	GEOINF2. MA. Nr. 529 / Prüfungs-Nr.:	Stand: 31.10.2017	Start: SoSe 2018
Module name:	Applied Spatial Data Analysis and Modelling for After Mine Care - Case Study		
Course coordinator:	Prof. Dr.-Ing. Jörg Benndorf		
Instructors:	Löbel, Karl-Heinz / Dr.-Ing. Benndorf, Jörg/ Prof. Dr.-Ing.		
Department:	Department of Mine Surveying and Geodesy		
Duration:	1 Semester		
Study goals	After successful completion of the course, students are able to: • independently create solutions for complex practical problems in mining and geoengineering applying knowledge about mine surveying, mining engineering, geotechnical engineering and engineering geology and utilizing modern methods in geospatial data analysis, geo-modelling and GIS. • critically assess and interpreted results of the analysis and provide recommendations related to expected impact of mining activities during active and post-mining phase. • coordinate team work, create project plans and manage the work progress • present results in a report and/or a presentation to a panel of independent experts. conduct auto-didactical education related to detailed handling of typical software.		
Content:	• project work on a case study related to after mine care • supporting acquisition of georeferenced data • impact analysis on environment and safety • data base structures suited to map the problem on hand • GIS project management • Interpolation, 2½- and 3D model building • Geospatial data analysis • Network analysis • Client/Server concepts • GIS and internet • Presentation of results in thematic maps and presentations		
Typical literature:	David Maguire, Michael Batty, Michael Goodchild: GIS, Spatial Analysis, and Modeling. ISBN: 1-58948-130-5; The ESRI Guide to GIS Analysis, Volume 1 - Geographic Patterns and Relationships. ISBN: 1-879102-06-4, Volume 2 - Spatial Measurements and Statistics. ISBN: 1-58948-116-X; Josef Fürst: GIS in Hydrologie und Wasserwirtschaft, ISBN 978-3-87907-413-6; Wolfgang Liebig, Jörg Schaller (Hrsg.) : ArcView GIS - GIS-Arbeitsbuch, ISBN 978-3-87907-346-7; Peter Fischer-Stabel (Hrsg.):Umweltinformationssysteme, ISBN 978-3-87907-423-5; Franz-Josef Behr: Strategisches GIS-Management - Grundlagen, Systemeinführung und Betrieb, ISBN 978-3-87907-350-4; Thomas Brinkhoff: Geodatenbanksysteme in Theorie und Praxis, ISBN • 978-3-87907-433-4		
Teaching mode:	S1 (SS): Lecture (1 SWS) S1 (SS): practical work in groups (2 SWS)		
Prerequisites:	**Recommended:** Introduction to GIS, 2014-06-16 Introduction to Mine Surveying .		
Term:	Summer Term.		
Examination:	Oral Exam Group Work Assignment		

ECTS (LP):	5
Grade:	Oral Exam (weight 2) Assignment (weight 3)
Study load:	Total estimated study lead is150h. It consists of 45h lectures 105 independent work including group work, practical, self-study and preparation for examination

Data:	MARKLAG. BA. Nr. 648 / Prüfungs-Nr.: -	Stand: 31.10.2017	Start: SoSe 2019
Module name:	Geomatics for Resource and Reserve Management		
Course coordinator:	Prof. Dr.-Ing. Jörg Benndorf		
Instructors:	Prof. Dr.-Ing. Jörg Benndorf		
Department:	Department of Mine Surveying and Geodesy		
Duration:	1 Semester		
Study goals	After successful completion of the course, students are able to create case specific work flows and apply methods that support a safe, economical end environmental responsible exploitation of mineral deposits. The particular focus of this module is on: - exploration of the resource and geo-mechanical aspects including tectonics, - evaluation of mineral resources and reserves according international standards, - monitoring of operational accessible reserves (in-pit reserves), - grade control and reconciliation, - operational production and safety monitoring and - aspects related to optimization of mine design.		
Content:	– Methods and phases of resource exploration – Resource/Reserve estimation – Operational production and safety monitoring – Grade control and reconciliation – Tectonic structures and its visualization in mine maps (folding structures and discontinuities) – Geotechnical design aspects – Applied operations resource for optimized mine design		
Typical literature:	Eisbacher, G.H.: Einführung in die Tektonik. Ferdinand Enke Verlag Stuttgart; Klassifikation von Lagerstätten. GDMB-Hefte, GDMB-Clausthal- Zellerfeld; Michaely, H., Blasgude H.G.: Rissmusteratlas- Bergmännisches Risswerk. FABERG-Normenausschuss Bergbau im DIN Deutsches Institut für Normung e.V. Domschke, W., Drexl, A., Klein, R., Scholl, A. (2015) Einführung in das Operations Research. Springer, Berlin.		
Teaching mode:	S1 (SS): Lecture (2 SWS) S1 (SS): exercises and practical work in groups (2SWS)		
Prerequisites:	Basic knowledge about mine mapping.		
Term:	Summer Term.		
Examination:	Oral Assessment (30 Minutes) Set of assignments Excursion (successful completion is a pre-requisite for oral examination)		
ECTS (LP):	6		
Grade:	Oral assessment (weight 1)		
Study load:	Total estimated study load is180h. It consists of 60h presence time (lectures and underground surveying practical), and 120 hours independent work including group work, practical, self-study and preparation for examination		

Data:	BODBEWB. BA. Nr. 646 / Prüfungs-Nr.: -	Stand: 31.10.2017	Start: SoSe 2019
Module name:	Special Topics Geokinematics		
Course coordinator:	Prof. Dr.-Ing. Jörg Benndorf		
Instructors:	Benndorf, Jörg/ Prof. Dr.-Ing. John, Andre / Dr.-Ing.		
Department:	Department of Mine Surveying and Geodesy		
Duration:	1 Semester		
Study goals	After successful completion of the course, students are able to: • solve topical problems related to predicting and monitoring mining induced ground movements, • utilize methods of inverse modelling to estimate parameters of prediction models based on monitoring data and • apply methods of machine learning to analyse highly dimensional data and identify relations between independent and dependent variables.		
Content:	• Review of methods for predicting mining induced ground movements on topical examples • Applied inverse modelling and geostatistics for parameter estimation in the context of ground movement prediction • Introduction to supervised and unsupervised learning (Machine Learning) in the context of resource extraction monitoring and prediction • Case studies of machine learning in the context of mining induced ground movement modelling and exploration • Case studies for ground movement prediction and parameter estimation		
Typical literature:	Kratzsch, Helmut: Bergschadenkunde. 4. Aufl., 2004, 873 S., ISBN 3-00-001661-9; Whittaker, B.N., Reddish D.J.: Subsidence. -Occurrence, Prediction and Control, 1989, 528 S., ISBN 0-444-87274-4; Kanevski, M., Timonin, V., & Pozdnukhov, A. (2009). Machine learning for spatial environmental data: theory, applications, and software. EPFL press Dzegniuk, B., Fenk, J., Pielok, J. : Analyse und Prognose von Boden und Gebirgsbewegungen im Flözbergbau. 1987,105 S., ISBN 0071-9390; Journals: Markscheidewesen, Geotechnik, Mathematical Geosciences, Computer and Geosciences, Journal of Mining Sciences		
Teaching mode:	S1 (SS): Lecture, language English (2 SWS) S1 (SS): practical work in groups (2 SWS)		
Prerequisites:	**Recommended:** Mining Subsidence Engineering (Allgemeine Grundlagen der Bergschadenkunde) Geomodelling (Geomodellierung) Geodetic Adjustment Theory (Ausgleichungsrechnung) .		
Term:	Summer Term.		
Examination:	Oral Exam Group Work Assignment		
ECTS (LP):	4		
Grade:	Oral exam of duration 20 to 30 minutes (weight 2) Set of assignment (weight 1)		

Study load:	Total estimated study lead is120h. It consists of 60h presence time (lectures and practical), and 60 hours independent work including group work, practical, self-study and preparation for examination

COURSE DESCRIPTIONS/
KARTY PRZEDMIOTÓW

second-level studies/ studia II stopnia
main field of study/ kierunek studiów:
Mining and Geology/ Górnictwo I Geologia

specialisation/specjalność:
GEOMATICS FOR MINERAL RESOURCE MANAGEMENT

ścieżka studiów/study track: LEOBEN

1-st Semester

Semestr 1

WYDZIAŁ **Geoinżynierii, Górnictwa i Geologii**

KARTA PRZEDMIOTU

Nazwa przedmiotu w języku polskim Wspomagane komputerowo modelowanie geologiczne i geostatystyka. ….(zajęcia są prowadzone w języku angielskim)
Nazwa przedmiotu w języku angielskim Computer Aided Geological Modelling and Geostatistics……………………………………………….
Kierunek studiów (jeśli dotyczy): Górnictwo i geologia.
Specjalność (jeśli dotyczy): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Poziom i forma studiów: II stopień, stacjonarna
Rodzaj przedmiotu: obowiązkowy *
Kod przedmiotu W06GIG-SM0038
Grupa kursów NIE*

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	15		45		
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	30		120		
Forma zaliczenia	~~Egzamin /~~ zaliczenie na ocenę*	Egzamin / zaliczenie na ocenę*	~~Egzamin /~~ zaliczenie na ocenę*	Egzamin / zaliczenie na ocenę*	Egzamin / zaliczenie na ocenę*
Dla grupy kursów zaznaczyć kurs końcowy (X)					
Liczba punktów ECTS	**1**		4		
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)			4		
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego udziału nauczycieli lub innych osób prowadzących zajęcia (BU)	1		2		

*niepotrzebne skreślić

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I KOMPETENCJI SPOŁECZNYCH

1. Mathematical Statistics,
2. Fundamentals of Geology and Mineral Deposits

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CELE PRZEDMIOTU

C1 Developing basic skills in computer modelling of 3-D objects.
C2 Introduction of the principles of digital modelling of typical geological structures.
C3 Introduction to the methods of deposit parameters estimation and resources evaluation.

PRZEDMIOTOWE EFEKTY UCZENIA SIĘ
Z zakresu wiedzy: PEU_W01 Estimation methods, principles of geostatistics, kriging estimators PEU_W02 Geostatistical modelling of the selected deposit parameters (domain analysis, variogram modelling, PEU_W03 Creating and validating 3-D models of various geological structures in the comprehensive dedicated software environment. Z zakresu umiejętności: PEU_U01 Application of relevant estimation methods for quality modelling of a deposit PEU_U02 Evaluating 3-D objects against structural and quality block models (volumes, tonnages, grades) PEU_U03 Describing the interpretation and applied approach, creating models, evaluation results, recommendations for possible enhancements Z zakresu kompetencji społecznych: PEK_K01 The student can think and act in a creative and enterprising way

TREŚCI PROGRAMOWE		
Forma zajęć - wykład		**Liczba godzin**
Wy1	Introduction to the course. Geological database and validation of the geological data.	2
Wy2	Geology of the seam.	2
Wy3	Structural model of the stratified deposit. Methods of the prediction of the surface layer parameters.	2
Wy4	Spatial distribution of samples values. Regionalized variable.	2
Wy5	BLUE Estimator of the mean value: Kriging.	2
Wy6	Quality model of the deposit – block model of the parameter layers. Estimation and evaluation of the block model.	2
Wy7	Reserves modelling and evaluation.	2
Wy8	Mineral resources. International reporting. The JORC Code	1
	Suma godzin	**15**

Forma zajęć - ćwiczenia		**Liczba godzin**
Ćw1		
Ćw2		
Ćw3		
Ćw4		
..		
	Suma godzin	0

Forma zajęć - laboratorium	**Liczba godzin**

La1	Determining the rules of work at the laboratory.	3
La2	Assignment of the individual dataset for the exercises and creating initial data files.	3
La3	Data validation and creating initial geological database.	3
La4	Construction of the structural wireframe model of stratigraphy layers.	3
La5	Construction of the block model of the deposit and overburden layers. Thickness and stripping ratio analysis.	3
La6	Data preparation to geostatistical analysis. Compositing of the samples.	3
La7	Domain analysis with the use of the statistical methods.	3
La8	Determination of the empirical variogram. Anisotropy analysis.	3
La9	Variogram modelling.	3
La10	Kriging Neighborhood Analysis - defining optimal parameters of the estimation procedure.	3
La11	Estimation of quality parameters in block model of the deposit layers. Validation of the estimation quality.	3
La12	Validation of the quality model and classification of the resources. Balance resources evaluation.	3
La13	Preparation of data for continuous surface mining ultimate pit design. Ultimate pit outlines generation	3
La14	Wireframe and block modelling of the ultimate pit	3
La15	Reserves evaluation, visualization and interrogation of created models	3
	Suma godzin	45

Forma zajęć - projekt		Liczba godzin
Pr1		
Pr2		
Pr3		
Pr4		
…		
	Suma godzin	0

Forma zajęć - seminarium		Liczba godzin
Se1		
Se2		
Se3		
…		
	Suma godzin	0

STOSOWANE NARZĘDZIA DYDAKTYCZNE
N1. Form of lectures - traditional, multimedia presentations using specialized software and demonstrations of its application "live", individual development of specialist topics covered during the lecture, N2. individual development of project tasks within the laboratories frames, individual development of electronic reports concerning project tasks within the laboratories frames, N3. evaluation of laboratory tasks reports with multipoint grade of student’s work, group analysis of the results obtained during laboratory tasks; preparation of conclusions concerning data dependencies and constraints of mining projects, skill control tests, duty hours in laboratory.

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW UCZENIA SIĘ

Oceny (F – formująca (w trakcie semestru), P – podsumowująca (na koniec semestru)	Numer efektu uczenia się	Sposób oceny osiągnięcia efektu uczenia się
F1	PEU_W01, PEU_W02	Lecture grade on the basis of the written examination
F2	PEU_W03,	Laboratory task assessment: "structural modelling assessment
F3	PEU_U01	Laboratory task assessment: "geostatistical modelling"
F4	PEU_U02, PEU_U03	Laboratory task assessment: "reserves evaluation".
P average of F1, F2, F3, F4		

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA

LITERATURA PODSTAWOWA:

[1] M. Armstrong, Basic Linear Geostatistics, Springer Verlag, 1998.
[2] P. Goovaerts: "Geostatistics for Natural Resource Evaluation", Oxford University Press, 1997.
[3] R. H. Grishong, Jr., 3-D Structural Geology, Springer Verlag, 2008
[4] K. Hefferan, J. O'Brien, Earth materials, Willey-Blacwell, Chichester U.K., 2010
[5] W. Hustrulid, M. Kuchta, Open pit mine planning and design. Chapter 3. Orebody description, Taylor&Francis, 2013.
[6] A. G. Journel, and C.J. Huijbregts, Mining Geostatistics, Academic Press, 1978.
[7] Ch.C. Plummer, D.H. Carlson, L. Hammersley, Physical geology, McGraw-Hill I.E. N.Y. 2010
[8] D.R. Prothero, R.H. Dott Jr., Evolution of the Earth, McGraw-Hill I.E. N.Y., 2010
[9] M.W. Rossi, C.V. Deutsch, Mineral Resources Estimation, Springer Verlag 2014.

LITERATURA UZUPEŁNIAJĄCA:

[10] Handouts, tutorials.

OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)

Dr inż. Krzysztof Hołodnik
Dr inż. Witold Kawalec, Dr Paweł Zagożdżon

Zał. nr 5 do ZW 8/2020
Załącznik nr … do programu studiów

WYDZIAŁ GEOINŻYNIERII, GÓRNICTWA i GEOLOGII

KARTA PRZEDMIOTU

Nazwa przedmiotu w języku polskim Geofizyka inżynierska
….(zajęcia są prowadzone w języku angielskim)
Nazwa przedmiotu w języku angielskim Engineering Geophysics
Kierunek studiów (jeśli dotyczy): górnictwo i geologia
Specjalność (jeśli dotyczy): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Poziom i forma studiów: ~~I~~ / II stopień / ~~jednolite studia magisterskie~~*, stacjonarna / ~~niestacjonarna~~*
Rodzaj przedmiotu: ~~obowiązkowy~~ / wybieralny / ~~ogólnouczelniany~~ *
Kod przedmiotu W06GIG-SM0040
Grupa kursów ~~TAK~~ / NIE*

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	15			15	
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	40			50	
Forma zaliczenia	~~Egzamin~~ / zaliczenie na ocenę*			~~Egzamin~~ / zaliczenie na ocenę*	
Dla grupy kursów zaznaczyć kurs końcowy (X)					
Liczba punktów ECTS	1			2	
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)				2	
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego udziału nauczycieli lub innych osób prowadzących zajęcia (BU)				2	

*niepotrzebne skreślić

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I KOMPETENCJI SPOŁECZNYCH

1. has knowledge of fundamentals of applied geophysics, physics and geology.
2. knows fundamentals of soil and rock mechanics.
3. is able to use MS Office software.
4. is able to work in a team.

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CELE PRZEDMIOTU

C1 familiarize with physical phenomena in geosphere of the Earth
C2 familiarize with engineering problems solved by means of geophysical surveying
C3 familiarize with various geophysical surveys.

C4 acquisition of skills to plan geophysical field surveying and to interpret its results. C5 development of skills to work in a group.

PRZEDMIOTOWE EFEKTY UCZENIA SIĘ
Z zakresu wiedzy: PEU_W01 recognizes, names and explains engineering problems in different fields. PEU_W02 identifies, describes and chooses geophysical surveying methods. PEU_W03 analyses and assesses case studies from solving the engineering problems. Z zakresu umiejętności: PEU_U01 is able to coordinate team work, create field research plans and manage the work progress. PEU_U02 is able to independently create solutions for complex practical problems in engineering and geoengineering applying knowledge about geophysical surveying, mining geophysics, utilizing modern methods in geophysical data acquisition and interpretation. PEU_U03 is able to critically assess, process and interpreted results of the geophysical surveying and provide recommendations related to engineering problems in mining, civil engineering, engineering geology, municipal waste site, archeology, engineering properties of soil and rocks, hydrogeology, monitoring seepage in river dykes or dams. PEU_U04 is able to solve geophysical problems. PEU_U05 is able to conduct auto-didactical education related to detailed handling of typical software. Z zakresu kompetencji społecznych: PEU_K02 understands the need to create and transfer to the society – among others by mass media- information and opinions related to mining engineering achievements and other activities of mining engineer; tries to transfer the information in commonly understood way, presenting different points of view; is aware of the quality and need to shape the work safety culture in mining and the responsibility for the health and life of other employees.

TREŚCI PROGRAMOWE		
Forma zajęć - wykład		**Liczba godzin**
Wy1	Physical properties of rocks. Inter-relationships between the various subdisciplines of applied geophysics. Overview of geophysical methods, their physical principles and applications. Methodology of geophysical surveying.	1
Wy2	Engineering problems solved with geophysical surveying. Case studies.	2
Wy3	Electrical resistivity methods. Tomography and VSE. IP method. Physical principles. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
Wy4	Electromagnetic methods. FDEM and TDEM methods. Magnetotelluric methods. Physical principles. Methods of field surveying. Equipment. Interpretation and application. Case studies.	2
Wy5	GPR surveying. Physical principles. Methods of field surveying.	2

	Equipment. Interpretation and application. Case studies.	
Wy6	Seismic tomography. Seismic interferometry. Physical principles. Applications. Case studies.	2
Wy7	Mine geophysics. Seismology. Seismic methods. Active and passive seismic tomography. Microgravimetry. Case studies.	2
Wy8	Gravity and magnetic surveying. Equipment. Methods of field surveying. Interpretation and application. Case studies.	2
	Suma godzin	**15**

Forma zajęć - projekt		Liczba godzin
Pr1	One selected geophysical technique. Fundamentals and equipment. Field surveying	4
Pr2	Processing and interpretation of field data.	3
Pr3	Solving the geophysical problems.	8
	Suma godzin	**15**

STOSOWANE NARZĘDZIA DYDAKTYCZNE
N1.Lecture aided by presentation. N2.Demonstration. N3.Discussion and consultations N3Calculations N5Practical field surveying

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW UCZENIA SIĘ

Oceny (F – formująca (w trakcie semestru), P – podsumowująca (na koniec semestru)	Numer efektu uczenia się	Sposób oceny osiągnięcia efektu uczenia się
P1	W01-W03	Test related to lecture content. Final grade.
F1	U01-U02, U05	Test. Project 1. Report on Project 1
F2	U03, U05	Test. Project 2. Report on Project 2
F3	U04, U05	Test. Solving geophysical problems
F1-F3, P2	U01-U05 K02	Grades are given for each of three project tasks including tests and reports. The final grade P2 for the project course is the weighted average grade of F1-F3.

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA

LITERATURA PODSTAWOWA:

[1] Aki, K., Richards P.G., 1980. Quantitative Seismology: Theory and Methods. W.H. Freeman Co.. San Francisco.
[2] Burger, H.R., Sheehan, A.F., Jones, C.H., 2006. Introduction to Applied Geophysics: Exploring the Shallow Subsurface. W.W. Norton & Company, Inc.
[3] Mendecki, A.J. (ed.), 1997. Seismic Monitoring in Mines. Chapman & Hall.
[4] Reynolds, J.M., 2011. An Introduction to Applied and Environmental Geophysics. Wiley – Blackwell. John Wiley & Sons.

[5] Sharma, Prem V., 2002. Environmental and engineering geophysics. Cambridge University Press.
[6] Torge, W., 1989. Gravimetry. Water de Gruyter. Berlin. New York.
[7] Selected Journal Publications (for example journals: Progress in Geophysics, Engineering Geophysics Journal, Environmental and Engineering Geophysics, Journal of Geophysics and Engineering, Pure and Applied Geophysics).

LITERATURA UZUPEŁNIAJĄCA:

[1] Lowrie, W., 2007. Fundamentals of Geophysics. Cambridge University Press.
[2] Milsom, J., 2003. Field Geophysics. John Wiley & Sons Ltd.
[3] Telford, W.M., Geldart, L.P., Sheriff, R.E., 1990. Applied Geophysics. Cambridge University Press.

OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)

ANNA BARBARA GOGOLEWSKA, anna.gogolewska@pwr.edu.pl

Zał. nr 5 do ZW 8/2020
Załącznik nr … do programu studiów

WYDZIAŁ GEOINŻYNIERII, GÓRNICTWA I GEOLOGII

KARTA PRZEDMIOTU

Nazwa przedmiotu w języku polskim: Zintegrowana analiza deformacji w geomechanice…….(zajęcia są prowadzone w języku angielskim)
Nazwa przedmiotu w języku angielskim: Integrated Analysis of Deformations in Geomechanical Engineering
Kierunek studiów (jeśli dotyczy): górnictwo i geologia
Specjalność (jeśli dotyczy): Geomatics for Mineral Resources Management
Poziom i forma studiów: ~~I~~ / II stopień / ~~jednolite studia magisterskie~~*, stacjonarna / ~~niestacjonarna*~~
Rodzaj przedmiotu: ~~obowiązkowy~~ / wybieralny / ~~ogólnouczelniany~~ *
Kod przedmiotu W06GIG-SM0041G
Grupa kursów ~~TAK~~ / NIE*

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	30		30		
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	90		60		
Forma zaliczenia	Egzamin / ~~zaliczenie na ocenę*~~		~~Egzamin~~ / zaliczenie na ocenę*		
Dla grupy kursów zaznaczyć kurs końcowy (X)					
Liczba punktów ECTS	5				
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)	3		2		
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego udziału nauczycieli lub innych osób prowadzących zajęcia (BU)	2,5		1,5		

*niepotrzebne skreślić

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I KOMPETENCJI SPOŁECZNYCH

1. Podstawowa wiedza z zakresu goemechaniki
2. Podstawową wiedza dotycząca eksploatacji górniczej
3. Podstawowa wiedza monitorowania zmian górotworu

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CELE PRZEDMIOTU

C1 Przedstawienie roli monitorowania w górnictwie zrównoważonym
C2 Przygotowanie i przeprowadzenie analizy deformacji górotworu spowodowanych działalnością górniczą

C3 Przygotowanie i przeprowadzenie analizy deformacji zapór i usypisk ziemnych
C4 Nauczenie zasad modelowania MES
C5 Nabycie umiejętności wykorzystania analizy zintegrowanej wykorzystując modelowanie deterministyczne MES i wyniki pomiarów geodezyjnych i geotechnicznych

PRZEDMIOTOWE EFEKTY UCZENIA SIĘ

Z zakresu wiedzy:

PEU_W01 Potrafi rozróżnić i opisać zastosowania technik monitorowania deformacji w sPEUtrum dyscyplin inżynieryjnych takich jak górnictwo i inżynieria budowlana

PEU_W02 Potrafi scharakteryzować górotwór i metody górnicze

PEU_W03 . Posiada wiedzę z zakresu analiz: empirycznych i deterministycznych z zastosowaniem FEM deformacji górotworu,

PEU_W04 . Posiada wiedzę podstaw i zastosowań analizy zintegrowanej metody deterministycznej z wynikami pomiarów geodezyjnych

PEU_W05 . Potrafi wyznaczyć główne założenia pomiaru geodezyjnego deformacji wywołanych eksploatacja górniczą

PEU_W06 Ma znajomość przygotowania modelu MES

Z zakresu umiejętności:

Z zakresu kompetencji społecznych:

PEU_K01 Potrafi ocenić rolę monitorowania i predykcji w górnictwie zrównoważonym w całym jego cyklu

TREŚCI PROGRAMOWE		
Forma zajęć - wykład		**Liczba godzin**
Wy1	Syllabus, warunki zaliczenia, literatura,	2
Wy2	Wstęp do zintegrowanej analizy deformacji	2
Wy3	Rola monitorowania w górnictwie zrównoważonym	2
Wy4	Opis zjawisk fizycznych: statyka- dynamika , rozchodzenie się ciepła, przepływ cieczy, zmiany siły grawitacji, zastosowania	2
Wy5	Metody analizy deformacji: stosując analizę systemów i mechaniki ciała stałego	2
Wy6	Ogólna klasyfikacja metod monitorowania: absolutne i względne pomiary deformacji,	**2**
Wy7	zalety i wady metod geodezyjnych i geotechniczno-strukturalnych, koncepcja pomiarów zintegrowanych	**2**

Wy8	Mechanika ciała stałego, Problem warunków brzegowych	**2**
Wy9	Rozwiązanie systemu kratownicy - relacja do MES MES	**2**
Wy10	Empiryczne metody wyznaczania deformacji powierzchni wywołanych eksploatacją podziemną (gaz i nafta) i eksploatacją odkrywkową, zastosowanie MES, Kategoria terenu	**2**
Wy11	Przykłady zastosowania integracji : stabilności zboczy w kopalniach odkrywkowych, Chiquqimata, Chile, NevadaUSA	**2**
Wy12	Przykłady zastosowania integracji : deformacja górotworu na terenach podziemnej eksploatacji górniczej w kopalni soli w Kanadzie,	**2**
Wy13	Problemy wydobycia gazu naturalnego i nafty	**2**
Wy14	Podsumowanie	**2**
Wy15	Kolokwium	**2**
	Suma godzin	**30**

Forma zajęć - ćwiczenia		Liczba godzin
Ćw1		
Ćw2		
Ćw3		
Ćw4		
..		
	Suma godzin	

Forma zajęć - laboratorium		Liczba godzin
La1	Przedstawienie zakresu ćwiczeń, warunków zaliczenia oraz literatury.	2
La2	Analiza wpływu obciążenia na górotwór –zastosowanie programu GeoStudio 2007	2
La3	Analiza naprężeń in-situ górotworu i górotworu obciążonego	2
La4	Zaprojektowanie pomiaru geodezyjnego na terenie górniczym prowadzenia podziemnej eksploatacji na podstawie wyników MES. Dyskusja projektu pomiarów.	2
La5	Wyznaczenie kategorii terenu górniczego Dyskusja wyników projektu	2
La6	Zaprojektowanie pomiaru geodezyjnego na terenie kopalni odkrywkowej na podstawie modelu MES . Dyskusja projektu pomiarów.	2
La7	Zaprojektowanie pomiaru geodezyjnego ziemnej zapory wodnej na podstawie modelu MES. Dyskusja analizy	2
La8	Podsumowanie	1
	Suma godzin	15

Forma zajęć - projekt		Liczba godzin
Pr1	Wyznaczenie MES deformacji górotworu spowodowanych eksploatacją podziemną, wyznaczenie kategorii terenu. Analiza sprężysta i nieliniowa . Omowienie monitorowania	6
Pr2	Podsumowanie	1
Pr3	Wyznaczenie MES deformacji usypiska/zapory ziemnej w warunkach zmiennego poziomu wody. Wyznaczenie wspolczynnika bezpieczeństwa stosując oprogramowanie Geostudio. Omowienie monitorowania	6
Pr4	Podsumowanie	2
…		
	Suma godzin	**15**

Forma zajęć - seminarium		Liczba godzin
Se1		
Se2		
Se3		
…		
	Suma godzin	

STOSOWANE NARZĘDZIA DYDAKTYCZNE
N1. Wykład, film N2. N3.

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW UCZENIA SIĘ

Oceny (F – formująca (w trakcie semestru), P – podsumowująca (na koniec semestru)	Numer efektu uczenia się	Sposób oceny osiągnięcia efektu uczenia się
F1	PEK_U01 – PEK_U06	Oceny z Lab 2-7, projekt 1 i 2.
F2		
F3		
P P PEU_W01 – PEU_W06, Kolokwium , Ocena końcowa z wykładu PEU_U01 – PEU_U06 Ocena końcowa z laboratorium . Średnia ze sprawozdań i projektu		

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA

LITERATURA PODSTAWOWA:

[1] Szostak-Chrzanowski, A., A. Chrzanowski,(2010), „INTEGETED ANALYSIS OF DEFORMATIONS IN GEOMECHANICS ", UNB, Fredericton, N.B., 220p.

LITERATURA UZUPEŁNIAJĄCA:

1 Szostak-Chrzanowski, A., A. Chrzanowski, M. Massiera (2005) "Use of deformation monit results in solving geomechanical problems – case studies ", *Engineering Geology,* vol. 7 Issues 1-2, pp. 3-12.

2 Chrzanowski,A. (1993):"Modern Surveying Techniques for Mining and Civil Engineering 33 in: *Comprehensive Rock Engineering,* Pergamon Press,Vol.3.Chapter 33, pp.773-809.

OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)

Anna Chrzanowska anna.chrzanowska@pwr.edu.pl

Zał. nr 5 do ZW 8/2020
Załącznik nr … do programu studiów

WYDZIAŁ **Geoinżynierii, Górnictwa i Geologii**

KARTA PRZEDMIOTU

Nazwa przedmiotu w języku polskim Bezpieczeństwo i higiena pracy ….(~~zajęcia są prowadzone w języku angielskim~~)
Nazwa przedmiotu w języku angielskim Occupational Health and Safety
Kierunek studiów (jeśli dotyczy): Górnictwo i geologia.
Specjalność (jeśli dotyczy): Mining Engineering
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Poziom i forma studiów: II stopień, stacjonarna
Rodzaj przedmiotu: obowiązkowy *
Kod przedmiotu W06GIG-SM0042
Grupa kursów NIE*

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	15			15	
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	30			30	
Forma zaliczenia	~~Egzamin /~~ zaliczenie na ocenę*	Egzamin / zaliczenie na ocenę*	Egzamin / zaliczenie na ocenę*	~~Egzamin~~ / zaliczenie na ocenę*	Egzamin / zaliczenie na ocenę*
Dla grupy kursów zaznaczyć kurs końcowy (X)					
Liczba punktów ECTS	**1**			1	
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)				1	
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego udziału nauczycieli lub innych osób prowadzących zajęcia (BU)	1			1	

*niepotrzebne skreślić

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I KOMPETENCJI SPOŁECZNYCH

1. Possesses basic knowledge of technologies used in open-pit mines and underground mines.
2. Is able to use Microsoft Office environment to prepare documents in Word, multimedia presentations in Power Point and work with Excel spreadsheets.
3. Is able to identify harmful, dangerous and nuisance factors in the workplace environment.

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CELE PRZEDMIOTU

C1. To introduce the principles of occupational risk assessment in accordance with relevant

standards C2 To present the principles of occupational risk assessment and the determination of admissibility with the use of STER software and the RISC SCORE method.

PRZEDMIOTOWE EFEKTY UCZENIA SIĘ

Z zakresu wiedzy:

PEU_W01 Possesses general knowledge of rules of occupational risk assessment formulation

PEU_W02 – Possesses knowledge of evaluating and determining the admissibility of occupational risk.

PEU _W0 3 – Possesses general knowledge of corrective and preventive actions regarding hazards of typical work posts in the mining industry.…

Z zakresu umiejętności:

PEU_U01 Is able to identify hazards of harmful, dangerous and nuisance factors of typical work posts in the mining industry

PEU_U02 Is able to estimate and determine risk acceptability with methods according to STER software and the RISC SCORE method.

PEU_U03 - Is able to plan corrective and preventive actions for hazards of typical work posts in the mining industry.…

Z zakresu kompetencji społecznych:

PEU_K01 - Is able to work in a team and together complete occupational risk assessment and develop its results and the required documentation in the form of a team report

TREŚCI PROGRAMOWE		
Forma zajęć - wykład		**Liczba godzin**
Wy1	Definition of occupational risk. Legal basics of occupational risk assessment. Risk assessment methods. Course of occupational risk assessment. Information necessary for occupational risk assessment. Identification of harmful, dangerous and nuisance factors in the work environment.	3
Wy2	Estimation of occupational risk assessment and determination of admissibility. Corrective and preventive actions. Familiarising employees with the results of occupational risk assessment. Implementation of agreed corrective and preventive actions. Monitoring the effectiveness of implemented actions. Periodic occupational risk assessment. Harmful factors – identification and assessment of risks.	3
Wy3	Dangerous factors - identification and assessment of risks.	3
Wy4	Nuisance factors in occupational risk assessment: psychological burden, static burden, monotype.	3
Wy 5	Methods of occupational risk assessment: STER software, the RISC SCORE method, written test	3
	Suma godzin	**15**

Forma zajęć - ćwiczenia		**Liczba godzin**
Ćw1		
Ćw2		
Ćw3		

Ćw4		
..		
	Suma godzin	

Forma zajęć - laboratorium		Liczba godzin
La1		
La2		
La3		
La4		
La5		
…		
	Suma godzin	

Forma zajęć - projekt		Liczba godzin
Pr1	Occupational risk assessment with the use of STER software for two work posts – description of work post, identification of hazards. Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of harmful factors (dust, noise)	3
Pr2	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of harmful factors (vibration, chemical agents)	3
Pr3	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility of dangerous factors (slippery or uneven surfaces, falling elements, moving parts, moving machinery and transported bimi items)	3
Pr4	Occupational risk assessment with the use of STER software for two work posts – estimation of occupational risk and determination of admissibility for nuisance factors (psychological burden, static burden, monotype)	3
Pr 5	Occupational risk assessment for a selected work post with the use of the RISC SCORE method, presentation of executed exercises, test	3
	Suma godzin	**15**

Forma zajęć - seminarium		Liczba godzin
Se1		
Se2		
Se3		
…		
	Suma godzin	

STOSOWANE NARZĘDZIA DYDAKTYCZNE
N1. Informative lecture with elements of problematic lectures. N2 Multimedia presentations. N3 Didactic discussions during lectures. N4 Didactic discussions during laboratory classes. N5Computer presentation of executed occupational risk assessments. N6Consultation.

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW UCZENIA SIĘ

Oceny (F – formująca (w trakcie semestru), P – podsumowująca (na koniec semestru)	Numer efektu uczenia się	Sposób oceny osiągnięcia efektu uczenia się
F1	PEU_W01-W03	grade from a test
F2	PEU_W01-W03 PEU_U01- U03	grade from a presentation
P2	PEU_W01-W03 PEU_U01- U03	final grade from project classes (arithmetic average of F1 and F2)
P		

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA

LITERATURA PODSTAWOWA:

[1] Iwona Romanowska Słomka, Adam Słomka Zarządzanie ryzykiem zawodowym. Wydawnictwo TARBONUS, Krakow Tarnobrzeg, 2009

[2] Iwona Romanowska Słomka, Adam Słomka Ocena ryzyka zawodowego. Wydawnictwo TARBONUS, Krakow Tarnobrzeg, 2010

[3] Wiesława Horst Ryzyko zawodowe na stanowisku pracy. Część 1, Ergonomiczne czynniki ryzyka. Wydawnictwo Politechniki Poznańskiej, Poznan, 2004

LITERATURA UZUPEŁNIAJĄCA:

[1] PN-N-18002 Systemy zarządzania bezpieczeństwem i higieną pracy - Ogólne wytyczne do oceny ryzyka zawodowego

[2]

OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)

Dr inż. Żaklina Konopacka

Zał. nr 5 do ZW 8/2020
Załącznik nr … do programu studiów

WYDZIAŁ **Geoinżynierii, Górnictwa i Geologii**

KARTA PRZEDMIOTU

Nazwa przedmiotu w języku angielskim: Project Management, Appraisal and Risk Evaluation ….(zajęcia są prowadzone w języku angielskim)

Nazwa przedmiotu w języku polskim :Zarządzanie projektami, ocena ich opłacalności i ryzyka.
Kierunek studiów (jeśli dotyczy): Górnictwo i geologia
Specjalność (jeśli dotyczy): Mining Engineering,
Geotechnical and Environmental Engineering,
Geomatics for Mineral Resource Management
Poziom i forma studiów: II stopień , stacjonarna
Rodzaj przedmiotu: obowiązkowy
Kod przedmiotu W06GIG-SM0039G
Grupa kursów TAK

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	15		30	15	
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	30		60	30	
Forma zaliczenia	Egzamin				
Dla grupy kursów zaznaczyć kurs końcowy (X)	X				
Liczba punktów ECTS	4				
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)	3				
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego udziału nauczycieli lub innych osób prowadzących zajęcia (BU)	3				

*niepotrzebne skreślić

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I KOMPETENCJI SPOŁECZNYCH

1. Knowledge of basic mathematical analysis, probability and statistical models
2. Skills in using Excel spreadsheets
3. Understanding of the need of lifelong learning and the importance of application of Economics, Management and Social Sciences in engineering.

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CELE PRZEDMIOTU

The course combines two groups of topics: basics of mineral economics and financial management and introduction to project management.
Part A: The purpose of the course is

C1 to introduce basic concepts of Microeconomics and financial management
C2 to introduce the concept of time value of money and present the methods used to evaluate investment projects. Different techniques are illustrated by examples and case studies. The range of application as well as the advantages and disadvantages of each method are discussed. The issues of inflation and risk analysis are included.

Part B:
C3 Introduction to project management basic concepts, methods and tools.
C4 Presentation of given project management areas: Project scope management, Project time management, Project cost management, Project risk management. Project planning, scheduling and control using Microsoft Project.
C5 Presentation of the issues of effective communication in project teams, group behaviour and leadership.

PRZEDMIOTOWE EFEKTY UCZENIA SIĘ

Z zakresu wiedzy:

PEU_W01 rozumie pojęcia podaży i popytu, elastyczności popytu i ich wpływ na rynki
PEU_W02 zna pojęcia kosztów w ekonomii i rachunkowości, rozumie różnice
PEU_W03 zna sposoby klasyfikacji kosztów w przedsiębiorstwach, zna i rozumie podstawowe pojęcia rachunku kosztów
PEU_W04 ma podstawową wiedzę o treści i wzajemnych relacjach bilansu, rachunku zysków i strat oraz rachunku przepływów pieniężnych, zna sposób prezentacji danych finansowych przedsiębiorstw w ustawowych sprawozdaniach finansowych i zna ich warianty.
PEU_W05 ma podstawową wiedzę na temat metody analizy wskaźnikowej sprawozdań finansowych
PEU_W06 zna pojęcia wartości przyszłej i wartości obecnej przepływów pieniężnych i rent rocznych
PEU_W07 zna podstawowe i zaawansowane metody oceny efektywności inwestycji (NPV, IRR, MIRR, DPBP, PBP) oraz zakresy ich stosowania
PEU_W08 ma podstawową wiedzę o metodach oceny ryzyka inwestycji

Z zakresu umiejętności:

PEU_U01 potrafi przeprowadzić analizę przyczyn i skutków zmiany popytu i podaży
PEU_U02 na podstawie krzywych kosztowych potrafi przeprowadzić optymalizację wielkości produkcji w różnych przypadkach.
PEU_U03 umie zinterpretować i korzystać z informacji zawartych w ustawowych sprawozdaniach finansowych. Umie przeprowadzić analizę wskaźnikową sprawozdań finansowych w podstawowym zakresie
PEU_U03 umie korzystać z danych kosztowych przedstawionych w różnych układach ewidencyjnych kosztów, umie stosować podstawowe metody rachunkowości zarządczej do podejmowania decyzji krótkoterminowych
PEU_U04 potrafi obliczyć wartość przyszłą i obecną pieniądza dla szeregu płatności oraz rozwiązać zadania rachunkowe z zakresu wartości pieniądza w czasie
PEU_U05 potrafi przeprowadzić ocenę opłacalności inwestycji poznanymi metodami
PEU_U06 potrafi przeprowadzić analizę wrażliwości i analizę scenariuszy z wykorzystaniem modelu finansowego inwestycji
PEU_U07 potrafi przygotować dokumentację projektową w podstawowym zakresie i

zainicjować projekt PEU_U08 potrafi zastosować podstawowe metody zarządzania projektami, monitorowania i zarządzania ryzykiem projektu PEU_U09 potrafi zastosować podstawowe metody zarządzania konfliktami w grupie PEU_U10 potrafi zastosować podstawowe metody zarządzania grupą i kreowania pozycji lidera, potrafi ocenić skuteczność zarządzania grupą Z zakresu kompetencji społecznych: PEU_K01 potrafi myśleć i działać w sposób systemowy, kreatywny i przedsiębiorczy PEU_K02 ma utrwaloną postawę ekonomicznego działania i podejmowania decyzji w oparciu o dostępne informacje finansowe i prognozy

TREŚCI PROGRAMOWE		
Forma zajęć - wykład		**Liczba godzin**
Wy1	Supply and demand, equilibrium price, changes in demand and supply. Stock and commodity markets used by mineral industries	2
Wy2	Costs in economics and in accounting. Cost and money outflow. Relevant cost, incremental cost, marginal cost, alternative cost. Short-term decision making.	2
Wy3	Costs as the subject of cost accounting, different systems of cost accounting Different methods of cost data presentation (by types, divided into direct and indirect costs). Cost allocation	2
Wy4	Variable and fixed costs. Break even point. Cost-volume –profit analysis.	1
Wy5	Basics of financial accounting. Income statement and cash flow statement. Balance sheet. Working capital. Examples of financial statements of mining companies	2
Wy6	Financial ratio analysis. Liquidity, profitability, activity and debt ratios. Financial and operating leverage.	2
Wy7	The concept of time value of money. Computation of future and present value of money by means of spreadsheet functions. Basics of capital budgeting. Evaluation of different methods.	2
Wy8	The concept of risk and return. Quantification of risk. Risk analysis in project evaluation: sensitivity analysis, scenario analysis, other methods.	2
	Suma godzin	15

Forma zajęć - projekt		**Liczba godzin**
Pr 1	Issues of understanding communication: Definitions Models (Schramm model, Berlo's SMCR (source, message, channel, receiver) model, McCroskey model, Reusch and Bateson model, Westley-MacLean model)	3
Pr 2	Conflict Sources of conflicts Kilmann and Thomas classification of conflict Kilmann and Thomas test Different styles of conflict solving Roles of conflict in group development.	3
Pr3	Team roles	3

	Team roles Belbin perspective Discussion group roles Effective managerial behaviour in the context of team roles	
Pr4	Leadership Hersey and Blanchard theory Black and Mouton approach to leadership Fiedler theory and his Least Preferred Coworker Scale Situational leadership self-assessment	3
Pr5	Summary; Effective managerial behaviour from the different contexts.	3
	Suma godzin	15

Forma zajęć - laboratorium		Liczba godzin
Part A		
La1	Supply and Demand curves. Elasticity of demand.	2
La2	Economic costs. Cost curves. Profit maximization cases.	2
La3	Managerial cost accounting. Decision making cases.	2
La4	Basic financial accounting. Creation of simple Balance Sheet, Profit and Loss Statement and Cash Flow Statement	2
La5	Ratio analysis based on financial statements of companies	2
La6	Time value of money and capital budgeting – calculation by means of Excel functions	2
La7	Financial model of an investment. Sensitivity and Scenario analysis.	3
Part B		
La8	Basic concepts (process, project, project management, management by projects, critical factors for project success, competences). Preparing and initiation of the project. Project analysis (project environment, stakeholders, project objectives).	3
La9	Planning and estimating of the project. Project phases and life cycle	3
La10	Project organization. Project scope management. Planning of activities, resources and costs.	3
La11	Project risk management. Project monitoring. Project management methodologies.	3
La12	Quality management. Change control. Project closing.	3
	Suma godzin	**30**

STOSOWANE NARZĘDZIA DYDAKTYCZNE

N1. Wykład interaktywny z pokazem slajdów i dyskusją
N2. Ćwiczenia laboratoryjne: indywidualne rozwiązywanie zadań z wykorzystaniem arkusza kalkulacyjnego.
N3. Ćwiczenialaboratoryjne: rozwiązywanie zadań w grupach. Prezentacja wyników. Dyskusja o otrzymanych wynikach
N4. Konsultacje
N5. Praca własna – rozwiązywanie zadań domowych
N6. Praca własna – samodzielne studia literaturowe

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW UCZENIA SIĘ

Oceny (F – formująca (w trakcie semestru), P	Numer efektu uczenia się	Sposób oceny osiągnięcia efektu uczenia się

– podsumowująca (na koniec semestru)		
F1	PEU_W01-W08 PEU_K01-K02	Dyskusja na zajęciach, ocena aktywności studentów na zajęciach laboratoryjnych i projektowych
F2	PEU_U01-U10 PEU_K01-K02	Ocena rozwiązań zadań uzyskanych przez studentów w trakcie zajęć laboratoryjnych i projektowych
P1	PEU_W01-W08 PEU_U01-U10 PEU_K01-K02	Egzamin pisemny
P2	PEU_W01-W08 PEU_U01-U10 PEU_K01-K02	Ocena indywidualnych rozwiązań zadań nadesłanych przez studentów po zajęciach

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA

LITERATURA PODSTAWOWA:

1. Erhardt M., Brigham E.: Financial Management Theory and Practice. South-Western Cengage Learning, USA
2. Brigham E.: Podstawy zarządzania finansami. Polskie Wydawnictwo Ekonomiczne, Warszawa 1997
3. Czekaj J., Dresler Z.: Podstawy zarządzania finansami firm. PWN Warszawa 1996
4. Jaruga A., Sobańska J., Kopczyńska L. Szychta A.: *Rachunkowość dla menedżerów*. Towarzystwo Gospodarcze RAFIB, Łódź 1996.
5. Jonson H.: Ocena projektów inwestycyjnych. Maksymalizacja wartości przedsiębiorstwa. Wyd. K.E. Liber, Warszawa 2000.
6. Nowak E.: Rachunek kosztów przedsiębiorstwa. Wydawnictwo Ekspert, Wrocław 2001
7. Sierpińska M., Jachna T.: Ocena przedsiębiorstwa według standardów światowych, PWN Warszawa 1994.
8. Świderska G. K.(red): Rachunkowość zarządcza. (praca zbiorowa) Wyd. Poltext, Warszawa 1997
9. Wysocki Robert K., McGary R., Efektywne zarządzanie projektami, OnePress, 2005
10. Lock Dennis, Podstawy zarządzania projektami, PWE, 2009

LITERATURA UZUPEŁNIAJĄCA:

1. Jajuga K., Jajuga T., 2006. Inwestycje. Instrumenty finansowe, aktywa niefinansowe, ryzyko finansowe, inżynieria finansowe, Wydawnictwo Naukowe PWN, Warszawa.
2. Jonson H.: Koszt kapitału. Klucz do wartości firmy. Wyd. K.E. Liber, Warszawa 2000
3. Turyna J., Pułaska-Turyna B.: Rachunek kosztów i wyników. Wyd. Finans-Servis, Warszawa 1997.
4. A Guide to Project Management Body of Knowledge (PMBOK®Guide Fourth Edition), Project Management Institute, 2008 (2004). wydanie polskie, MT&DC Warszawa, 2009 (2006)

OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)

Dr inż. Gabriela Paszkowska, Gabriela.paszkowska@pwr.wroc.pl

Zał. nr 5 do ZW 8/2020
Załącznik nr … do programu studiów

WYDZIAŁ GEOINZYNIERII, GÓRNICTWA I GEOLOGII

KARTA PRZEDMIOTU

Nazwa przedmiotu w języku polskim ***Zasady i zastosowania InSAR oraz GIS w górnictwie***
Nazwa przedmiotu w języku angielskim ***Principles and Application of InSAR and GIS in mining***
Kierunek studiów (jeśli dotyczy): Górnictwo i geologia
Specjalność (jeśli dotyczy): ***Geomatics for Mineral Resources Management (Geomatyka w zarządzaniu surowcami mineralnymi)***
Poziom i forma studiów: ~~I~~ / II stopień / ~~jednolite studia magisterskie~~*, stacjonarna / ~~niestacjonarna~~*
Rodzaj przedmiotu: obowiązkowy / ~~wybieralny~~ / ~~ogólnouczelniany~~ *
Kod przedmiotu W06GIG-SM0037
Grupa kursów ~~TAK~~ / NIE*

	Wykład	Ćwiczenia	Laboratorium	Projekt	Seminarium
Liczba godzin zajęć zorganizowanych w Uczelni (ZZU)	30		45		
Liczba godzin całkowitego nakładu pracy studenta (CNPS)	60		90		
Forma zaliczenia	Egzamin / ~~zaliczenie na ocenę*~~		~~Egzamin~~ / zaliczenie na ocenę*		
Dla grupy kursów zaznaczyć kurs końcowy (X)					
Liczba punktów ECTS	2		3		
w tym liczba punktów odpowiadająca zajęciom o charakterze praktycznym (P)			3		
w tym liczba punktów ECTS odpowiadająca zajęciom wymagającym bezpośredniego udziału nauczycieli lub innych osób prowadzących zajęcia (BU)	2		2		

*niepotrzebne skreślić

WYMAGANIA WSTĘPNE W ZAKRESIE WIEDZY, UMIEJĘTNOŚCI I KOMPETENCJI SPOŁECZNYCH

1. Zna podstawy programowania w językach: C++ oraz Python.
2. Ma podstawową wiedzę z zakresu roli narzędzi geoinformacyjnych (GIS) oraz z zakresu technik pozyskiwania danych przestrzennych.
3. Potrafi posługiwać się pakietem oprogramowania GIS
4. Ma podstawową wiedzę z zakresu baz danych

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CELE PRZEDMIOTU

C1 Przedstawienie wiadomości z zakresu satelitarnej interferometrii radarowej, a także możliwości wykorzystania jej w pomiarach deformacji terenu.
C2 Nabycie umiejętności wyznaczania przemieszczeń powierzchni terenu w oparciu o satelitarne dane radarowe.

C3	Przedstawienie wiadomości dotyczących stosowania GIS w zaawansowanej analizie obiektów, zjawisk i procesów zachodzących w przestrzeni
C4	Nabycie umiejętności formułowania i rozwiązywania zadań z zastosowaniem funkcji analitycznych GIS
C4	Nabycie umiejętności korzystania z danych i usług danych przestrzennych zgodnie z dyrektywą INSPIRE

PRZEDMIOTOWE EFEKTY UCZENIA SIĘ

Z zakresu wiedzy:

PEU_W01 Posiada poszerzoną wiedzę w zakresie wykorzystywania systemów geoinformacyjnych do gromadzenia i przetwarzania danych wykorzystywanych w modelowaniu zjawisk i procesów zarówno naturalnych jak i antropogenicznych

PEU_W02 Zna zasady budowy i funkcjonowania systemów geoinformacyjnych w branży górniczej i administracji publicznej

Z zakresu umiejętności:

PEU_U01 Potrafi korzystać z zaawansowanych narzędzi GIS w górnictwie, badaniach zjawisk przyrodniczych, oddziaływaniu górnictwa na otoczenie i zagospodarowaniu przestrzeni,

PEU_U02 Potrafi formułować i rozwiązywać zadania przestrzenne w środowisku GIS

PEU_U03 Potrafi interpretować otrzymane wyniki oraz wyciągać wnioski

Z zakresu kompetencji społecznych:

PEU_K01 Potrafi formułować i przekazać wiedzę na temat wykorzystania systemów geoinformacyjnych w analizach przestrzennych i prezentacji ich wyników

TREŚCI PROGRAMOWE

	Forma zajęć - wykład	**Liczba godzin**
Wy1	Omówienie syllabusu, warunków zaliczenia, literatury	2
Wy2	Wprowadzenie do teorii sygnałów mikrofalowych do obserwacji Ziemi	2
Wy3	Wykorzystanie pasywnej i aktywnej teledetekcji satelitarnej do wyznaczania przemieszczeń powierzchni terenu	2
Wy4	Akwizycja i przetwarzanie danych SAR	2
Wy5	Teoria obrazów SAR (geometryczne właściwości, polaryzacja)	2
Wy6	Podstawy obliczeń danych SAR metodami: DinSAR oraz SBAS	2
Wy7	Wykorzystanie danych SAR w monitorowaniu aktwyności powierzchni terenu (czynniki naturalne i antropogeniczne)	2
Wy8	Usystematyzowanie podstawowych pojęć z zakresu systemów informacji geograficznej	2
Wy9	Modelowanie danych w GIS. Reprezentacja danych przestrzennych. Bazy danych przestrzennych. Stan obecny i trendy rozwojowe	2
Wy10	Metody analiz przestrzennych w GIS	2
Wy11	Interpolacja danych przestrzennych	2
Wy12	Algebra mapy. Analizy powierzchni, funkcje lokalne, funkcje strefowe	2
Wy13	Podstawy statystyki przestrzennej	2
Wy14	Infrastruktury Informacji Przestrzennej. Dyrektywa Inspire. Open data	2
Wy15	Przykłady zastosowań systemów geoinformacyjnych w górnictwie i ochronie środowiska	2
	Suma godzin	**15**

Forma zajęć - laboratorium		Liczba godzin
La1	Konfiguracja środowiska do obliczeń SAR	3
La2	Wprowadzenie do obliczeń danych radarowych – zadania obliczeniowe	6
La3	Pozyskanie danych radarowych oraz obliczenia interferogramu – metoda DInSAR	3
La4	Rozwiniecie fazy interferometrycznej – obliczenia	3
La5	Prezentacja wyników obliczeń danych SAR w środowisku GMT	6
La6	Interpolacja danych dyskretnych. Przygotowanie danych wejściowych do analizy (np. pomiar przemieszczeń powierzchni terenu górniczego)	3
La7	Interpolacja danych dyskretnych. Opracowanie map rozkładu przestrzennego przemieszczeń różnymi metodami interpolacji.	3
La8	Interpolacja danych dyskretnych. Analiza i ocena jakości interpolacji. Mapa prognozy. Opracowanie map zmian zanieczyszczenia pomiędzy dwoma okresami z zastosowaniem kalkulatora rastrowego.	3
La9	Analizy przestrzenne – ocena przydatności terenu pod lokalizację wybranej inwestycji górniczej. Budowa bazy danych przestrzennych kryteriów lokalizacji	3
La10	Analizy przestrzenne – ocena przydatności terenu pod lokalizację Inwestycji górniczej. Wybór procedur i przeprowadzenie operacji analitycznych.	3
La11	Analizy przestrzenne – ocena przydatności terenu pod lokalizację inwestycji górniczej. Opracowanie modelu przetwarzania danych przestrzennych.	3
La12	Analizy przestrzenne – ocena przydatności terenu pod lokalizację inwestycji górniczej. Analiza i interpretacja wyników. Prezentacja graficzna i statystyczna wyników. Geowizualizacja	3
La13	GIS mobilny. Pozyskiwanie danych przestrzennych i atrybutowych w terenie.	3
	Suma godzin	**45**

STOSOWANE NARZĘDZIA DYDAKTYCZNE

N1. Wykład z elementami wykładu problemowego
N2. Prezentacje multimedialne
N3. Wykonanie indywidualnej pisemnej pracy semestralnej na zadany temat
N4. Materiały multimedialne (MOOC)
N5. Instrukcje laboratoryjne
N6. Wykonanie zadań laboratoryjnych i przygotowanie sprawozdań
N7. Konsultacje

OCENA OSIĄGNIĘCIA PRZEDMIOTOWYCH EFEKTÓW UCZENIA SIĘ

Oceny (F – formująca (w trakcie semestru), P – podsumowująca (na koniec semestru)	Numer efektu uczenia się	Sposób oceny osiągnięcia efektu uczenia się
F, P	PEU_W01 – 02 PEU_U01 – 03 PEU_K01	F1 Ocena końcowa z egzaminu w formie pisemnej, F2 Ocena z pisemnej pracy semestralnej, P Ocena końcowa z wykładu (średnia ważona z F1 – 80% oraz F2 - 20%)
F, P	PEU_W01 – 02 PEU_U01 – 03	F3 Ocena z wykonanych zadań i sprawozdań Pisemnych,

	PEU_K01	F4 Ocena ze sprawdzianów pisemnych, P2 Ocena końcowa z laboratorium (średnia ważona z F3 – 80% oraz F4 - 20%)

LITERATURA PODSTAWOWA I UZUPEŁNIAJĄCA

LITERATURA PODSTAWOWA:

[1] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. 2015: Geographic Information Science and Systems, 4th Edition, John Wiley & Sons;
[2] Maguire D., Batty M., Goodchild M., 2005. GIS Spatial Analysis and Modelling. ESRI Press
[3] Berry J., 2007-2013. Beyond Mapping IV — GIS Modelling
[4] Satellite InSAR Data: Reservoir Monitoring from Space, A. Ferretti, EAGE; 1st edition, 2014
[5] GMTSAR: An InSAR Processing System Based on Generic Mapping Tools (Second Edition), D. Sandwell i in., Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA, USA, 2016
[6] InSAR Principles - Guidelines for SAR Interferometry Processing and Interpretation, ESA Publications, 2008

LITERATURA UZUPEŁNIAJĄCA:

[1] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)
[2] Kennedy M., 2009: Introducing Geographic Information Systems with ArcGIS: A Workbook Approach to Learning GIS, Second Edition, John Wiley and Sons;
[3] Longley P. A., Goodchild M. F., Maguire D. J., Rhind D. W., 2006. GIS. Teoria i praktyka. Wydawnictwo Naukowe PWN, Warszawa
[4] Urbański J., 2010. GIS w badaniach przyrodniczych, Wydawnictwo Uniwersytetu Gdańskiego
[5] Dokumentacja środowiska GMT (Generic Mapping Tools) - http://gmt.soest.hawaii.edu/projects/gmt/wiki/Documentation

OPIEKUN PRZEDMIOTU (IMIĘ, NAZWISKO, ADRES E-MAIL)

Wojciech Milczarek, wojciech.milczarek@pwr.edu.pl
Jan Blachowski, jan.blachowski@pwr.edu.pl

Semestr 2

Montanuniversitaet Leoben

Mine Surveying Project Study

Course Nb	200.032
ECTS	4,5
Type	Project Work
Offering period	Wintersemester
Lecturer	Mayer, Pilgram
Course description	
Content	• Project study on various topics in the field of Mine Surveying and Mining Subsidence Engineering
Previous knowledge expected	• Good English skills (Minimum: CEF Level B1) • Successful completion of the courses o Applied Geodesy (200.199) o Applied Geodesy Practical (200.200) o Engineering Surveying (200.201) o Engineering Surveying Practical (200.202) o Pre-Calculation of Ground Movements (200.028)
Objective (expected results of study and acquired competences)	On completion of this course the participants shall be able to: • Structure the project, define the sequence with milestones and form working groups • Combine interdisciplinary knowledge from mine surveying and mining subsidence engineering on a practical topic
Languages of instruction	English
Teaching and learning method (delivery of skills) workload for students	Practical teamwork

Further information	
Recommended reading	Ghilani, C. D., Wolf, P., Elementary Surveying Kratzsch, H.: Bergschadenkunde, ISBN 3-00-001661-9 Kratzsch, H.: Mining Subsidence Engineering, ISBN 0-387-11930-2 Möser, Müller, Schlemmer, Werner: Handbuch Ingenieurgeodäsie- Grundlagen; 3.Auflage; ISBN 3-87907-293-0 Torge, W., Müller, J.: Geodesy; 4th edition; ISBN 978-3-11-020718-7
Note	The assessment methods and the compulsory readings of this course will be announced in detail in the first lecture. The latest version of the lecture notes will be uploaded at the beginning of the semester.
Study Program	
Master program	Mining and Tunneling Specialty 1 "Mining" / Systems Engineering and Open Pit Mining
Type	Compulsory subject

Mining Subsidence Engineering

Course Nb	200.045
ECTS	3
Type	Lecture
Offering period	Wintersemester
Lecturer	Pilgram
Course description	
Content	• Legal issues applied to mining subsidence engineering especially the pre-calculation of ground subsidence • The dynamics of ground movement and the critical areas of extraction in a subsidence trough after Lehmann • Calculation of trough components • Some varieties of calculation procedure • Measures to reduce mining damage • The components of ground movement • The time factor • Mining damage above ground • Compensation of subsidence damage • The calculation of diminished value
Previous knowledge expected	• Good English skills (Minimum: CEF Level B1)
Objective (expected results of study and acquired competences)	On completion of this course the participants shall be able to: • plan, implement and evaluate the pre-calculation of Ground Movements with some simple different methods. • plan, assemble and analyze deformation profiles and monitoring networks of ground movements

	• know the basics about the legal relationship between mining and land ownership • calculate the diminished value • plan and implement measures to reduce mining damage • share the costs for damage from two or more mines.
Languages of instruction	English
Teaching and learning method (delivery of skills) workload for students	Lectures Active participation, discussions Practical examples
Further information	
Recommended reading	Kratzsch, H.: Bergschadenkunde, ISBN 3-00-001661-9 Kratzsch, H.: Mining Subsidence Engineering, ISBN 0-387-11930-2 Pilgram, R.: Lehrbehelf zur Vorausberechnung von Bodenbewegungen, The Precalculation of Ground Subsidence, Chair of Mining, Montanuniversitaet Leoben
Note	The assessment methods and the compulsory readings of this course will be announced in detail in the first lecture. The latest version of the lecture notes will be uploaded at the beginning of the semester.
Study Program	
Master program **Type**	Mining and Tunneling Specialty 1 "Mining" / Rock Mechanics, Systems Engineering und Underground Mining Compulsory subject

Risk Management in Mines

Course Nb	200.145
ECTS	1,5
Type	Lecture
Offering period	Wintersemester
Lecturer	Wagner
Course description	
Content	• Introduction into the objectives and methods of risk management in mines • Definitions: hazard, risk, damage, severity number, risk number • Types of risks in mining: safety, human, geological, technical, economic, contractual, political, time, environmental • Safety risk-safety statistics • Acceptable and tolerable risks • Methods of risk identification: brain storming, risk check lists, expert risk evaluation • Methods of risk analysis: Regression and correlation analysis, probabilistic event analysis, fault tree analysis, Delphi-method, Monte Carlo simulation, scenario building • Risk classification: risk matrix-severity and probability; risk register • Risk treatment: eliminate • Monitoring: physical, environmental, financial, human • Human factor in risk management

Previous knowledge expected	• Good English skills (Minimum: CEF Level B1) • Proven knowledge of mining engineering (Bachelor in Mineral Resources Engineering, examination in major mining engineering subjects) • In case these are missing the student has to pass an entrance test at the beginning of the course with the following contents: o Surface and underground mining methods o Mining equipment o Mine ventilation o Geology
Objective (expected results of study and acquired competences)	On completion of this course the participants shall be able to: • Have an appreciation of the inherent risks in mining • Have skills to identify and quantify mining risks • Know the risk management process with the emphasis on mining risks • Know risk analysis and evaluation techniques • Know about basic capabilities to perform risk assessment and management in mines.
Languages of instruction	English
Teaching and learning method (delivery of skills) workload for students	Lectures Active participation and discussion
Examination	Oral examination
Further information	
Recommended reading	Hartman, h. L. and Mutmansky, J. M. (2002): Introductory Mining Engineering, John Wiley &Sons Inc., 570 pp.

	ISO 3100- Risk Management. Intern. Standards Organization Wagner, H. (2001): Die Besonderheiten des Risikomanagements im Bergbau. Berg- und Hüttenmännische Monatshefte, BHM., 146 Jg., Springerverlag Wien, S.37-41.
Note	The assessment methods and the compulsory readings of this course will be announced in detail in the first lecture. The latest version of the lecture notes will be uploaded at the beginning of the semester.
	Study Program
Master program	Mining and Tunnelling Specialty 1 "Mining" / Elective Subjects
Type	Compulsory subject
Master program	Mining and Tunneling Specialty 3 "Raw Materials and Energy Systems" / Restricted Electives
Type	Compulsory subject
Master program	International Master of Science in Advanced Mineral Resources Development Restricted Electives
Type	Elective subject

Spatial Planning

Course Nb	200.177
ECTS	1,25
Type	Lecture / Practical
Offering period	Wintersemester
Lecturer	Pilgram
Course description	
Content	• Functional and Legal Spatial Planning • Overview of the levels and planning instruments of Spatial Planning in Austria • How to use these planning tools • How and where can I get information about sources of data and accuracy of these data • Data sets and services of the Austrian provinces for free of use based on the principles of Open Data • Spatial Planning tasks associated with Mining License Procedures • Reorganization of Land • Cadaster and Land registration
Previous knowledge expected	• Good English skills (Minimum: CEF Level B1)
Objective (expected results of study and acquired competences)	On completion of this course the participants shall be able to: • Use the basics of Functional and Legal Spatial Planning • Use the planning instruments of Spatial Planning in Austria, the countries and Planning Tools of the regions and urbans • Know how and where to get information about sources of data and accuracy of these data

	• Use data sets and services of the Austrian Provinces • Use Spatial Planning Tasks associated with Mining License Procedures • Know about reorganization of land • Know about cadaster and land registration
Languages of instruction	English
Teaching and learning method (delivery of skills) workload for students	Lectures Active participation, discussions
Further information	
Note	The assessment methods and the compulsory readings of this course will be announced in detail in the first lecture. The latest version of the lecture notes will be uploaded at the beginning of the semester.
Study Program	
Master program	Mining and Tunneling Specialty 1 "Mining" / Elective Subjects
Type	Compulsory subject

Underground Mining

Course Nb	200.036
ECTS	4,5
Type	Lecture
Offering period	Wintersemester
Lecturer	Moser P.
Course description	
Content	• Underground mining methods. • Mine development. • Stoping methods for tabular deposits. • Rock Mechanic design of room and pillar system. • Pillar extraction mining. • Longwall mining. • Cut and fill mining methods. • Shrinkage stoping. • Open stoping. • Caving methods • Backfill
Previous knowledge expected	• Good English skills (Minimum: CEF Level B1) • Sustainable knowledge in the following fields - successful completion of the following lectures: o Mining Rock Mechanics (200.179) o Basics of Excavation Engineering (200.054)
Objective (expected results of study and acquired competences)	On completion of this course the participant should be able to -on the basis of a practical (deposit) example-: • Design the access to the deposit • Develop a mining method

	• Discuss the geotechnical requirements and implications of different mining methods • Join together and combine all his acquired knowledge (systems thinking)!!
Languages of instruction	English
Teaching and learning method (delivery of skills) workload for students	• Lectures • Active participation and discussion.
Further information	
Recommended reading	Brady, B.H.G. and Brown, E.T.; Rock mechanics for underground mining; 3rd Ed., 2004 Cernica, J.; Soil Mechanics; 1995 Hustrulid: Underground mining methods. 200 Potvin, Y.; Thomas, E.; Handbook in Mine Fill; 2005
Note	The assessment methods and the compulsory readings of this course will be announced in detail in the first lecture. The latest version of the lecture notes will be uploaded at the beginning of the semester.
Study Program	
Master program	Mining and Tunneling Specialty 1 "Mining" / Rock Mechanics, Excavation Engineering und Underground Mining
Type	Compulsory subject
Master program	Mining and Tunneling Specialty 3 "Raw Materials and Energy Systems" / Raw Materials
Type	Compulsory subject
Master program	International Master of Science in Advanced Mineral Resources Development Restricted Elective Subjects
Type	Elective subject

3-rd Semester

Semestr 3

Montanuniversitaet Leoben

Environmental Aspects of Mineral Extraction

Course Nb	200.058
ECTS	3
Type	Lecture
Offering period	Summersemester
Lecturer	Tscharf
Course description	
Content	This course provides a comprehensive outline and understanding on the impacts that mineral extraction may have on society and environment. The unit covers 7 broad areas • Mining, sustainability and ethical responsibilities • Impacts of mining projects on atmospheric environment • Impacts of mining projects on terrestrial environment • Impacts of mining projects on aquatic environment • Impacts of mining projects on social values • Site reclamation and mine closure • Environmental Impact Assessment (EIA)
Previous knowledge expected	• Good English skills (Minimum: CEF Level B1) • Basics of Open Pit Mining (200.061) • Basics of Underground Mining (200.180)
Objective (expected results of study and acquired competences)	The students should become familiar and be capable of demonstrating an understanding with the environmental and social aspects associated with mining projects as well as environmental impact assessment processes (EIA) in Austria,

	Europe and Overseas. On completion of this course the participants shall be able to • Describe the principles of mining and sustainable development in context with ethical responsibilities • Identify, analyze and understand the major impacts of mining projects in atmospheric, terrestrial and aquatic environments • Describe the major issues associated with social/community impacts of mining projects • Discuss the aspects of site reclamation and mine closure in context with the prevention of environmental impacts for decades after mining ceases • Describe the purpose and the stages of the EIA process
Languages of instruction	English
Teaching and learning method (delivery of skills) workload for students	Lecture Active participation, discussions
Further information	
Recommended reading	Azcue, J. M., Ed.: Environmental impacts of mining activities. Springer, 1999. Environmental Law Alliance Worldwide (ELAW): Guidebook for Evaluation Mining Project EIAs, 1st edition, 2010 Evans, A.M.: An introduction to economic geology and its environmental impact. Blackwell Science Ltd, 1997.

	Sengupta, M.: Environmental impacts of mining – monitoring, restoration and control. Lewis Publishers, 1993. Wagner, H. et al.: Umweltauswirkungen der Rohstoffgewinnung. Montanuniversitaet Leoben, 2006.
Note	The assessment methods and the compulsory readings of this course will be announced in detail in the first lecture. The latest version of the lecture notes will be uploaded at the beginning of the semester.
	Study Program
Master program	Mining and Tunneling Specialty 1 "Mining" / Rock Mechanics, Excavation Engineering und Underground Mining
Type	Compulsory subject
Master program	Mining and Tunneling Specialty 3 "Raw Materials and Energy Systems" /
Type	Restricted Electives Compulsory subject

Applied Geodesy

Course Nb	200.199
ECTS	3
Type	Lecture
Offering period	Summersemester
Lecturer	Mayer, Pilgram
Course description	
Content	• Theory of errors in observations and adjustments; method of least squares • Reference and mapping systems • Methods of precise surveying • Gyroscopic surveying • Methods of 3D positioning

Previous knowledge expected	• Good English skills (Minimum: CEF Level B1)
	• Sustainable knowledge in the field of surveying.
	• At the beginning of the course the students have to pass an entrance test with the following contents:
	  ○ Implementation and evaluation of an angle measurement with a theodolite
	  ○ Calculation of the 1st and 2nd main task of geodesy
	  ○ Planning, implementation and calculation of a traverse
	  ○ Planning, implementation and calculation of a levelling
	  ○ Coordinate and mapping systems in geodesy and reference systems for position and height measurements

Objective (expected results of study and acquired competences)	On completion of this course the participants shall be able to • Detect and adjust errors in surveying • Apply reference and mapping systems including calculations • Plan, implement and evaluate precise surveying methods for distance measurements, angle measurements and levelling • Plan, implement and evaluate measurements with gyrotheodolites • Apply 3D positioning methods such as traversing, GNSS-surveying, free positioning, reverse cut and forward cut
Languages of instruction	English
Teaching and learning method (delivery of skills) workload for students	Lectures Active participation and discussion
Further information	
Recommended reading	Ghilani, C. D. and Wolf, P. R., Elementary Surveying
Note	The assessment methods and the compulsory readings of this course will be announced in detail in the first lecture. The latest version of the lecture notes will be uploaded at the beginning of the semester.
Study Program	
Master program **Type**	Mining and Tunneling Specialty 1 „Mining" – Elective Subjects Compulsory subject

Applied Geodesy (Practical)

Course Nb	200.200
ECTS	2
Type	Practical
Offering period	Summersemester
Lecturer	Mayer, Pilgram
Course description	
Content	• See Applied Geodesy (200.199)
Previous knowledge expected	• Good English skills (Minimum: CEF Level B1) • Sustainable knowledge in the field of surveying. • At the beginning of the course the students have to pass an entrance test with the following contents: o Implementation and evaluation of an angle measurement with a theodolite o Calculation of the 1st and 2nd main task of geodesy o Planning, implementation and calculation of a traverse o Planning, implementation and calculation of a levelling o Coordinate and mapping systems in geodesy and reference systems for position and height measurements
Objective (expected results of study and acquired competences)	• See Applied Geodesy (200.199)
Languages of instruction	English

Teaching and learning method (delivery of skills) workload for students	Practical exercises
Further information	
Recommended reading	Ghilani, C. D., Wolf, P. R.: Elementary Surveying
Note	This Practical can only be enrolled together with the lecture Applied Geodesy (200.199)! The assessment methods and the compulsory readings of this course will be announced in detail in the first lecture. The latest version of the lecture notes will be uploaded at the beginning of the semester.
Study Program	
Master program **Type**	Mining and Tunneling Specialty1 „Mining" – Elective Subjects Compulsory subject