BOOK OF SUBJECTS

MINING ENGINEERING

MASTER ACADEMIC STUDIES
(II LEVEL OF ACADEMIC STUDIES)

2023

CONTENT

Study program: Mining Engineering

Course: MATHEMATICAL PROCESSING OF EXPERIMENTAL DATA

Lecturer/s: Ivana Z. Đolović

Status of the course: Compulsory

ECTS: 6

Prerequisite: /

Course goals: Students should be able to use appropriate mathematical and statistical concepts and tools in recognizing and solving problems

Learning outcomes: Students should be able to apply theoretical knowledge from statistics in recognizing and solving tasks in the sense of processing of experimental data using different and appropriate statistical tools and techniques

Course description:
Lectures:
Introduction to probability. Random event. Discrete and continuous random variables and most important distributions (the binomial probability distribution; the Poisson probability distribution; the normal distribution; Student's t- distribution; the Chi-squared distribution; the F distribution); the probability density function; expected value and variance; Introduction to statistics (statistical data, frequency distribution, mean values; measures of dispersion; coefficient of skewness; Pearson's moment coefficient of kurtosis (excess kurtosis); population and sample); Confidence intervals; Hypothesis tests (selected parametric and non-parametric tests); Regression analysis(linear regression; exponential regression; logarithmic regression)
Practice:

Calculation exercises and application in real problems (with and without some statistical packages - advantages and disadvantages)

Literature:

Recommended:

1. I.Đolović, Statistika, Univerzitet u Beogradu, Tehnički fakultet u Boru, Bor, 2016.

2. I.Đolović, Zbirka zadataka iz statistike, Univerzitet u Beogradu, Tehnički fakultet u Boru, Bor, 2011.

Ancillary:

1. Mann S.P., Uvod u statistiku (srpsko izdanje), Centar za izdavačku delatnost Ekonomskog fakulteta, Beograd, 2009.

2. Mann S.P., Introductory Statistics (many editions in English)

Number of classes per week	**Lectures: 2**	**Practical classes: 2**	**Study research work: /**	**Other forms of teaching: /**

Teaching methods

Frontal teaching for theoretical knowledge and group, individual and combined learning in practical parts of lessons (students engagement through active learning – applications and discussions)

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	/	Written part of the final exam	**50**
Exercise attendance	/	Oral part of the final exam	/
Coloquium exam/s	**30**	.....	
Term paper	**20**		

Study program: Mining engineering

Naziv predmeta: Technical and economic assessment of projects

Lecturer: dr Dejan T. Riznić, red. prof., dr Saša S. Stojadinović, van. prof.

Course status: Obligatory

ECTS: 6

Prerequisites: Passed exam on Economics and Business Organization

Course goal

Introducing students to the basics of the procedure and manners of performing technical and economic assessment of projects in order to determine the viability of the project.

Course outcome

Ability to make independent and qualified consideration of the possible impacts, social, economic, technical, environmental and other, to viability of the project execution.

Course description

Theoretical:

The basics of business economics. Costs, Cost structure, Investment costs, fixed costs, variable costs, concept of depreciation, cost calculation, discounting, project value determination, Net Present Value, Internal Rate of Return, Planned investments, Investment dynamics. Types of technical and economic grades, TEA of mineral deposits, Preliminary economic assessment, Preliminary feasibility study, Feasibility study, Due Diligence analysis. Base case assessment, cost-benefit base case analysis, Project case assessment, cost-benefit project case analysis,

Practicals:

Computational exercises that accompany the lecture program

Literatura

D. Riznić, R. Nikolić, Ekonomika i organizacija poslovanja, TF Bor, Bor, 2017.
V. Stefanović, R. Nikolić, Ekonomika i organizacija preduzeća, PMF, Niš, 2000.
Begg. D, Ward. D, Economic for bussiness, McGraw-Hill Higher education 2006.
M. Savić, M. Bugarin, Modeliranje ležišta sa procenom resursa i planiranjem otkopavanja na površinskim kopovima, IRM Bor, Bor, 2019.
Ian C. Runge, Mining economic and strategy, SMME, Littleton, USA, 1998.

Number of classes per weak	**Theoretical: 2**	**Practical: 2**

Lecture methods

Predavanja, Vežbe

Grading system (Maximum of 100 points)

Prerequisits	points	**Final examination**	points
Active participation / lectures	**10**	written exam	**20**
Active participation/exercises	/	oral exam	**30**
colloquium	**20**		
Assignment	**20**		

Study program: Mining Engineering

Course: Theoretical principles of physical processes of preparation and concentration

Lecturer/s: Lecturer/s: PhD. Milan Ž. Trumić, full professor, PhD. Jovica M. Sokolović, full professor

Status of the course: Elective for PMS and RTOR modules

ECTS: 9

Prerequisite: Acquired knowledge at undergraduate academic studies on PMS and RTiOR modules

Course goals: Acquiring of students with theoretical principles of physical processes of preparation and concentration of mineral or secondary raw materials.

Learning outcomes: Enabling students for independent scientific research paper in the field of physical processes of preparation and concentration or continuing training in this field.

Course description:

Lectures: Theoretical principles of comminution raw materials. Calculation of mass movement schemes and introduction with typical schemes of comminution and classification of raw materials. Liberation of the minerals and particle-size of mineral raw material. Mathematical models of liberation of the minerals. Theoretical basses of comminution. Laws of comminution. Theory of crushing and grinding processes. Kinetics of grinding bodies-the grinding medium. Grinding kinetics. Choice of grinding mill. Bond work index. Theoretical principles of classification of raw materials. Theoretical foundations of the screening process. Study of the parameters that characterize the screening process. Kinetics of screening. Study the conditions for the movement of raw materials on the sifting surface. Choice of sieves. Theoretical foundations of the classification process. Theoretical principles of operation of devices for hydraulic and air classification. Study the performance indicators of the classifier. Theoretical principles of gravity methods of concentration. Theoretical principles of grain stratification in fluids. Theoretical principles of operation of separators with suspensions for gravity concentration. The minimum (critical) grain diameter in the gravity concentration process. Theoretical principles of gravitational concentration in water. Phases of grain movement. Analysis of forces during movement of grains down an oblique plane in a thin layer of water. Analysis of the forces during grain movement in the working section of the sedimentation machine. Theoretical principles of control of gravitational concentration processes . Methods of predetermining the results of the concentration of raw materials. Theoretical principles of magnetic concentration methods. Theoretical principles of operation of magnetic separators. Theoretical analysis of forces in the process of magnetic concentration. Minimum (critical) grain diameter in the process of magnetic concentration. Magnetohydrodynamic and magnetohydrostatic separation of minerals. Theoretical principles of electrical concentration methods. Theoretical principles of operation of electrostatic separators. Theoretical analysis of the forces acting on grains of different electrical conductivity in the separation zone of the separator. The minimum (critical) grain diameter in the electrical concentration process.

Practice: Laboratory and computational exercises and other forms of teaching.

Literature:

1. Magdalinović, N. (1999). Comminution and classification, Nauka, Belgrade.
2. Magdalinović, N. (1985). Crushing and classification of mineral raw materials - practical course, Technical Faculty in Bor, Bor.
3. Ćalić, N. (1990). Theoretical basis of preparation of mineral raw materials, Faculty of Mining and Geology, Belgrade,
4. Ignjatović, M., Ignjatović, R., Trumić, M., (1999). Principles of operation of separators with suspensions, Technical Faculty in Bor, Bor.
5. Ignjatović, M. (1997). Magnetic separation, new trends in the preparation of mineral raw materials, Belgrade.
6. Svoboda, J. (2004). Magnetic techniques for the treatment of materials, Springer, 2004.

Number of classes per week	**Lectures: 3**	**Practical classes: 3**	**Study research work:**	**Other forms of teaching:**

Teaching methods

Theoretical teaching is conducted through lectures, and practical in the form of exercises based on an interactive principle with active participation of students and preparation of a term paper.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**10**	Written part of the final exam	**20**
Exercise attendance	**10**	Oral part of the final exam	**40**
Coloquium exam/s			
Term paper	**20**		

Study program: Mining Engineering

Level of study: Master Academic Studies

Course: THEORETICAL PRINCIPLES OF PHYSICAL-CHEMICAL AND CHEMICAL CONCENTRATION PROCESSES

Lecturer/s: Dr Maja Trumić, Associate Professor, Dr Grozdanka Bogdanović, Full Professor

Status of the subject: Obligatory subject

ECTS: 9

Prerequisite: Acquired knowledge from the subject of Flotation and Leaching and Solutions Processing

Course goals: Introducing students with theoretical and fundamental principles on which flotation concentration and chemical processes of concentration are based.

Learning outcomes: Theoretical and practical training of students for work in educational and scientific research institutions as well as in the practice of flotation concentration and chemical concentration processes (leaching).

Course description:

Lectures: Flotation: INTRODUCTION (phenomena in the flotation system, definitions and terminology) PULP PHASE (solid phase: mineral crystalline structure and types of bonding in crystal lattice, crystal defect, hydrophobic and hydrophilic solid surfaces, liquid phase: physical and chemical water properties, chemical composition of natural waters, gaseous phase: air and gases used in flotation - SO_2 and N, and their physical and chemical characteristics), PHASE BOUNDARY - INTERFACE (phenomenon on phase boundary, electrokinetic potential, electrode potential, dual electric layer, hydration and hydrolysis, ion exchange), FLOTATION REAGENTS (adsorption of surfactants at the three-phase wetting interface); LEACHING: Physico-chemical basis of the leaching processes. Chemical and electrochemical reactions. Potential-pH equilibrium diagrams**.** Leaching kinetics**:** rate, order of reaction and influence of temperature. Reactions at the solid surface and geometric models selection: diffusion controlled reactions; chemically controlled reactions; complex reaction kinetics. Leaching agents. Metals leaching. Leaching of primary raw materials (oxide, carbonate, silicate and sulphide minerals). Leaching of technogenic raw materials (mining tailings, flotation tailings, dusts and sludges). Leaching of solid waste and ash of incinerators. The role of microorganisms in the process of leaching. Methods of leaching and equipment. Heap, dump and in-situ leaching.

Practice: Practical teaching is carried out in laboratories in the form of experimental and calculus exercises, and according to the theoretical teaching program.

Literature

Recommended:

1. M. M. Gifing, Stages of flotation pulp, RGF, Belgrade, 1986.
2. S. Milošević, Flotation concentration, TF, Bor, 1995.
3. M. R. Vujasinović, V. Grekulović, Theory of Hydro and Electrometallurgical Processes, Bor, 2017
4. N. Pacović, Hydrometallurgy, ŠRIF, Bor, 1980.
5. G.D. Bogdanović, M.M. Antonijević, Behavior and oxidation of chalcopyrite in an aqueous environment, Technical Faculty, Bor, 2011.
6. F. Habashi, A Textbook of Hydrometallurgy, Metallurgie Extective Quebec, Enr., 1992
7. J.Solyom, Fundamentals of the Physics of Solids. Springer, 2009..
8. A.W.Adamson, Physical Chemistry of Surfaces, John Wiley&Sons, Inc., 1997,
9. J. Drzymala, Mineral Processing, Foundations of theory and practice of minerallurgy, Wroclaw University of Technology, Wroclaw 2007
10. H. Ibach, Physics of Surfaces and Interfaces, Springer, 2006.

Number of classes per week	Lectures: 3	Exercises: 3

Teaching methods: Lectures with interactive work with students, practical work through laboratory and computational exercises. Pre-examination of knowledge through two colloquiums and seminar work

Knowledge evaluation (max. number of points 100)

Pre-examination obligations	**Points**	**Final exam**	**Points**
Lecture attendance	5	Written exam	
Exercise attendance	10	Oral exam	50
Colloquium 1+2	10+10		
Term paper	15		

Study program: Mining Engineering

Course: Sanitation and recultivation

Lecturer/s: PhD. Jovica M. Sokolović, full professor

Status of the course: Elective course on ELMS, PMS and RTOR modules

ECTS: 6

Prerequisite: Acquired knowledge at undergraduate academic studies

Course goals: Training students in technologies and equipment used for sanation and reclamation in general, and in mining in particular.

Learning outcomes: The ability of the student to make a qualified decision on the choice of technology and equipment for sanation and recultivation and to be able to calculate their basic parameters.

Course description:

Lectures: Introductory remarks. Historical development, significance, condition and trends in the field of sanation and reclamation. Basic concepts and terms. Standards and legislation in the field of rehabilitation and reclamation. Technologies for rehabilitation of degraded areas. Reclamation technologies. Technical reclamation. Biological reclamation. Care and maintenance of the reclaimed area.

Practice: Preparation of a term paper related to rehabilitation and recultivation.

Literature:

Recommended:

1. Pavlović, V., (2000). Reclamation of surface mines and landfills, Faculty of Mining and Geology, Belgrade.
2. Vujić, S., Cvejić, J., I. Miljanović, I., Dražić, D., (2009). Designing recultivation and landscaping of surface mines (monograph), Faculty of Mining and Geology, Belgrade.
3. Dražić, D., (2002). Multifunctional valorization of the landscape and ecosystem created by the reclamation of the surface mine disposal site of the Kolubara basin, Federal Secretariat for Labour, Health and Social Welfare, Sector for the Environment, Belgrade.
4. Đorđević-Miloradović, J., Miloradović, M., Savić, N., (2012). Recultivation and greening of tailings and ash dumps in Kostolac (II edition), Požarevac.
5. Žikić, M., Sokolović, J., (2018). Sanation and land reclamation (authorized lectures), University of Belgrade, Faculty of Engineering, Bor.

Number of classes per week	**Lectures: 3**	**Practical classes: 2**	**Study research work:**	**Other forms of teaching:**

Teaching methods

Teaching is conducted in the form of lectures and auditory exercises with an effort to involve the students as much as possible, i.e. to be interactive. This is realized directly in classes or in the form of presentations, which have been previously prepared by a team of students or individually. In the lectures, the theoretical part of the material is presented with constant illustration with characteristic examples from practice. During the exercises, specific cases are analyzed and instructions are given regarding the preparation of the term paper. Teaching and exercises are intensively supported by Moodle platform. Engagement of students in lectures and exercises, as well as prepared term paper, are scored as pre-exam activities.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**10**	Written part of the final exam	
Exercise attendance	**10**	Oral part of the final exam	**60**
Coloquium exam/s	/		
Term paper	**20**		

Study program: Mining Engineering

Course: PROCESSES MODELING AND OPTIMIZATION

Lecturer: Dr Dejan Petrović, assistant professor

Status of the course: Elective for EMD Module

ECTS: 6

Prerequisite: Knowledge of Mathematics and understanding of mining processes

Course goals: Understanding of the modeling and optimization methods and their application to mining, mineral processing or recycling processes

Learning outcomes: Individual competencies for decision making and management in mining, mineral processing or recycling related processes.

Course description:

Lectures:

Introduction, Formulation of mathematical models. Linear programming. Basic terminology. Convex sets.

Limiting set allowed domain. Geometric interpretation of linear programming problem. General shape of linear programming model and its properties. Standard shape of LP model and its general solutions. Simplex method. Duality in LP. Sensibility analysis. Transportation problem. Problem formulation. Closed model of transportation problem. Initial allowed solution. Optimum solution of transportation model. Open model of transportation problem. Prohibited route transportation problem. Activity executors selection. Network planning. Project activities and Gantt chart. Structure analysis. Time analysis. Time and cost analysis

Practice:

Practical use of LP and Network planning techniques to solve modeling and optimization problems.

Literature:

Recommended:

1. M.Vujošević, M. Stanojević, N. Mladenović, Metode optimizacije, Društvo operacionih istraživača Jugoslavije, Beograd, 1996.
2. S. Krčevinac, M. Čangalović, V. Kovačević-Vujčić, M. Martić, M. Vujošević, Operaciona istraživanja, Fakultet organizacionih nauka, Beograd, 2006.
3. M. Perišić, Linearni modeli optimizacije i odlučivanja u rudarstvu, Rudarski institut, Beograd, 1986

Number of classes per week	**Lectures: 3**	**Practical classes: 2**	**Study research work:**	**Other forms of teaching:**

Teaching methods

Oral lectures, calculation tasks, discussion

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**10**	Written part of the final exam	**60**
Exercise attendance	**5**	Oral part of the final exam	
Coloquium exam/s	**25**	.....	
Term paper			

Study program: Mining Engineering

Course: AUTOMATION OF TECHNOLOGICAL PROCESSES

Lecturer/s: Dr. Zoran Stević, full professor

Status of the course: Elective for all modules

ECTS: 6

Prerequisites: None

Course goals: Acquiring knowledge about systems for controlling and monitoring of industrial processes. Acquiring skills about designing advanced controlling systems that can be implemented in industrial processes

Learning outcomes: Students should master the techniques of industrial process control system design using computers, through practical work in the laboratory with application in real industrial processes.

Course description:

Lectures:

Control of complex technological processes. Centralized control. Distributed control. Hierarchical control. Application of computers for real-time process control. Computer system in control with and without feedback. Connecting the computer to the control object. Types of computer-process coupling. Input/output devices. Software support for control in real-time systems. The use of microcomputers in the design and implementation of control systems. Functions and organization of programmable logic controllers (PLC). Typical input/output modules of programmable logic controllers. Concept of acquisition and control (SCADA) systems. Practical application of PLC and SCADA systems in process control. Distributed control systems. Industrial computer networks. Remote monitoring and process control.

Practice:

Through practical exercises in the laboratory, research work and the development of applications for visualization and monitoring of industrial processes, students process the methodological units that are given in within theoretical teaching.

Literature:

1. V. Drndarević, Personalni računari u sistemima merenja i upravljanja, Akademska misao, Beograd, 2003.

2. S. Turajlić, Upravljanje industrijskim procesima, skripta, Elektrotehnički fakultet, Univerzitet u Beogradu, Beograd, 2011.

3. K. Astrom, J.Wittenmark, Computer Controlled Systems, Pearson, 1996.

Number of classes per week	**Lectures: 3**	**Practical classes: 2**	**Study research work: None**	**Other forms of teaching: None**

Teaching methods

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**10**	Written part of the final exam	/
Exercise attendance	**40**	Oral part of the final exam	**50**
Coloquium exam/s	/		
Term paper	/		

Study program: Mining Engineering

Course: CONSTRUCTION OF SPECIAL UNDERGROUND FACILITIES

Lecturer/s: dr Dragan Zlatanović, assistant professor

Status of the course: Compulsory for ELMS students...

ECTS: 8

Prerequisite: Undergraduate studies

Course goals:

Introduction to special underground facilities construction techniques, technological phases and rock behavior.

Outcome of the course

Individual competences for special underground facilities design.

Course description:

Lectures:

Introductory remarks. Historic development, definitions and classification of underground facilities. Geology conditions and tunneling operations. Dimensioning: Railroad tunnels. Subways. Road tunnels. Hydrotechnical tunnels. Underground chambers. Support calculation.

Construction methods: General. Drill and blast tunneling. Mechanized tunneling. Chamber construction methods.

Concrete. Underground concrete works and paving.

Practice: Mine visits

Practicals: Calculation tasks, Support calculation. Scheduling. Equipment selection. Design.

Literature:

Recommended:

1. P. Jovanović, Izrada podzemnih prostorija velikog profila, Građevinska knjiga, Beograd, 1984.

Ancillary:

1. V.Milić, Ž.Milićević, Osnovi eksploatacije ležišta mineralnih sirovina, Tehnički fakultet, Bor

Number of classes per week	**Lectures: 3**	**Practical classes: 2**	**Study research work: ?**	**Other forms of teaching: ?**

Teaching methods

Oral lectures, calculation tasks, discussion

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**5**	Written part of the final exam	
Exercise attendance	**25**	Oral part of the final exam	**70**
Coloquium exam/s		.....	
Term paper			

Study program: Mining Engineering

Course: SUSPENSION OF MINING OPERATIONS

Lecturer: Vušović M. Nenad

Status of the course: elective for ELMS module students

ECTS: : 6

Prerequisite: It is not intended

Course goals: Acquaintance of students with the technology and equipment that is used in case of suspension of work in mines, along with the calculation of basic parameters

Learning outcomes: The ability of the student to make qualified decisions about the choice of technology and equipment for the needs temporary or permanent suspension of mining operations

Course description:

Lectures:

Introductory remarks. Historical development, significance, state and trends related to the suspension of mining operations. Basic concepts and terms. Regulations regarding the suspension of mining operations. Temporary suspension of mining operations. Permanent suspension of mining operations. Abandoned mines and mining facilities. Rehabilitation and reclamation of mines after the suspension of mining operations. Reconstruction of mining works and facilities.

Practice: Preparation of a seminar paper related to the temporary or permanent suspension of mining works, for a given mine, with the calculation of technological stages

Literature:

Recommended:

2. Жикић М., Стојадиновић С., Стандарди, законска регулатива и техничка документација у рударству, Технички факулет у Бору, Бор (2018).
3. Павловић В., Технологија површинског откопавања експлоатације, Рударско-геолошки факултет, Београд, 1992.
4. Милићевић Ж., Милић В., Технологија подземне експлоатације лежишта минералних сировина, Технички факултет у Бору, Бор, (2013).
5. Павловић В., Рекултивација површинских копова и одлагалишта, Рударско-геолошки факултет, Београд, (2000).
6. Вујић С., Миљановић И., Цвејић Ј., Дражић Д., Пројектовање рекултивације и уређење предела површинских копова. Рударско-геолошки факултет, Београд (2009).

Ancillary:

7. Закони и подзаконски акти у непосредној и посредној вези са рударством (2015)
8. Збирка прописа за полагање општег дела стручног испита из области рударства и геологије (друго измењено и допуњено издање), Савез инжењера и техничара Србије, Београд (2017).

Number of classes per week	**Lectures:** 2	**Practical classes:** 2	**Study research work:** 0	**Other forms of teaching:** 0

Teaching methods lectures through presentations (https://moodle.tfbor.bg.ac.rs), followed by exercises

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance		Written part of the final exam	
Exercise attendance		Oral part of the final exam	60
Term paper	40		

Study program: Mining Engineering

Course: STABILITY OF MINING FACILITIES

Lecturer/s: Dr Radoje Pantović, full professor

Status of the course: Elective

ECTS: 6

Prerequisite: Passed the Rock and Soil Mechanics exam

Course goals: Acquaintance of students with the causes of underground pressure, methods of forecasting and measurement of underground pressure and room deformations, as well as understanding the procedure for choosing the appropriate substructure of the mine room.

Learning outcomes: Students should acquire knowledge about the influence of the construction of mine rooms on the disruption of the natural stress state, theoretical methods of determining stress-deformation states around the mine room, field methods of measuring forces, stresses, deformations and displacements. Based on the above, students should evaluate the stability of a certain mine room and choose the type and load-bearing capacity of the appropriate substructure.

Course description:

Lectures: Stress state of the uninitiated rock massif. Stress distribution around the constructed mine room of different shape and orientation in space, in the cracked and in the elastic environment. Underground pressures due to physical and chemical processes. Swelling pressures. Grobb's Law of Swelling. Theories of relief vault. Substructure theories. Classifications of rock massifs are significant from the perspective of assessing the stability of mine premises. Classification of RQD. Q classification. Rabcevic's classification for the application of anchoring. Talobre's classification. Lauffer's classification. Dynamic manifestation of underground pressures. Measurements aimed at determining and controlling underground pressures. Direct measurement of underground pressure. Convergence measurement. Measurement of voltage in the substructure, i.e. cladding. Pressure cells. Measurement of forces in anchors. Measurement of forces in pulleys. Measurement of rock mass deformations with extensometers. The choice of substructure type depends on the predicted dynamics of voltage changes and deformations around the room.
Practice: Development of a model of the stress-deformation behavior of the rock mass around the mine room using appropriate software. Calculation of stresses and deformations around corridors, manholes, manholes, in different working environments. Evaluation of the influence of the weather factor on the stability of the room. Safety factor calculation. Subgrade selection.

Literature:

Recommended:

1. M. Stević, Mehanika tla i stijena, RGF, Tuzla, 1991.

2. B. Kujundžić, Osnove mehanike stena, Građevinski kalendar, 1979.

Ancillary:

3. E. Hoek , Practical Rock Engineering, 2000. www.rocscience.com/hoek/PracticalRockEngineering.asp
4. E. Hoek, P.K. Kaiser, W.F. Bawden: Support of Underground Excavations in Hard Rock, 1995.

Number of classes per week	**Lectures: 3**	**Practical classes: 2**	**Study research work:**	**Other forms of teaching:**

Teaching methods

Oral lectures, computational exercises with calculations of the stability of mine premises using software and preparation of studies

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**10**	Oral part of the final exam	**50**
Term paper	**20**		
Coloquium exam/s	**20**		

Study program: Mining engineering

Course: MINING LEGISLATION

Lecturer: dr Saša Stojadinović, van. prof.

Course status: Obligatory

ECTS: 4

Prerequisites: N/A

Course goal

Acquisition of basic knowledge of the regulations (standards and legislation) that accompany mining

Course outcome

The ability of the student to effectively search, analyze and apply regulations relating to mining.

Course description

Theoretical:

Introductory remarks. Historical development, significance, state and trends in the development of regulations in general and those related to mining. Basic concepts and terms. Structure and division of regulations. Standards and related documents in general and related to mining. Constitution, social and economic order of the Republic of Serbia. Working relationship. General administrative procedure. Laws and bylaws in general and in direct connection with mining. Laws and bylaws indirectly related to mining. Examples.

Practical:

N/A.

Literature

M. Žikić, S. Stojadinović, Standardi, zakonska regulativa i tehnička dokumentacija u rudarstvu, Tehnički fakulet u Boru, Bor, 2018.

Zbirka propisa za polaganje opšteg dela stručmnog ispita iz oblasti rudarstva i geologije (drugo izmenjeno i dopunjeno izdanje), Savez inženjera i tehničara Srbije, Beograd, 2017.

Standards and related documents in direct and indirect connection with mining.

Laws and bylaws in direct and indirect connection with mining.

Additional literature as recommended by the lecturer.

Number of classes per weak	**Teorijska nastava: 2**	**Praktična nastava: 0**

Lecture methods

Classes are conducted in the form of lectures only with the effort to maximally involve students, i.e. to be interactive. This is realized directly in classes or in the form of presentations, which are previously prepared by a team of students or individually. The lectures present the theoretical part of the material with constant illustration of characteristic examples from practice. The teaching is intensively supported by a distance learning platform (Moodle). Students' involvement in teaching is scored as a preliminary activity.

Grading system (Maximum of 100 points)

Prerequisits	points	**Final examination**	points
Active participation / lectures	**30**	written exam	/
Active participation/exercises	/	oral exam	**70**
colloquium	/		
Assignment	/		

Study program: Mining Engineering

Course: UG MINE PRODUCTION PLANNING

Lecturer/s: dr Dragan Zlatanović, assistant professor

Status of the course: Elective for ELMS students...

ECTS: 8

Prerequisite: Acquired knowledge in the subject Modeling and optimization of processes

Course goals: Introducing students to the techniques and planning of the technological process of exploitation in mines with underground exploitation.

Outcome of the course
Acquiring a general understanding of planning the technological process for underground mining.

Course description:
Lectures:
Planning and implementation of projects. The role of planning in the production process, managing production, and types of plans. This includes the long-term production plan, annual production plan, monthly plan, and operational planning, as well as the methods of operational planning, such as deterministic and stochastic models. Additionally, production capacity and planning of production capacities will be covered, along with the application of software for optimizing and planning pit production.
Practice:

These classes will involve computational exercises that accompany the thematic areas covered in lectures.

Literature:

Recommended:

1. M. Pinedo. Scheduling – Theory, Algorthms and Systems.Third edition. Springer 2008. New York.
2. P. Jovanović. Upravljanje projektom. Deveto izdanje. Visoka škola za projektni menadžment, Beograd, 2010.
3. T. Mikac, D. Blažević. Planiranje i upravljanje proizvodnjom. Tehnički Fakultet u Rijeci, Rijeka 2007.
4. D. Malindžak. Production Logistics I. Štroffek publishing. Košice, 1998.

Number of classes per week	**Lectures: 3**	**Practical classes: 3**	**Study research work: ?**	**Other forms of teaching: ?**

Teaching methods

Lectures and practitioners

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**10**	Written part of the final exam	
Exercise attendance	**30**	Oral part of the final exam	**60**
Coloquium exam/s		.....	
Term paper			

Study program: Mining engineering

Course: OPTIMISATION OF SURFACE MINES

Lecturer: dr Saša S. Stojadinović, van. prof.

Course status: Izborni predmet modula ELMS

ECTS: 8

Prerequisites: Completed and passed courses of Technology of surface mining and Mine design
Mine

Course goal

Introducing students to the basics, principles and procedures for definition and selection of optimum open pit outline .

Course outcome

The ability of students to provide appropriate input data in concrete conditions, choose the appropriate method and optimize the surface mine in the design phase.

Course description

Theoretical teaching:

Deposit modeling, resource evaluation, block models, economic block models, constraints, factors influencing optimization, optimization methods, floating cone, Lerch Grosmann algorithm, possible surface mine outline, selection of optimal outline, criteria for choosing the optimal outline. Software packages for modeling and optimization of surface mines.

Practical classes:

Computational and demonstration exercises that accompany the program of lectures, individual work of students using software packages for design and optimization of surface mines.

Literature

1. M. Savić, M. Bugarin, Modeliranje ležišta sa procenom resursa i planiranjem otkopavanja na površinskim kopovima, IRM Bor, Bor, 2019.

Number of classes per weak	**Teorijska nastava: 3**	**Praktična nastava: 3**

Lecture methods

Lectures, Exercises, Working with software packages

Grading system (Maximum of 100 points)

Prerequisits	points	**Final examination**	points
Active participation / lectures	**10**	oral exam	**60**
Active participation/exercises	**10**		
Assignment	**20**		

Study program: Mining Engineering

Course: MINERAL PROCESSING DESIGN

Lecturer/s: PhD Milan Trumić, full professor, PhD. Vladan Milošević, assistant professor

Status of the course: Elective for module MP

ECTS: 6

Prerequisite: Acquired knowledge in the field of comminution and classification of materials, flotation and physical methods of concentration

Course goals:

Introducing students with basic principles of technical documentation preparation and design and equipment selection in plants for the mineral processing

Learning outcomes:

Acquiring basic knowledge in the field of design and preparing technical documentation

Course description:

Lectures:

Theoretical teaching: Introduction to the design of technological processes and plants. Technical documentation preparation: basic concepts and terminology, administrative and technical conditions. Documentation collection for design (collecting the data about technical characteristics of the device for equipment selection, and for the equipment supply and construction works). Defining a project task. Analysis of all phases that are an integral part of the design project of the basic technological process for the mineral raw materials concentration. Equipment selection from the catalog and preparation of technological data and substrates for other designs (mechanical, electrical, construction).

Practice:

Production of reports in the form of a technological project of the plant. Demonstration exercises with examples of project design for different plants in mineral processing.

Literature:

Recommended:

1. M. Trumić, I. Budić, M. Trumić, Osnovi projektovanja u PMS-u, autorizovana predavanja, Tehnički fakultet, Bor, 2008.
2. D. Salatić, D. Knežević, Tehnološke osnove projektovanja postrojenja za PMS, Rudarski institut, Beograd, 1996.

Ancillary:

1. B. Kolonja, D. Knežević, Transport u PMS-u, RGF, Beograd, 2000.
2. N. Magdalinović, M. Magdalinović-Kalinović, Upravljanje prirodnim resursima, Inorog, Bor, 2007.
3. Mineral Processing Handbook 7/07, Telsmith, Inc., USA, 2007.

Number of classes per week	**Lectures: 2**	**Practical classes: 2**

Teaching methods

Lectures with interactive work with students and practical in the form of demonstration exercises with the active participation of students and elaboration of the reports.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**10**	Written part of the final exam (5 points min.)	**20**
Exercise attendance	**10**	Oral part of the final exam	**40**
Coloquium exam/s		.....	
Term paper	**20**		

Study program: Mining Engineering

Course: Technologies for processing metallic mineral raw materials

Lecturer: PhD Zoran Štirbanović, Associate Professor

Status of the course: Elective for module MP

ECTS: 6

Prerequisite: none

Course goals: Introducing students with the basic technological processes used in the processing of metallic mineral raw materials, as well as the most modern trends in this field.

Learning outcomes: Teaching students to independently create technological processes for the processing of metallic mineral raw materials, in accordance with the latest trends in this field and the basic principles of sustainable development.

Course description:

Lectures: Introduction. Industrial processes for the processing of metallic mineral raw materials. Comminution processes (crushing and grinding). Classification processes (sieving and classification). Concentration processes (flotation, gravity concentration, magnetic concentration, electric concentration, leaching). Application of the process of preparation and concentration in technologies for the processing of metallic mineral raw materials: ores of non-ferrous metals (copper, lead, zinc, nickel, antimony, tin), ores of ferrous metals (iron, chromium and manganese), ores of light and rare metals, ores of precious metals (gold, silver, platinum and palladium). Technological indicators and control of industrial processes. Material balancing of processes. Contemporary trends in the field of technologies for the processing of metallic mineral raw materials. Sustainability of the process of processing metallic mineral raw materials. Economic assessment. Environmental impact assessment.

Practice: Practical work is conducted according to the program of theoretical lectures and include:

a) creation of technological schemes for the processing of metallic mineral raw materials based on the given characteristics of the raw material, and in accordance with the most modern trends and basic principles of sustainable development.

b) Calculation exercises: Determination of the material balance of technological schemes. Technological indicators and process control.

Literature:

Recommended:

1. D. Draškić, Industrial application of mineral processing, Book I, Student Publishing and Information Center, Belgrade, 1975. (*In Serbian*)
2. D. Draškić, Industrial application of mineral processing, Book II, Faculty of Mining and Geology, Belgrade, 1986. (*In Serbian*)

Ancillary:

1. C. G. Anderson, R. C. Dunne, J. L. Uhrie, (Eds.) Mineral Processing and Extractive Metallurgy : 100 Years of Innovation, Society for Mining, Metallurgy & Exploration (SME), Englewood, Colorado, USA, 2014.
2. A. Gupta, D. S. Yan, Mineral Processing Design and Operation: An Introduction, 1st edition, Elsevier, Amsterdam, Netherlands, 2006.
3. B. A. Wills, T. Napier-Munn, Wills' Mineral Processing Technology : An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery, 7th edition, Elsevier, Oxford, UK, 2006.

Number of classes per week	**Lectures: 2**	**Practical classes: 2**	**Study research work:**	**Other forms of teaching:**

Teaching methods

Lectures include interactive work with students, practical work through example analysis and computational exercises. Pre-exam knowledge check through one colloquium and one term paper.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**15**	Written part of the final exam	
Exercise attendance	**15**	Oral part of the final exam	**50**
Coloquium exam/s	**10**	.....	

Term paper	**10**		

Study program: Mining Engineering			
Course: PROCESSING TECHNOLOGIES OF NON-METALLIC MINERAL RAW MATERIALS			
Lecturer/s: Dr Maja Trumić, Associate Professor, Dr Vladan Milošević, Assistant Professor			
Status of the course: Elective subject, module MP			
ECTS: 6			
Prerequisite: Previous knowledge acquired in the study program Mining Engineering			
Course goals: The main goal is to acquaint students with technologies for the processing of non-metallic mineral raw materials, as well as the practical application of procedures for the preparation of non-metallic mineral raw materials. In addition, the goal is to familiarize students with the parameters of technological processes that are of essential importance for the choice of these processing technologies, i.e. starting from the basic principles: non-metallic mineral raw material and its characteristics (physical, chemical, physical-chemical, mineralogical, etc.) - industrial process and its applicability - applicability of equipment (machines and devices) – final product, its purpose, quality and user requirements; familiarization with the control of the processing process, as well as with technological, economic and ecological effects that are realized by applied processing technologies.			
Learning outcomes: Acquiring knowledge of theoretical and practical principles of Technologies for the processing of non-metallic mineral raw materials and the ability to apply that knowledge in the processes of preparing non-metallic minerals for individually stages of the process. The acquired knowledge forms the basis for further individual training in this area.			
Course description: *Theoretical teaching:* General about Technologies for the processing of non-metallic mineral raw materials: talc, pyrophyllite, zeolite, mica, feldspar, fluorite, dolomite, bentonite, clay, quartz sand limestone, basalt, magnesite, wollastonite, barite, white bauxite, dunite, borate, and raw materials for the construction, ceramic and new materials industry based on non-metallic mineral raw materials. *Practical classes-exercises:* Laboratory exercises (experimental and theoretical); familiarization with all stages of the process preparation of some non-metallic mineral raw materials: zeolite (crushing, grading), feldspar-mica (flotation concentration), quartz sand (grading, attrition).			
Literature 1. P. A. Ciullo, INDUSTRIAL MINERALS AND THEIR USES, Copyright @ 1996 by Noyes Publications, Library of Congress Catalog Card Number: 96-29173 2. J. Pavlica, D. Draškić: Preparation of non-metallic mineral raw materials, Mining and geological faculty, Belgrade, 1997. 3. Domestic non-metallic mineral raw materials for use in the economy, Editor: Siniša Milošević, ITNMS, Belgrade, 1998. 4. Lj. Andrić: "Production of non-metallic mineral raw materials", Chapter in the monograph: "Mineral raw material complex of Serbia today: challenges and crossroads", Academy of Engineering Sciences of Serbia (AINS), Faculty of Mining and Geology, University of Belgrade, Chamber of Commerce of Serbia,, 2010, Belgrade, pp. 189-202. 5. Lj. Andrić Preparation of non-metals in Serbia, Chapter in the monograph: Status and perspectives preparation of mineral raw materials in Serbia, Engineering Academy of Serbia, Belgrade, pp. 39-60 6. Lj. Andrić:Situation and perspectives of non-metallic mineral resources in Serbia, Chapter in Monographs:Firefighting, today and tomorrow, Association of Metallurgical Engineers, 2013, 65-81. 7. Lj. Andrić, editor of the chapter: "Exploitation of non-metallic mineral raw materials", in the monograph: "Serbian mining and geology in the second half of the 20th century", Academy of Engineering Sciences of Serbia, Matica Srpska, Mining Institute, p.413-461, 2014. 8. Lj. Andric, D. Radulović, M. Petrov, Non-metallic mineral raw materials as a basis of the long-term development of the economy of Serbia, IX Colloquium on the preparation of mineral raw materials, Department of preparation of mineral raw materials, University of Belgrade, Faculty of Mining and Geology, Belgrade, 2018, pp.50-92,			
Number of classes per week		Lectures: 2	Practical classes: 2
Methods of teaching: Audio-visual			

Knowledge rating (max. number of points 100)			
Pre-examination obligations	points	**Final examination**	points
Lecture attendance	10	Written part of the final exam	
Exercise attendance	10	Oral part of the final exam	50
Coloquium exam/s	10		
Seminars	20		

Study program: Mining Engineering

Course: Coal processing technologies

Lecturer/s: PhD. Jovica M. Sokolović, full professor

Status of the course: Elective course on PMS module

ECTS: 6

Prerequisite: Acquired knowledge at undergraduate academic studies

Course goals: Theoretical and practical familiarization of students with the principles, possibilities and basic procedures of coal processing.

Learning outcomes: Ability to independently choose the scheme of the technological process of coal processing, both integrally and by individual stages of the process, based on the characteristics of different types of raw coal.

Course description:

Lectures: Introduction. Coal: origin, basic characteristics, classification. Technical and elemental analysis of coal. Production, purpose and use of coal. Market requirements. Coal processing technologies. Theoretical basis of the process of gravity (in heavy medium, water and air) and flotation concentration of coal. Industrial processes of mine coal processing: crushing, sieving, grading, manual selection, gravity concentration (in heavy medium, water and air) and flotation concentration. Technological schemes of mine coal processing. Balance of coal preparation and concentration. Optimization and control of coal preparation and concentration processes. Predetermination of industrial results of coal preparation and concentration Theoretical basics of briquetting and pelleting. Technologies of briquetting and pelletizing. Devices for briquetting and pelletizing coal. Coal refining: drying, coking and semi-coking, gasification and liquefaction of coal.

Practice: Analysis of technological schemes of the processing of different types of raw coal in our country and in the world. Creation of technological schemes based on the given characteristics of raw coal. Determination of the material balance of technological schemes.

Literature:

Recommended:

1. Ignjatović, M., Milanović, D., Magdalinović, S., Urošević, D. (2011). Coal - industrial preparation and cleaning technologies. Copper Institute, Bor.
2. Draškić, D. (1975). Industrial application of the preparation of mineral raw materials, Book I, Student Publishing and Information Center, Belgrade.
3. Meyers, RA, Laskowski, JS, Walters, AD (2003). Coal preparation. In RA Meyers (Ed.), The encyclopedia of physical science and technology (pp. 79–106). San Diego: Academic Press. (electronic edition)
4. Nikolić P., Dimitrijević D., (1990). Coal of Yugoslavia, Invention, Belgrade.
5. Pantić, N., Nikolić, P. (1973). Ugalj, Naučna kljiga, Belgrade.

Number of classes per week	**Lectures: 2**	**Practical classes: 2**	**Study research work:**	**Other forms of teaching:**

Teaching methods

Teaching is conducted in the form of lectures and practical in the form of interactive exercises with the active participation of students and preparation of a term paper.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**10**	Written part of the final exam	
Exercise attendance	**10**	Oral part of the final exam	**50**
Coloquium exam/s	/		
Term paper	**30**		

Study program: Mining Engineering

Course: INDUSTRIAL WASTEWATER TREATMENT

Lecturer/s: Dr Grozdanka Bogdanović, Full Professor

Status of the course: Elective for module MP

ECTS: 6

Prerequisite: Acquired knowledge from course Wastewaters in Mineral and Recycling Technologies.

Course goals: Introducing students with industrial wastewater generated in mining **(**ore deposits of mineral raw materials and mineral processing plant**)** and technologies for their purification

Learning outcomes: Obtaining the necessary engineering knowledge on modern technologies of processing industrial wastewater.

Course description:

Lectures: The origin and quantities of industrial wastewater. Characterization of waste water**.** Requirements for the degree of wastewater treatment - legal regulations, treatment options. Industrial wastewater treatment. Physical (mechanical) procedures: clarification, settling, filtration. Chemical methods (neutralization, precipitation, oxidation, reduction). Physico-chemical methods (coagulation, flocculation, flotation, adsorption, ion exchange, extraction. Membrane processes. Biological methods (biological filtration, activated sludge, aeration lagoons, anaerobic processes). Sludge treatment and disposal. Examples of industrial wastewater treatment lines.

Practice: Study and interpretation of technology and scheme of technological processes

Literature:

1. R. Aćić, N. Magdalinović, M. Trumić, LJ. Šutulović, Dewatering and Tailing (in Serbian), Science, Belgrade, 2001 (Selected chapters)
2. M. Dimitrijević, Oxidation of pyrite and acid mine water (in Serbian) ,TF Bor, 2013.
3. M. Dimitrijević, S.Milić, Sulphide mining waste. Characteristics, environmental impact and treatment (in Serbian), TF Bor, 2017. (Selected chapters).
4. C. Forster, Wastewater Treatment and Technology, London, 2003.
5. F. Habashi, A Textbook of Hydrometallurgy, Metallurgie Extective Quebec, Enr., 1992 (Selected chapters)

Number of classes per week	**Lectures: 2**	**Practical classes: 2**

Teaching methods: Lectures, practise and practical work with interactive work with students

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**10**	Written part of the final exam	
Exercise attendance	**10**	Oral part of the final exam	50
Term paper	**30**		

Study program: Mining Engineering

Course: Design and management of municipal landfill

Lecturer/s: PhD. Jovica M. Sokolović, full professor

Status of the course: Elective course on RTiOR module

ECTS: 6

Prerequisite: Acquired knowledge at undergraduate academic studies

Course goals: Acquaintance of students with the technologies and equipment used for the construction and management of municipal landfills.

Learning outcomes: The ability of the student to make qualified decisions on the choice of technology and equipment for the construction and management of municipal landfills.

Course description:

Lectures: Introductory remarks. Historical development, significance, condition and trends in the field of municipal landfills. Basic concepts and terms. Standards and legislation in the field of design and waste management. Types and classification of waste. Municipal waste. Influential parameters and bases for design. Selection of macro and micro locations. Collection and treatment of municipal waste before disposal. Technologies for municipal waste disposal and construction of landfills. Closure and reclamation. Collection and treatment of waste water and landfill gas. Machines and devices. Management of municipal landfills. Examples of bad and good practice.

Practice: Preparation of a term paper related to the municipal landfill and its management, with the calculation of basic technological and economic parameters..

Literature:

Recommended:

1. Knežević, D., Torbica, S., Rajković, Z., Nedić, M., (2014). Disposal of industrial waste, Faculty of Mining and Geology, Belgrade.
2. Ilić, M.R., Miletić, S.R., (1998). Basics of solid waste management. Institute for Materials Testing, Belgrade.
3. Vujić, G., Dubavin, D., Stanisavljević, N., Batinić, B., (2012). Waste management in developing countries, Faculty of Technical Sciences, Novi Sad.
4. Nešić, B., (2010). Municipal waste management and potential for recycling in southern and southeastern Serbia, Center for the Development of Civil Society, Niš.
5. Žikić, M., Sokolović, J., (2018). Landfill design (authorized lectures), University of Belgrade, Faculty of Engineering, Bor.
6. Additional literature recommended by the lecturer.

Number of classes per week	**Lectures: 2**	**Practical classes: 2**	**Study research work:**	**Other forms of teaching:**

Teaching methods

Teaching is conducted in the form of lectures and auditory exercises with an effort to involve the students as much as possible, i.e. to be interactive. This is realized directly in classes or in the form of presentations, which have been previously prepared by a team of students or individually. In the lectures, the theoretical part of the material is presented with constant illustration with characteristic examples from practice. During the exercises, specific cases are analyzed and instructions are given regarding the preparation of the term paper. Teaching and exercises are intensively supported by Moodle platform. Engagement of students in lectures and exercises, as well as prepared term paper, are scored as pre-exam activities.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**10**	Written part of the final exam	
Exercise attendance	**10**	Oral part of the final exam	**60**
Coloquium exam/s	/		
Term paper	**20**		

Study program: Mining Engineering

Course: Recycling of metals and metal waste

Lecturer/s: PhD. Jovica M. Sokolović, full professor

Status of the course: Elective course on RTiOR module

ECTS: 6

Prerequisite: Acquired knowledge at undergraduate academic studies

Course goals: Theoretical and practical familiarization of students with the principles, possibilities and basic procedures of metal and metal waste recycling.

Learning outcomes: Acquisition of engineering knowledge necessary for further training in the field of metal recycling and metal waste.

Course description:

Lectures: Introduction. Sources, types and composition of waste. Life cycle of metals and metal waste. Collection, sorting and preparation of metal and metal waste for recycling. Copper and waste copper recycling technologies and procedures. Technologies and procedures of aluminum and scrap aluminum recycling. Technologies and procedures for recycling lead and waste lead. Technologies and procedures of zinc and waste zinc recycling. Technologies and procedures of iron and scrap iron recycling. Rare metals recycling technologies and procedures. Technological indicators and material balances of metal and metal waste recycling processes. Contemporary trends in the field of metal recycling and metal waste. Economic and ecological aspects of metal and metal waste recycling.

Practice: Practical classes are conducted according to the program of theoretical classes and include the analysis of technological schemes of the recycling process of various types of metals and metal waste in our country and in the world, as well as calculation exercises (determining the material balance of technological schemes; technological indicators and process control).

Literature:

Recommended:

1. Hodolic, J., Vukelic, Đ., Hadžistević, M. Budak, I. Badida, M. Shoosh, Lj. Kosec, B. Bosak, M. (2011). Recycling and recycling technologies, Faculty of Technical Sciences, Novi Sad.
2. Worrell, E., Reuter, M. (Eds.). (2014). Handbook of Recycling: State-of-the-art for Practitioners, Analysts, and Scientists. Newnes. (selected chapters)
3. Ristic, M. Vuković, M., (2006). Solid waste management, solid waste processing and disposal technologies, Technical Faculty in Bor, Bor.
4. Trumic, M. Andrić, Lj. Trumic, M., (2014). Waste management and treatment, Technical Faculty in Bor, Bor. (selected chapters)
5. Ilić, M.R., Miletić, S.R., (1998). Basics of solid waste management. Institute for Materials Testing, Belgrade.

Number of classes per week	**Lectures: 2**	**Practical classes: 2**	**Study research work:**	**Other forms of teaching:**

Teaching methods

Teaching is conducted in the form of lectures and practical in the form of interactive exercises with the active participation of students and preparation of a term paper.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**10**	Written part of the final exam	
Exercise attendance	**10**	Oral part of the final exam	**50**
Coloquium exam/s	/		
Term paper	**30**		

Study program: Mining Engineering

Course: Recycling of non-metallic waste

Lecturer: PhD Zoran Štirbanović, Associate Professor

Status of the course: Elective for module RTSD

ECTS: 6

Prerequisite: none

Course goals: Introducing students with basic technological processes applied for non-metallic waste recycling, as well as the most modern trends in this field.

Learning outcomes: Theoretical and practical training of students for the independent creation of technological processes for non-metallic waste recycling, as a prerequisite for work in scientific, educational and economic organizations dealing with this issue.

Course description:

Lectures:

Introduction. Industrial processes for separation and recycling of non-metallic waste. Comminution processes (crushing, grinding, shredding). Classification processes (sieving and classification). Concentration processes (flotation, gravity concentration, magnetic concentration, electric concentration, etc.). Application of preparation and concentration processes in non-metallic waste recycling technologies: plastic, paper, glass, wood, textile, rubber. Technological indicators and control of industrial processes. Material balances of processes. Contemporary trends in the field of non-metallic waste recycling.

Practice:

Practical work is conducted according to the program of theoretical lectures and include the creation of technological process schemes for recycling different types of non-metallic waste, as well as calculation exercises (determining the material balance of technological schemes; technological indicators and process control).

Literature:

Recommended:

1. J. Hodolič, Đ. Vukelić, M. Hadžistević, I. Budak, M. Badida, Lj. Šooš, B. Kosec, M. Bosak, Recycling and recycling technologies, Faculty of Technical Sciences, Novi Sad, 2011. (*In Serbian*)

Ancillary:

1. P. Bajpai, Recycling and Deinking of Recovered Paper, Elsevier, 2014.
2. M. Forrest, Recycling and Re-use of Waste Rubber, A Smithers Group Company, Shrewsbury, UK, 2014.

Number of classes per week	**Lectures: 2**	**Practical classes: 2**	**Study research work:**	**Other forms of teaching:**

Teaching methods

Lectures include interactive work with students, practical work through example analysis and computational exercises. Pre-exam knowledge check through one colloquium and one term paper.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**15**	Written part of the final exam	
Exercise attendance	**15**	Oral part of the final exam	**50**
Coloquium exam/s	**10**	.....	
Term paper			

Study program: Mining Engineering

Course: Thermal treatment of waste

Lecturer/s: PhD Zoran Štirbanović, Associate Professor; PhD Zoran Stević, Full Professor

Status of the course: Elective for module RTSD

ECTS: 6

Prerequisite: none

Course goals: Introducing students with theoretical and practical principles of thermal treatment of waste in order to obtain different types of energy**.**

Learning outcomes: Theoretical and practical training for work in scientific, educational and economic organizations dealing with this issue.

Course description:

Lectures: Introduction to thermodynamics. Work and heat. Heat capacity. The first law of thermodynamics. The second law of thermodynamics. Combustion. The heating power of the fuel. Composition and amount of combustion products. Gases and vapors. Legal regulations on the types of waste for which thermal treatment is carried out. Conditions and criteria for determining the location, technical and technological conditions for the design, construction, equipment and operation of thermal waste treatment facilities. Dealing with the residue after thermal treatment. Technologies for thermal treatment of waste. Incineration. Pyrolysis. Gasification. Plasma process. Modern technologies for thermal treatment of waste.

Practice: Practical work is conducted according to the program of theoretical lectures and include analyzes of various examples and computational exercises.

Literature:

Recommended:

1. J. Đoković, Thermodynamics, Technical Faculty in Bor, Bor, 2013. (*In Serbian*)
2. B. D. Đorđević, V. J.Valent, S. P. Šerbanović, Thermodynamics with thermotechnics, Faculty of Technology and Metallurgy, Belgrade, 2007. (*In Serbian*)
3. R. Šelmić, Technical thermodynamics, Scientific book, Belgrade, 1995. (*In Serbian*)
4. Law on Waste Management, Official Gazette of the Republic of Serbia. (*In Serbian*)
5. Regulation on types of waste for which thermal treatment is carried out, conditions and criteria for determining the location, technical and technological conditions for the design, construction, equipment and operation of facilities for thermal treatment of waste, handling of the residue after incineration, Official Gazette of the Republic of Serbia, no. . 102 of December 30, 2010, 50 of May 18, 2012. (*In Serbian*)
6. M. Ristić, M. Vuković, Solid waste management - solid waste processing and disposal technologies, Technical Faculty in Bor, Bor, 2006. (*In Serbian*)
7. M. Ž. Trumić, Lj. Andrić, M. S. Trumić, Waste management and treatment, Technical Faculty in Bor, Bor, 2014. (*In Serbian*)

Ancillary:

7. Forbes R. McDougall, Peter R. White, Marina Franke, Peter Hindle, Integrated Solid Waste Management - A Life Cycle Inventory 2nd Edition, Blackwell Science, Oxford, 2003.

Number of classes per week	**Lectures: 2**	**Practical classes: 2**	**Study research work:**	**Other forms of teaching:**

Teaching methods

Lectures include interactive work with students, practical work through example analysis and computational exercises. Pre-exam knowledge check through one colloquium and one term paper.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**15**	Written part of the final exam	
Exercise attendance	**15**	Oral part of the final exam	**50**
Coloquium exam/s	**10**	.....	

Term paper	**10**		

Study program: Mining Engineering			
Course: CHEMICAL AND BIOLOGICAL TREATMENT OF WASTE			
Lecturer/s: Dr Grozdanka Bogdanović, Full Professor			
Status of the course: Elective for module RTSD			
ECTS: 6			
Prerequisite: Required knowledge in the field of waste management			
Course goals: Introducing students with chemical and biological treatment of waste, as well as the application of acquired knowledge in choose the most favorable technology for waste treatment			
Learning outcomes: Theoretical and practical training of students for work in educational and scientific research institutions, state and economic organizations engage in this issue.			
Course description: Lectures: Introduction. Sources, types and composition of waste. Physical, chemical and biological properties of waste. Chemical treatment: Basics of the chemical process. Hydrolysis. Neutralization. Chemical deposition. Oxidation processes. Reduction processes. Electrochemical processes. Biological treatment: Basics of the biological treatment process. Types of microorganisms. **Necessary** conditions for the biological decomposition. Aerobic composting. Anaerobic digestion. Waste transformation, energy utilization and obtaining useful products. Practice: Analysis of specific examples of chemical and biological waste treatment technologies, with an emphasis on its transformation into useful products			
Literature: 1. M. Ristić, M. Vuković, Solid Waste Management, Solid Waste Processing Technology (in Serbian), TF Bor, 2006. 2. M.Trumić, Lj.Andrić, M.Trumić, Management and Treatment of Waste (in Serbian), TF Bor, 2014 (Selected chapters) 3. Forbes R. McDougall, Peter R. White, Marina Franke, Peter Hindle, Integrated Solid Waste Management - A Life Cycle Inventory 2nd Edition, Blackwell Science, Oxford, 2003. (Selected chapters) 4. P. Fečko, M. Kušnierova, V. Čablik, I. Pečtova, Environmental Biotechnology, VŠB-Technical University of Ostrava, Ostrava, 2006.			
Number of classes per week	**Lectures: 2**	**Practical classes: 2**	
Teaching methods: Lectures, exercises, term paper			
Knowledge evaluation (maximum 100 points)			
Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**5**	Written part of the final exam	
Exercise attendance	**10**	Oral part of the final exam	55
Term paper	**30**		

Study program: Mining Engineering

Course: STUDY RESEARCH WORK ON THEORETICAL BASIS OF THE MASTER THESIS

Lecturer/s: Dr Milan Trumić, Full Professor, Dr Mira Cocić, Full Professor, Dr Maja Trumić, Associate Professor

Status of the course: Obligatory subject

ECTS: 6

Prerequisite: Acquired knowledge through obligatory and elective subjects of the curriculum

Course goals: Acquiring knowledge for identifying and analyzing problems, finding solutions, presenting research results in the form of work and public presentation

Learning outcomes: Students are trained to independently identify problems, search literature, make conclusions and presentations

Course description:

Theoretical teaching: Getting acquainted with libraries and databases that contain scientific literature. Access and methods of searching library literature and literature on the Internet. Literature processing and citation literature. Processing of survey results using software packages for diagram processing, tables and images. Structure of master work. Methods for preparing a public presentation of the master's work.

Practical classes-exercises: Accessing and searching databases with specific examples. Processing concrete research results using software packages. Preparing the presentation.

Literature

Recommended:

1. M. Vuković, Ž. Živković, Methodology of scientific research work, Grafožig, Beograd, 2005.

Ancillary:

1. Databases of scientific journals on the Internet.

Number of classes per week	Lectures: 2	Practical classes: 2

Teaching methods: Theoretical lectures are conducted with lectures and practical in the form of demonstration exercises with the active participation of students and elaboration of the reports.

Knowledge rating (max. number of points 100)

Pre-examination obligations	points	**Final examination**	points
Lecture attendance	10	Written part of the final exam	
Exercise attendance	10	Oral part of the final exam	50
Seminars	30		

Study program: Mining Engineering

Course: Professional Practice

Lecturer/s: PhD. Jovica M. Sokolović, full professor, PhD. Saša Stojadinović, associate professor

Status of the course: Compulsory for Mining Engineering

ECTS: 4

Prerequisite: Passed the first semester

Course goals: The aim of the Professional Practice of master's academic studies is to familiarize students with the individual stages of the production process in the chosen organization in accordance with the optional module of the study program.

Learning outcomes: Training students for the practical application of previously acquired theoretical knowledge in solving specific industrial problems in the company where the internship is carried out and in similar companies. In addition to practical knowledge, students gain experience in presentation, analysis of results, finding solutions and giving conclusions. The ultimate outcome of the professional practice of the master's academic studies is the training of students for the future independent preparation of the master's thesis.

Course description:

Lectures: Professional practice is a form of teaching in which students acquire broader practical knowledge, skills and abilities. Professional practice takes place in the second semester and is a mandatory part of the study program. The student chooses an organization from the state, private or public sector, independently or with the help of the Professional Practice manager, in which he will perform the professional practice in the Republic of Serbia. The content of Professional Practice is different for students of individual modules of the Mining Engineering study program. The Professional Practice program is created by the student, in consultation with the teacher-coordinator of the Professional Practice of the corresponding module of the Mining Engineering study program and the specifics of the technological process of the company where the internship is carried out. After the completed Professional Practice, and based on the student's report and the confirmation of the responsible person who confirms with the Organization's signature and seal that the internship has been completed, the Professional Practice Manager verifies the completed Professional Practice.

Practice: Writing Professional Practice report.

Literature:

1. Technical documentation from the plant industry

Number of classes per week	**Lectures: 0**	**Practical classes: 6**	**Study research work:**	**Other forms of teaching:**

Teaching methods

After completing the Professional Practice, the student hands over three copies of the Professional Practice report to the teacher-coordinator. The teacher-coordinator of the professional practice examines the written elaboration of the professional practice and confirms with his signature in the index that the student has successfully completed it, which allows the student to certify the second semester of master's academic studies with other signatures.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**25**	Written part of the final exam	
Exercise attendance	/	Oral part of the final exam	**50**
Coloquium exam/s	/		
Term paper (report)	**25**		

Study program: Mining Engineering

Course: MASTER`S THESIS

Lecturers: All professors on study program are potential mentors

Status of the course: Compulsory for the study program

ECTS: 4

Prerequisite: Completed first semester on the study program Mining Engineering at master academic studies

Course goals: Preparing of students for completely independent research work after completing the master's degree study, expanding already acquired theoretical and practical knowledge as a good basis for later improvement in doctoral academic studies.

Learning outcomes: Practical application of acquired knowledge for independent scientific-research work and the creation of a master's thesis.

Course description:

The master's thesis is the result of the student's independent research work, which systematizes and applies scientific and professional knowledge in order to solve specific problems in the field of mining engineering. The student proves the ability to solve problems, originality in approach, ability to draw appropriate conclusions by the Master's thesis, as well as the ability to present a specific subject to the professional public. The master's thesis must be in the field of the elective module that the student enrolled. The candidate, under the guidance of a mentor, during the second semester performs study research related to the topic of the master's thesis, that is, prepares the theoretical basis for the preparation of the master's thesis. The student acquires the theoretical and practical phases of scientific research methods and searches available literature databases (KOBSON, SCOPUS, SCIENCE DIRECT, etc.). The student has a higher degree of independence during using the appropriate devices, equipment and software. The mentor guides the candidate and provides assistance in all phases of the research, through: choosing the subject of the master's thesis, formulating the title of the thesis, goal of the thesis, scientific and engineering methods, ways of solving it, approaching the problem, choosing the way to process the problem, experimental work and data collection.

Literature:

Number of classes per week	**Lectures:**	**Practical classes:**	**Study research work: 8**	**Other forms of teaching:**

Teaching methods

Mentoring work. Laboratory and field research. Independent preparation of individual chapters of the master's thesis in accordance with the content and plan and program of the chosen topic.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance	**25**	Written part of the final exam	
Exercise attendance	**25**	Oral part of the final exam	**50**
Coloquium exam/s		.....	
Term paper			

Study program: Mining Engineering

Course: PREPARATION AND DEFENDING OF MASTER`S THESIS

Lecturers: All professors on study program are potential mentors

Status of the course: Compulsory for the study program

ECTS: 4

Prerequisite: All exams passed on the study program Mining Engineering at master academic studies and completed professional practice

Course goals: The goal of the master's thesis is that the student independently process a certain scientific or practical problem, through theoretical analysis, experimental research and analysis of the achieved results.

Learning outcomes: Through the written presentation of the master's thesis and its public defense, the student demonstrates the ability to apply theoretical knowledge and practical skills in future engineering practice. Students are also capable for education at doctoral academic studies.

Course description:

The master's thesis represents the independent research work of students in narrower scientific and professional fields, mining, mineral processing and recycling technology and sustainable development. The content of the master's thesis is different for each student individually, aligned with the specifics of all three modules of the Mining Engineering study program. Mentor for the preparation and defense of the master's thesis is determined in accordance with the module of the study program. The student, in consultation with the mentor, independently creates the research program of his master's thesis in order to solve the tasks given to him. The candidate independently prepares individual parts of the master's thesis with the goal of sublimation of acquired knowledge in the study program. The results of the research should presented in the following form: introduction, theoretical part, experimental part, results with discussion, conclusion and literature. Final form of master's thesis the student submits three copies to the Faculty, after which the thesis is publicly defended in front of a three-member commission formed by teachers of this study program.

Literature:

Relevant literature in the field of mining engineering in paper and electronic form.

Number of classes per week	**Lectures:**	**Practical classes:**	**Study research work:**	**Other forms of teaching: 4**

Teaching methods

Mentoring and independent work of students in accordance with the chosen topic of the master's thesis. Laboratory research. After the mentor's approval of the finished work, the student defences master's thesis to a three-member commission. At the defense of the Master's thesis, the student must demonstrate that he has knolege of the subject matter from which he is defending the thesis, justify the conclusions and findings he has reached and defend them.

Knowledge evaluation (maximum 100 points)

Pre-examination obligations	Points	**Final exam**	Points
Lecture attendance		Written part of the final exam	**50**
Exercise attendance		Oral part of the final exam	**50**
Coloquium exam/s		.....	
Term paper			