	University of Belgrade Technical faculty in Bor	
	Accreditation of the study program	
	METALLURGICAL ENGINEERING	BASIC ACADEMIC STUDIES

METALLURGICAL ENGINEERING

UNDERGRADUATE ACADEMIC STUDIES

BOOK OF COURSES

2013

List of courses:

Study program: Mining Engineering, Metallurgical Engineering, Technological Engineering and Engineering Management

Level of study: Undergraduate Academic Studies

Course: MATHEMATICS I

Lecturer: Dr. Darko Kocev, assistant professor

Status of the course: Compulsory for Mining Engineering, Metallurgical Engineering and Technological Engineering and elective for Engineering Management

ECTS: 8

Prerequisite: Acquired secondary school knowledge of mathematics

Course goals: Application of acquired knowledge in the field of content items

Learning outcomes: Mastering the necessary fund of knowledge for following upcoming mathematical subjects as well as subjects for which we need mathematical tools

Course description:

*Lectures***:**

Introducing of basic notions (sets, relations, algebraic structures, sets of numbers); Matrices (definitions, equality of matrices, addition and multiplication of matrices); Determinants; Matrix inverse; Rank of a matrix; Systems of linear equations (solving the system using Gaussian method of elimination, Cramer's rule and Kronecker-Capelli theorem); Real functions of a real variable (basic notions); Limits of functions; Continuity of functions; Derivative of a function; Differential of a function; Theorems about differentiation; L'Hopital's rule; Taylor's formula; Determination of intervals of monotonicity of a function and finding local extremums of a function; Intervals of convexity and concavity and inflection points; Analysis of a function and drawing the graph of a function; Functions of two variables (basic notions, definitions, partial derivatives, Taylor's formula, local extremums) .

*Practice***:**

Calculation exercises

Literature

Recommended:

1. M. Janić, Matematika (I i II), TF Bor, 2003. (*in Serbian*)
2. M. Janić, Zbirka rešenih zadataka iz Matematike (I i II), TF Bor, 1996. (*in Serbian*)
3. M. Uščumlić, P. Miličić, Zbirka zadataka iz više matematike I, Nauka Beograd, 1996. (*in Serbian*)
4. S. Vukadinović, D. Sučević, Z. Šami, Matematika II sa zbirkom zadataka, Saobraćajni fakultet, Beograd, 2003. (*in Serbian*)

Ancillary:

1. B.P. Demidovič, Sbornik zadač i upražnenii po matematičeskomu analizu, Nauka, Moskva, 1997. (*in Russian*)

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

Methods of teaching: Frontal lectures with special emphasis on the application in the main courses of study program.

Knowledge rating (max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	20	Written exam	40
Practical classes		Oral exam	
Preliminary exam	40		
Independent work			

Study program: Mining Engineering, Metallurgical Engineering, Technological Engineering

Level of study: Undergraduate Academic Studies

Course: PHYSICS

Lecturer: Dr. Čedomir Maluckov, associate professor

Status of the course: Obligatory course for Mining Engineering, Metallurgical Engineering, Technological Engineering

ECTS: 8

Prerequisite: High school knowledge in physics

Course goals: Acquisition of basic knowledge of physical phenomena and relationships between physical quantities

Learning outcomes: Introduction to basic physical laws, in order to successful monitoring of teaching in higher years of study

Course description:

Theory teaching: Basics of vector analysis. International system units. Dimensional analysis. MECHANICS Basic concepts of kinematics. Straight and circular motion. Newton's laws of dynamics and defining basic concepts of dynamics. Conservation Laws of momentum, Energy and angular momentum. Basic concepts of statics. Newton's law of gravity. Elastic deformations. Oscillatory motion. Mathematical pendulum. Mechanical waves (polarization, interference and wave diffraction). Mechanics of fluid. Bernoulli equation. HEAT AND TEMPERATURE. The concept of temperature and heat. Expansion the body during heating. Gas laws. First and second law of thermodynamics. Adiabatic processes. Change in aggregate state. Real gases and critical temperatures. Transferring and passing the heat. ELECTROMAGNETICS. Coulomb law, the intensity of the electric field, the electric potential and the voltage. Force in an electric field. Electrical capacitance. DC, electrical resistance, Om's law. Kirchhoff's rules. Magnetic field. Magnetic induction. Electrical oscillations and electromagnetic waves. Alternating current. OPTICS. Light sources and photometric units. Geometric optics. Dispersion of waves. Total reflection. Thin lenses. Wave optics (interference, diffraction and polarization of light). Photoelectric effect. ATOMIC AND NUCLEAR PHYSICS. Rutherford-Bohr model of atom. Rydbergs constant and the interpretation of atomic spectra. X-ray radiation. Sommerfeld theory of elliptic pathways. Bohr magneton. Spatial quantization. Spin. Quantum numbers and Paul's principle. Radioactive radiation. The law of radioactive decay. Radioactive series. Nuclear reactions. Proton-neutron hypothesis of the atomic nucleus. The dimension of the core and the binding energy of the nucleus. Nuclear forces. Elemental particles. Particles and antiparticles. Classification of elemental particles.

Practical classes: Exercises, Other forms of teaching, Study research work

Computer and laboratory exercises follow lectures.

Literature

Recommended:

1. B. Pavlović, Fizika – prvi deo, Tehnološko-Metalurški fakultet, Beograd, 2004. (*in Serbian*)
2. B. Pavlović, Fizika – drugi deo, Tehnološko-Metalurški fakultet, Beograd, 2000. (*in Serbian*)
3. B. Pavlović, S. Milojević, Praktikum računskih vežbanja iz fizike, Naučna knjiga, Beograd, 1983. (*in Serbian*)

Ancillary:

1. B. Pavlović, S. Knežević, M. Radišić i D. Vesić, Praktikum za laboratorijske vežbe iz fizike, Tehnički fakultet u Boru, 1991. (*in Serbian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Grading system (max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	20
Practical classes	10	Oral exam	20
Preliminary exam	40		
Testing	5		

Study program: Mining Engineering, Metallurgical Engineering, Technological Engineering

Level of study: Undergraduate Academic Studies

Course: GENERAL CHEMISTRY

Lecturer: Dr. Milan Antonijević, full professor

Status of the course: Obligatory course for Mining Engineering, Metallurgical Engineering and Technological Engineering

ECTS: 8

Prerequisite: Acquired basic knowledge in the field of chemistry.

Course goals: The acquisition of basic knowledge about the structure of atoms and molecules, chemical bonding, chemical reactions and equilibrium. Students are mastering chemical calculations as well as practical classes in which the basic chemical laws are demonstrated.

Learning outcomes: Students are enabled to successfully master the material for the future study of chemistry at senior years.

Course Description:

Theoretical classes:

Chemical laws. Mol. Chemical reactions and stoichiometry. Periodic table of elements. Structure of atoms. Bohr atomic model. Wave-mechanical model of atom. Ionization energy, electron affinity and electronegativity. Chemical bonding. Covalent bonding. Complex compounds. Ionic bonding. Metallic bonding. Hybridization. Molecular orbitals. Characteristics of state of matter. Gases. Solutions. Amorphous and crystalline substances. Types of chemical reactions. Thermo-chemistry. Chemical thermodynamics. Chemical equilibrium. Chemical kinetics. Acid-base reactions. Sedimentation reactions. Redox reactions. Oxidation number. Electrode potential. Complexation reactions. Electrolytic dissociation. Ionic reactions. The main classes of inorganic compounds.

Practical classes: Exercises, Other forms of classes, Study research work

Laboratory classes.

Literature:

Recommended:

1. M. Dragojević, M. Popović, S. Stević, V. Šćepanović, Opšta hemija (I deo), Tehnološko-metalurški fakultet, Beograd, 2007. (*in Serbian*)
2. M. Popović, D. Vasović, LJ. Bogunović, D. Poleti, O. Ćuković, Zbirka zadataka iz opšte hemije, Tehnološko-metalurški fakultet, Beograd, 2007. (*in Serbian*)
3. S. Grujić, A. Hadži-Tonić, S. Jevtić, M. Nikolić, J. Rogan, Opšta hemija I – praktikum, Tehnološko-metalurški fakultet, Beograd, 2007. (*in Serbian*)

Ancillary:

1. D. Poleti, N. Rajić, Opšta hemija I – priručnik, Tehnološko-metalurški fakultet, Beograd, 2007. (*in Serbian*)
2. S. R. Arsenijević, Opšta i neorganska hemija, Partenon, Beograd, 2001. (*in Serbian*)
3. LJ. Bogunović, O. Leko, M. Popovič, S.Stevič, O.Ćuković, J. Šašić, D. Poleti, Zbirka zadataka iz Opšte hemije, TMF, Beograd, 1985. (*in Serbian*)

Number of classes per week				Other classes:
Lectures: 3	Practical Classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching: Classical lectures with interactive discussions, calculation and laboratory exercises, consultations with teachers and assistants, preliminary exams.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	10	Written exam	60
Practical classes	10	Oral exam	
Preliminary exam	20		
Independent work			

Study program: Mining Engineering or Metallurgical Engineering or Technological Engineering or Engineering Management

Level of study: Undergraduate Academic Studies

Course: **INFORMATICS I**

Lecturers: Dr. D. Brodić, associate professor, D. Stanujkić, associate professor

Status of the course: Compulsory course

ECTS: 4

Prerequisite: The basic informatics knowledge from high school

Course goals:

Acquiring basic computer knowledge in information technology

Learning outcomes:

Introducing students with the operation of computer systems and their application for data processing basic level

Course Description:

Numeral systems and number translation: The essence of numeral system, the translation of numbers from one numeral system to another, the conversion from binary to octal and hexadecimal numeral systems, binary arithmetic, basic arithmetic operations in the system with an arbitrary basis. Representation of data in computer: BCD data, one's complement, two's complement, complement arithmetic, ASCII codes. Boolean and switching algebra: definition of Boolean algebra and basic examples, idempotence law, the law of involution operation of negation, De Morgan's theorem, the law of absorption, the simplification of logic expressions, minimization of logical expressions, Karnaugh maps, switching algebra, analysis and synthesis logic circuits. Switching and logic gates: Switching gates, AND, OR and NOT logic gates, examples of logic gates, analysis and synthesis of switching gates.

Literature

Recommended:

Milos Ercegovac, Thomas Lang, Jaime H. Moreno, Introduction to Digital Systems, John Wiley and Sons, ISBN: 978-8-126-52251-4

Supplementary:

Darko Brodic, Milena Jevtic, Book of Assignments in Computer Science I, translation in English

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

Methods of teaching

Theoretical teaching with particular reference to the practical application of the material being taught.

Grading system (max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	10	Written exam	
Practical classes		Oral exam	40
Preliminary exam	40		
Term paper	10		

Study program: Mining Engineering, Metallurgical Engineering, Technological Engineering and Engineering Management

Level of study: Undergraduate Academic Studies

Course: ENGLISH LANGUAGE 1

Lecturer: Sandra Vasković, English language teacher

Status of the course: Compulsory course

ECTS: 2+2

Prerequisite: Basic language user

Goal of the course: Developing all language skills; the adoption of grammatical structures, vocabulary and an emphasis on functional English corresponding to the lower middle level (CEFR-A2)

Learning outcomes: Students can understand sentences and frequently used expressions related to areas of most immediate relevance (e.g. very basic personal and family information, shopping, local geography, employment). They can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters. They can also describe, in simple terms, aspects of his/her background, immediate environment and matters in areas of immediate need.

Course description:
Topics: Everyday life, Appearances, Life stories, The future, Comparison, People and places, In your life, Food and health, Possibilities, Activities, The media, Planet Earth, Time, Work .
Grammar: Verb tenses (present simple and continuous, past simple and continuous, present and past perfect, going to vs. will), First conditional, Second conditional, Comparison of adjectives, Modals, compound nouns and adjectives, phrasal verbs.
Language functions: making arrangements, life events, leaving messages, shopping, giving directions, ordering a meal, polite requests, telephone expressions, arranging a time, small talk.

Literature
Recommended:
1. Tom Hutchinson, Lifelines, Pre-Intermediate, Student's Book, OUP, Oxford, 2009
Supplementary:
1. Slavica Stevanović, Elementary grammar workbook with answers, Tehnički fakultet u Boru, 2018.
2. Raymond Murphy & William R. Smalzer, Basic Grammar in Use, CUP, Cambridge, 2007

Number of classes per week				Other classes:
Lectures: 1	Practical classes: 1	Other forms of teaching:	Study research work:	

Methods of teaching: eclectic method

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity participation	10	Final exam	40
Attendance	10		
Midterm exam	40		
Independent work			

Study program: Mining Engineering, Metallurgical Engineering, Technological Engineering

Level of study: Undergraduate Academic Studies

Course: INORGANIC CHEMISTRY

Lecturer: Dr. Snežana Milić, associate professor

Status of the course: Compulsory course for study programs: Metallurgical Engineering and Technological Engineering; Elective course for study program: Mining Engineering

ECTS: 8

Prerequisite: Acquired knowledge of general chemistry

Course goals: Students acquire basic knowledge of properties of elements, their reactions and compounds

Learning outcomes: Better understanding of technological subjects.

Course Description:
Theoretical lectures:
General characteristics of elements. Aboundance. Reactivity. Compounds. Application. Chemistry of hydrogen and noble gases. Chemistry of nonmetals and metaloides. Chemistry of metals. s and p elements. Transition metals (d and f elements). Chemical aspects of environment pollution.
Practical lectures: Exercises and other types of lectures. Study research.
Laboratory exercises.

Literature:
Recommended:
1. D. Poleti, Opšta hemija – II deo – hemija elemenata, Tehnološko-metalurški fakultet, Beograd, 2000. (*in Serbian*)
2. S. Grujić, A. Hadži – Tonić, S. Jevtić, M. Nikolić, J. Rogan, Opšta hemija II-praktikum,Tehnološko metalurški fakultet, Beograd, 2008. (*in Serbian*)
3. N. L. Glinka, Zadaci i vežbe iz opšte hemije, Naučna knjiga, Beograd, 1994. (*in Serbian*)
Supplementary:
1. N. Rajić, Praktikum neorganske hemije, Tehnološko – metalurški fakultet, Beograd, 2004. (*in Serbian*)
2. S. R. Aresenijević, Opšta i neorganska hemija, Partenon, Beograd, 2001. (*in Serbian*)
3. Lj. Bogunović i saradnici, Praktikum opšte hemije, II deo, TMF, Beograd, 1989. (*in Serbian*)
4. M. Jovanović, Kvalitativna analiza, Naučna knjiga, Beograd, 1989. (*in Serbian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 1	Other forms of teaching:2	Study research work:	

Methods of teaching
Traditional lectures with interactive discussions, computational and laboratory exercises, consultation and preliminary exams.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Active class participation	10	Written exam	60
Practical classes	10	Oral exam	
Preliminary exam	20		
Independent work			

Study program: Mining Engineering or Metallurgical Engineering or Technological Engineering or Engineering Management

Level of study: Undergraduate Academic Studies

Course: **INFORMATICS II**

Lecturers: Dr. D. Brodić, associate professor, D. Stanujkić, associate professor

Status of the course: Compulsory course

ECTS: 6

Prerequisite: Acquired IT knowledge of the course Informatics 1

Course goals:
Acquiring higher IT knowledge in information technology.

Learning outcomes:
Introduction to computer systems and their application for data processing at a higher level.

Course Description:
Theoretical work: Microsoft Office: Overview of software package Microsoft Office, The advantages of using packages, basic elements of Microsoft Word, Excel and PowerPoint. Practical work: Microsoft Excel: Entering data into a worksheet, work with columns, types and cells, formatting, worksheets, absolute and relative addresses, work with graphic objects, diagrams, internal database, sorting and filtering, subtotals, IF loops, practical exercises in the Excel, applications of the Excel. Microsoft PowerPoint: Creating presentations, add text to a slide, add, delete and re-arrange slides, types of animation, adding lists, the choice of modes of presentation, presentation design changes, inserting a chart from Excel, practical exercises in Power Point. Corel: CorelDraw environment, drawing basic shapes, moving and transforming objects, forming Line-Shape tool, cutting objects with a knife, the use of erasers, coloring and filling of objects, the contours of objects, tools for organizing objects, copying, duplication and cloning objects, effects envelope and distortions, and blending contour objects, practical exercises in Corel. Computers and computer systems: Hardware: The basic organizational unit of the computer, a block diagram of a computer, input/output units of computers, central processing units of computers, other computer parts and computer systems. Software: Types of the software, intellectual property, freeware and license software, computer viruses, software protection.

Literature
Recommended:
1. John Walkenbach, Microsoft Excel 2013 Bible, John Wiley & Sons, ISBN: 978-1-118- 49036-5
2. Faithe Wempen, Microsoft Powerpoint 2013 Bible, John Wiley & Sons, ISBN: 978-1- 118-48811-9
3. Roger Young, How Computers Work: Processor and Main Memory, ISBN: 978-1-442- 11398-5
Supplementary:
Darko Brodic, Book of Assignment for Computer Science II, translation in English

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

Methods of teaching
Theoretical teaching with particular reference to the practical application of the material being taught.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	10	Written exam	
Practical classes		Oral exam	40
Preliminary exam	40		
Seminar work	10		

Study program: Mining Engineering, Metallurgical Engineering and Technological Engineering

Level of study: Undergraduate Academic Studies

Course: ENGINEERING GRAPHICS

Lecturer: Dr. Dejan Tanikić, associate professor

Status of the course: Compulsory course

ECTS: 6

Prerequisite:

Course goals:
Obtaining knowledge about the basic geometric shapes, their mutual positions and intersections and their representation in the drawings, using manual sketching and drawing, as well as computer graphics.

Learning outcomes:
Students have mastered technical rules, regulations and conventions and can successfully use the most modern tools required for successful communication in the technical field.

Course description:
Theoretical teaching: Introduction to the Engineering Graphics. Modern graphic software. The basics of the projective representation (projection methods; projection planes; orthogonal projection; single and multiple views projections; projection of the point; projection of line; projection of planes; projection of solids; intersection of a plane and a solid; intersection of solids). Drawing geometric objects in three orthogonal projections. Axonometric representation of the geometric objects. Dimensioning and surface roughness marking. Tolerances. Sketching and drawing of the geometric objects. Drawing assemblies and part's details. Using computer to draw and model geometric objects. Saving, plotting and printing drawings. Using various available software packages for drawing.
Practical teaching: Exercises. Other forms of teaching.
Practical use of AutoCAD software package.

Literature
Recommended:
1. R. Ljubojević, M. Stevanović, Inženjersko crtanje, TMF Beograd, 1989. (*in Serbian*)
2. T. Pantelić, Tehničko crtanje, Naučna knjiga, Beograd, 1989. (*in Serbian*)
Supplementary:
1. Grupa autora, Programirana zbirka zadataka iz tehničkog crtanja sa nacrtnom geometrijom, Naučna knjiga, Beograd, 1990. (*in Serbian*)
2. Grupa autora, AutoCAD User's Guide, Copyright © 2001 Autodesk, Inc

Number of classes per week				Other classes:
Lectures: 2	Practical classes: 1	Other forms of teaching: 1	Study research work:	

Methods of teaching
Lectures, exercises, practical work, preliminary exams

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**	
Activity during the lecture	20	Written exam	0	60*
Activity during the practicals	10	Oral exam		
Practical work	10			
Preliminary exams	30+30=60			

* Students can pass the written exam by passing all preliminary exams.

Study program: Mining Engineering, Metallurgical Engineering, Technological Engineering

Level of study: Undergraduate Academic Studies

Course: MATHEMATICS II

Lecturer: Dr. Ivana Đolović, full professor

Status of the course: Compulsory course

ECTS: 8

Prerequisite: Fundamental knowledge in Mathematics I

Course goals: Application of the theoretical knowledge in further work

Learning outcomes: Students should be able to apply formal mathematical knowledge in recognizing and solving tasks in further studying process as well as real problems in engineering, sciences, business and technology fields

Course Description:

Indefinite integral(definition, substitution rule, integration by parts); Integration of rational and irrational functions; Integration of trigonometric functions; definite integrals; Improper integrals; Application of definite integrals; Differential equations of first order; Separable differential equations of first order; First order homogeneous linear equation; Linear differential equation of first order; Bernoulli differential equation; Lagrange's differential equation; Clairauts' differential equation ; Exact differential equation;. Differential equations of second order; Reduction of order of differential equation;

Second order linear homogeneous differential equations with constant coefficients

Second order linear homogeneous differential equations with variable coefficients; Second order linear nonhomogeneous differential equations with constant coefficients;

Second order linear nonhomogeneous differential equations with variable coefficients.. Lagrange's method of variation of parameters (constants)

Literature

Recommended:

1. M. Janić, Matematika (I i II), TF Bor, 2003. (*in Serbian*)
2. M. Janić, Zbirka rešenih zadataka iz matematike (1 i 2) TF Bor, 1996. (*in Serbian*)
3. M. Ušćumlić, P. Miličić, Zbirka zadataka iz više matematike I, Nauka Beograd, 1996. (*in Serbian*)
4. D. Mitrinović, J.Kečkić, Matematika II, Građevinska knjiga, Beograd, 1991. (*in Serbian*)
5. S. Vukadinović, D. Sučević, Z. Šami, Matematika II sa zbirkom zadataka, Saobraćajni fakultet, Beograd, 2003.

Supplementary:

1. Б.П.Демидович, Сборник задач и упражнении по математическому анализу, Наука, Москва, 1977 (*in Russian*)

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

Methods of teaching

Frontal teaching emphasizing application in the vocational subjects in the coming semesters

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture		Written exam	40
Practical classes		Oral exam	
Preliminary exam	60		
Independent work			

Study program: Engineering Management , Metallurgical Engineering, Technological Engineering

Level of study: Undergraduate Academic Studies

Course: STATISTICS

Lecturer: Dr. Ivana Đolović, full professor

Status of the course: Compulsory course

ECTS: 9

Prerequisite: Fundamental knowledge in mathematics

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 further studying process as well as real problems in engineering, sciences, business and technology fields

Course Description:
Introduction (statistical data, frequency distribution, absolute and relative frequencies, cumulative frequency); Mean values (arithmetic mean, geometric mean, harmonic mean, median,); measures of dispersion (range, quartiles and interquartile range, mean absolute deviation, variance, standard deviation); Coefficient of variation and meaning; Coefficient of skewness; Pearson's moment coefficient of kurtosis (excess kurtosis); Discrete and continuous random variables; The Binomial probability distribution; The Poisson probability distribution; The normal distribution; χ^2 - distribution; Student's t- distribution; Population and sample (types of sample, sample parameters); Point estimates of the population parameters; Confidence interval for population mean; Confidence interval for population proportion; Confidence interval for the difference of two population means; Confidence interval for the difference of two population proportions; Hypothesis tests; Hypothesis tests about the population mean; Hypothesis tests for the variance; Hypothesis tests of the equality of two means; Hypothesis tests about the population proportion; non-parametric tests; (χ^2 -test of independence; χ^2 - test of distribution); The correlation coefficient; Regression analysis; Coefficient of determination; standard error of the regression; Linear regression; Quadric regression; Exponential regression; Logarithmic regression

Literature
Recommended:

1. I. Đolović, Statistika, Univerzitet u Beogradu, Tehnički fakultet u Boru, Bor, 2016. (*in Serbian*)
2. N.Vuković, Statističko zaključivanje, FON, Beograd, 2007. (*in Serbian*)
3. S.Vukadinović, J. Popović, Matematička statistika, Saobračajni fakultet, 2004. (*in Serbian*)
4. I. Đolović, Zbirka zadataka iz statistike, Univerzitet u Beogradu, Tehnički fakultet u Boru, Bor, 2011. (*in Serbian*)

Supplementary:

1. Lj. Petrović, Teorijska statistika – Teorija statističkog zaključivanja, Centar za izdavačku delatnost Ekonomskog fakulteta, Beograd, 2006. (*in Serbian*)
2. Mann S.P., Uvod u statistiku (srpsko izdanje), Centar za izdavačku delatnost Ekonomskog fakulteta, Beograd, 2009. (*in Serbian*)

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

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

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the	20	Written exam	40

lecture			
Practical classes		Oral exam	
Preliminary exam	40		
Independent work			

Study programs: Technological Engineering, Metallurgical Engineering, Mining Engineering

Level of study: Undergraduate Academic Studies

Course: PHYSICAL CHEMISTRY

Lecturer: Dr. Marija B. Petrović Mihajlović, associate professor

Status of the course: Compulsory course for Technological Engineering, Metallurgical Engineering; and elective course for Mining Engineering

ECTS: 9

Prerequisite: Acquired knowledge of General chemistry

Course goals: Students introduction to physicochemical concepts, laws and principles. Theoretical foundation for studying structure and states of matter, physical processes and phase equilibrium in material systems, as well as chemical reactions and chemical equilibrium. Study fundamentals of chemical thermodynamics and kinetics, as well as electrochemistry.

Learning outcomes: Mastering and adopting fundamental physicochemical terms and principles. Identifying and understanding physicochemical processes associated with technological, metallurgical and mining processes. Acquiring knowledge of experimental physicochemical methods, measurements and data processing.

Course Description:

Theoretical instruction:

1. Structure of the atom; Chemical bonding (ionic, covalent, metallic bonds, hybridization of atomic orbitals, delocalized molecular orbitals, chemical bonding in complex compounds, Van der Waals and hydrogen bonding); Aggregate states of matter; 2. Introduction to chemical thermodynamics; Thermodynamic properties of a multicomponent homogeneous system; Conditions of the phase equilibrium and phase transformations; Equilibrium in solutions; The heat of chemical reaction; Chemical affinity; Chemical equilibrium; Surface phenomena; Transport phenomena; Chemical kinetics; 3. Properties of electrolyte solutions; Electrochemical thermodynamics; Irreversible processes on electrodes; Fundamentals of electrochemical kinetics.

Practical instruction: Exercises, Other forms of teaching, Study research work

Experiments in the field of gaseous state of matter, chemical thermodynamics, chemical equilibrium, solutions, phase equilibrium, adsorption, kinetics and electrochemistry. Calculation exercises.

1st cycle: Determination of partial pressure; Determination of vapour pressure of liquids; Determination of viscosity; 2nd cycle: Structural analysis; Adsorption; Determination of reaction order and the rate constant; 3rd cycle: Determination of electrical conductivity; Electromotive forces; Corrosion of metals.

Literature

Recommended:

1. S. Đ. Đorđević, V. J. Dražić, Fizička hemija, TMF, Beograd, 2005. (*in Serbian*)
2. D. Minić, A. Antić-Jovanović, Fizička hemija, FFH, BF, Beograd, 2005. (*in Serbian*)

Supplementary:

1. D. Ovcin, D. Jovanović, V. Dražić, M. Maksimović, N. Jakovljević-Halai, Lj. Vračar, S. Jovanović, K. Jeremić, D. Šepa, M. Vojnović, Fizička hemija - zbirka zadataka, TMF, Beograd, 2004. (*in Serbian*)
2. Z. Stanković, M. Rajčić-Vujasinović, Eksperimenti u fizičkoj hemiji, TF, Bor, 2006. (*in Serbian*)
3. Lj. Vračar, A. Despić, V. Dražić, S. Zečević, K. Jeremić, D. Jovanović, S. Jovanović, M. Maksimović, B. Nikolić, D. Ovcin, D. Šepa, Eksperimentalna fizička hemija, TMF, Beograd, 2004. (*in Serbian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching: Lecturing with interactive discussions, calculation and laboratory exercises, consultations and preliminary exams.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	30
Practical classes	5	Oral exam	40
Preliminary exams	20		
Independent work			

Study program: Mining Engineering, Metallurgical Engineering, Technological Engineering

Level of study: Undergraduate Academic Studies

Course: MINERALOGY AND PETROGRAPHY

Lecturer: Dr. Mira Cocić, associate professor

Status of the course: Compulsory course

ECTS: 8

Prerequisite: Basic chemistry knowledge

Course goals: Introducing students to basic knowledge of basic and special mineralogy, as well as subject of petrology and rock types

Learning outcomes: Acquiring necessary knowledge for mineral deposit exploration as well knowledge necessary for other professional subjects in mining, metallurgy and technology areas

Course Description:

Theoretical part:

Mineralogy: Subject, importance of minerals and their participation in construction of mineral raw material, classification of minerals. Basic mineralogy: crystallography, occurrence of crystal mineral shapes, crystal systems, crystallochemistry, crystallophysics, mineral genesis, methodology of mineral studies.

Special mineralogy: Silicate minerals (nesosilicates, sorosilicates, ciclosilicates, inosilicates, philosilicates and tectosilicates), non-silicate minerals (minelars Ca, Na, K, Mg, Ba, Sr, C, Cu, Au, Ag, Zn, Pb, Mo, Sb, Ni, Co, Sn, W, Bi, As, S, Te, Se, Hg, Al, Fe, Cr, Mn).

Petrography: Subject and classification of rocks, basic characteristics of rocks: structure, texture, leaching, origin and genesis of rocks. Magmatic rocks: intrusive, porphyry ad effusive. Sedimentary rocks: characteristics and origin, classic rocks, organic rocks. Metamorphic rocks: origin, type of metamorphism, regional and contact metamorphic rocks.

Practical part: Practices in mineralogical-petrographical collection: crystallography of minerals, recognition of minerals and rocks.

Literature

Recommended:

1. D. Babič, Mineralogy, Belgrade, 2003. (*in Serbian*)
2. S. Janjić, Mineralogy, Naučna knjiga, Belgrade, 1995. (*in Serbian*)
3. V. Đorđević, P. Đorđević, D. Milovanović, Osnovi petrologije, Nauka, Belgrade, 1991. (*in Serbian*)

Supplementary:

1. Ž. Milićević, Mineralogija, Autorizovana predavanja dostupna u elektronskom obliku, 2009. (*in Serbian*)
2. Ž. Milićević, Petrografija, Autorizovana predavanja dostupna u elektronskom obliku, 2009. (*in Serbian*)

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

Methods of teaching

Lectures, practice, practical classes, preliminary exams

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	
Practical classes	5	Oral exam	40
Preliminary exam	25		
Preliminary exam	25		

Study program: Mining Engineering, Metallurgical Engineering, Technological Engineering, Engineering Management

Level of study: Undergraduate Academic Studies

Course: ENGLISH LANGUAGE 2

Lecturer: Mara Manzalović, teacher of English

Status of the course: Compulsory course

ECTS: 4+2

Prerequisites: at least A1 level of knowledge (according to CEFR)

Course goals: developing all language skills; acquisition of grammar structures, vocabulary and language functions as learning outcomes of A2 level (according to CEFR)

Learning outcomes: Students use oral and written language structures and vocabulary to describe everyday topics. They understand academic texts and are able to scan and skim through the text looking for a particular piece of information.

Course description:
Grammar: Revision of basic tenses, conditionals, gerund and infinitive, relative clauses, modals, the passive voice
Topics: Human mind, the world around us, life styles, environmental issues, communication, cultural differences, free time, management (time, money, stress), famous failures
Language functions: expressing opinion, agreement/disagreement; describing people, places, events

Literature
Recommended:
1. Authorised textbook : English language 2, by Mara Manzalovic

Supplementary:
1. Raymond Murphy & William R. Smalzer, Grammar in Use - intermediate, CUP, Cambridge 2007.
2. Bilingual dictionaries

Number of classes per week				Other classes:
Lectures: 1	Practical classes: 1	Other forms of teaching:	Study research work:	

Methods of teaching: direct, grammar-translation, audio-lingual, task-based

Grading (max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Attendance and active participation	10	Written exam	50
Practical classes		Oral exam	40
Mid-term exams*	(25+25)		
Term paper (optional)	up to 20		

* Students who acquire at least 25 points at mid-term exams, do not have to take written exam, but only oral exam.

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: TESTING OF METALS 1

Lecturer: Dr. Desimir Markovic, full professor

Status of the course: Compulsory course for study program Metallurgical Engineering

ECTS: 8

Prerequisite: Required knowledge of Physics, General Chemistry and Inorganic Chemistry

Course goals: Providing the basic knowledge in the field of mechanical testing, fracture mechanics, toughness of metals, metal fatigue and metal creep.

Learning outcomes: Acquiring the theoretical and the practical knowledge for working in the areas of metal quality control in factories, in specialized laboratories and working in research that is based on physics of the materials.

Course Description:

Theory teaching:

Stress and Strain. Mechanical Testings. Tensile testing, Compression test, Torsion test, Bend test, and Shear test. Ductility and Fracture, Ductile Fracture, Brittle Fracture, Fracture Mechanic. **Impact Toughness of Metals**. Fracture Toughness, Test Methods, Charpy Impact test, Impact Test Specimens, Factors Affecting Impact Toughness. **Metal Fatigue**. Types of Fatigue Loading, S-N (Wöhler) Curves, Diagrams of Dynamic Endurance: Gerber Diagram, Haigh Diagram, Smith Diagram. Factors Affecting Fatigue, Mechanism of Metal Fatigue. **Metal Creep**. Phenomenology of Creep, Stages of Creep, Temperature and Stress Dependence of Creep, Dislocation Creep, Diffusion Creep, Grain Boundari Creep, Deformation Mechanism Maps, Factors Affecting Creep, Materials Selection for High-Temperature Use, Stress Relaxation. **Hardness Testing**. Brinel Hardness Test, Meyer Hardness Test, Vickers Hardness Test, Rockwel Hardness Test, Dynamic Hardness Testing Methods, Portable Dynamic Hardness Testing. **Technological Tests of Metals**.

Practical studies:

Theoretical studies are followed by laboratory exercises in the field of mechanical testing

Literature

Recommended:

1. Д. Марковић, Испитивање метала I, Ауторизована предавања (Metals Testing 1, Manuscript),ТФ Бор, 2011. (*in Serbian*)
2. П. Терзић, Испитивање метала, Институт за испитивање материјала Србије, Београд, 1985. (*in Serbian*)
3. З. Бурзић, Ј. Чуровић, Механичка карактеризација конструкцијских материјала у ваздухопловству применом савремене опреме и метода, Војнотехнички институт, Београд, 2000. (*in Serbian*)
4. М. Арсенијевић, А. Валчић, М. Брекић, Физичко-механичка испитивања материјала, Грађевинска књига, Београд, 1972. (*in Serbian*)
5. Бошко Перовић, Физичка металургија, Металуршко-технолошки факултет, Подгорица, 1997. (*in Serbian*)

Supplementary:

1. J. R. Davis (editor), Tensile Testing, Second Edition, ASM International, Materials Park, Ohio, 2004.
2. А. Мајсторовић, В. Ђукић – Испитивање машинских материјала, практикум, Научна књига, Београд, 1991. (*in Serbian*)
3. Ч. Петровић, Приручник за вежбе из испитивања материјала, Научна књига, 1990. (*in Serbian*)
4. J. Rösler, H. Harders, M. Bäker, Mechanical Behaviour of Engineering Materials, Springer-Verlag, Berlin, Heidelberg, 2007.
5.Jaap Schijve, Fatigue of Structures and Materials, Kluwer Academic Publishers, New York, 2004.
6. H. Czichos, T. Saito, L. Smith (Eds.), Springer Handbook of Materials Measurement Methods, Springer Science+Business Media, Inc. 2006.

Number of classes per week				Other classes
Lectures: 3	Practical classes: 1	Other forms of teaching: 2	Study research work	

Methods of teaching

Traditional lectures, practice

Grading system(max. number of points 100)			
Pre-examination obligations	**Number of points**	**Final examination**	**Points**
Activity during the lecture	5	Written exam	
Practical classes	15	Oral exam	50
Preliminary exams	2 x 15 = 30		
Indenpendent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: METALLURGICAL THERMODYNAMICS 1

Lecturer: Dr. Aleksandra Mitovski, assistant professor

Status of the course: Compulsory course

ECTS: 8

Prerequisite: Knowledge in Mathematics and Physical chemistry is required

Course goals:

Training students for independent work in the thermodynamic calculations of metallurgical processes and the application of the modern software in the field of metallurgical thermodynamics.

Learning outcomes:

Students should learn the basic principles of calculations in metallurgical thermodynamics in order to obtain the necessary basis for further study of metallurgical processes and various technologies in the field of extractive metallurgy and the production of metal materials.

Course Description:

Lectures: Historical development of thermodynamics. Basic terminology in thermodynamics. Thermodynamics of ideal and real gas. The first law of thermodynamics. State change at constant volume and pressure. Internal energy. Enthalpy. Heat capacity. Application of the first law of thermodynamics in metallurgical thermochemistry. The second law of thermodynamics. Change of entropy for reversible and irreversible processes. Entropy of mixing. Statistical interpretation of entropy. Maxwell's relations. Thermodynamic potentials. Gibbs's energy. Helmholtz's energy. Chemical potential of pure substance. Fugacity and activity. Application of the second law of thermodynamics in metallurgical thermochemistry. Formulation and application of the third law of thermodynamics. Nernst's theorem. General conditions of chemical equilibrium. Affinity of chemical reaction and chemical equilibrium. Determining the standard equilibrium constant and the effect of temperature. Chemical balance for ideal and real gases. Balance of chemical reactions in homogeneous and heterogeneous systems. Stability of pure substances. Phase transformation. Clapeyron's equation. Gibbs's phase rule. Ideal solutions. Real solutions. Diluted solutions. Partial molar properties. Mixing functions. Excess functions. Gibbs-Duhem equation. Graphical interpretation of thermodynamic state functions.

Practical classes: Exercises, Other forms of teaching, Study research work

Calculations and laboratory exercises follow lectures. Application and construction of: Ellingham diagrams; E-pH diagrams; PSD diagrams. Application of software “HSC Chemistry” in thermodynamic calculations.

Literature

Recommended:

1. D.Živković, Introduction to metallurgical thermodynamics, Authorized lectures, TF Bor, 2011. *(in Serbian)*
2. Ž.Živković, V.Savović: Principles of metallurgical thermodynamics, Bakar, Bor, 1997. *(in Serbian)*
3. D.Živković, Ž.Živković: Theory of metallurgical processes workbook, Part I – Introduction to metallurgical thermodynamics, Bakar, Bor, 1994. *(in Serbian)*
4. D.Živković, Ž.Živković: Theory of metallurgical processes workbook, Part II – Thermodynamics od solutions, Thermodynamics of crystal defects, Kinetics of metallurgical reactions, Grafomed, Bor, 2001. *(in Serbian)*

Supplementary:

1. H.Donald Brooke Jenkins, Chemical thermodynamics at a glance, Blackwell Publishing, Oxford, 2008.
2. D.R. Gaskell, Introduction to Metallurgical Thermodynamics, McGraw-Hill, New York, 1973.
3. O.F.Devereux, Topics in Metallurgical Thermodynamics, MIR, Moscow, 1986.
4. Y.K. Rao, Stoichiometry and Thermodynamics of Metallurgical Processes, Cambridge University Press, New York, 1985.

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 2	Other forms of teaching: 1	Study research work:	

Methods of teaching

Lectures, exercises and practical work, organized on an interactive principle, which besides traditional lectures and presentations, includes discussions and active participation of students in all aspects of teaching.

Grading system(max. number of points 100)			
Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	20
Practical classes	15	Oral exam	20
Preliminary exam	2x20=40		
Independent work			

Study program: Mining Engineering or Metallurgical Engineering or Technological Engineering

Level of study: Undergraduate Academic Studies

Course: ANALYTICAL CHEMISTRY

Lecturers: Dr. Slađana Alagić, associate professor and Dr. Tanja Kalinović, assistant professor

Status of the course: Compulsory course for the students of metallurgical and technological engineering and elective course for the students of mining engineering

ECTS: 8

Prerequisite: Necessary knowledge about the properties of certain classes of inorganic compounds (acids, bases, salts), chemical bonding, chemical reactions and dynamic equilibrium.

Course goals: Introducing students with theoretical basics of quantitative chemical analysis. Calculation of basic parameters essential for chemical analysis. Applying of chemical dynamic equilibrium important for chemical analysis. Mastering theoretical and practical knowledge with regard to identification and determination of the elements, ions and compounds in aqueous solutions - laboratory determination of acids, bases, anions and cations.

Learning outcomes: By mastering the course content, students will be able to monitor and control technological processes easily and also, the basics of their training for assessing the quality of the samples of various industrial raw materials and products are established.

Course Description:

Theoretical:

Subject and tasks of analytical chemistry. Classification of methods of the chemical analysis. Chemistry of the solutions. Chemical dynamic equilibriums. Acid-base reactions. Sedimentation reactions, solubility product. Reactions of formation of complexes. Redox reactions. Gravimetric reactions, colloidal and crystalline precipitates, gravimetric calculations, gravimetric determination of individual cations and anions. Volumetric analysis: classification of volumetric methods (precipitation titrations, acid-base titration methods, complexometry and redox titrations), indicators and calculation in volumetric analysis, volumetric determination of individual cations and anions.

Practical:

Gravimetric and volumetric determination of elements. Calculation exercises.

Literature

Recommended:

1. O. Vitorović, R. Šaper, Analitička hemija-teorijske osnove, TMF, Beograd, 1989. (*in Serbian*)
2. Lj. Rajaković, A. Perić-Grujić, T. Vasiljević, D. Čičkarić, Analitička hemija, kvantitativna hemijska analiza, Praktikum, TMF, Beograd, 2000. (*in Serbian*)
3. Lj. Rajaković: Zbirka zadataka iz analitičke hemije, TMF, Beograd, 2005. (*in Serbian*)

Supplementary:

1. J. Savić, M. Savić, Osnovi analitičke hemije, Svjetlost, Sarajevo, 1990. (*in Serbian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching: Teaching with interactive discussions, experimental work and calculations, consultations and preliminary exams.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	45
Practical classes	10	Oral exam	
Preliminary exams	20+20		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: ELECTROCHEMISTRY

Lecturer: Dr. Mirjana M. Rajčić Vujasinović, full professor

Status of the course: Elective course in Metallurgical Engineering and Technological Engineering

ECTS: 4

Prerequisite: Knowledge from physical chemistry

Course goals: Course goals is to introduce students with the basic subjects and lows related to the structure of electrochemical systems and electrode processes which appear in electrochemical engineering

Learning outcomes: Student capable for independent managing and control of electrochemical processes in metallurgy an inorganic chemical technology

Course Description:

Lectures: Electrochemical system (structure, electrodes, electrolyte). Electrochemical sources and consumers of electrical energy. Thermodynamics of electrochemical systems. Conductivity of solutions and melts. Basic kinetics equations in electrode processes. Current efficiency and energy consumption. Measurement methods in electrochemistry. The most important electrochemical processes in metallurgy and inorganic chemical technology (hydrogen evolution and oxidation, evolution and reduction of oxygen, electrochemical extraction and refining of metals, chlorine-alkaline electrolysis, electroplating, anodizing, electrochemical synthesis of oxides)

Laboratory exercises follow content of the lectures

Literature

Recommended:

1. М. Рајчић-Вујасиновић, З. Станковић, Електрохемија, Ауторизована предавања, ТФ Бор, 2006. 2. А. Деспић, Основе електрохемије 2000, Завод за уџбенике и наставна средства, Београд, 2003. (*in Serbian)*

Supplementary:

1. М. Рајчић-Вујасиновић, В. Златковић, Теорија хидро и електрометалуршких процеса, Практикум за вежбе, ТФ Бор, 2001. (*in Serbian)*

2. З. Станковић, М. Рајчић-Вујасиновић, Практикум за вежбе из Физичке хемије, ТФ Бор, (*in Serbian)*

3. С. Ђорђевић и други, Галванотехника, Техничка књига, Београд, 1998. (*in Serbian)*

4. J. O`M. Bockris, Modern Aspects of Electrochemistry, Plenum Press, New York, 1973. 5. K. Izutsu, Electrochemistry in Nonaqueous Solutions, Wiley-Vch Verlag GmbH and Co, 2002.

Number of classes per week				Other classes:
Lectures: 2	Practical classes: 1	Other forms of teaching: 1	Study research work:	

Methods of teaching

Lectures with interactive discussions, experimental exercises, visits to other laboratories, term papers, consultations.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	10	Written exam	
Practical classes	10	Oral exam	60
Preliminary exam	20		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: INTRODUCTION TO METALLIC MATERIALS

Lecturer: Dr. Svetlana Lj. Ivanov, associate professor

Status of the course: Elective course

ECTS: 4

Prerequisite: Requires knowledge in Physical chemistry and Metal testing 1.

Course goals:

The goal of this course is to provide theoretical and practical basics to students about metallic materials and technologies.

Learning outcomes:

The outcome of this course is to gain knowledge about the different metallic materials, their structures, properties and applications.

Course Description:

Theoretical studies:

Introduction. Engineering materials, classification, metals, ceramics, glass, polymers, composites. Material properties: mechanical, electrical, magnetic, optical. Material processing - general terms. Chemical bonding types. Crystalline and amorphous structures. Crystalline structure of metallic materials, types of crystal lattices. Defects in crystal structures, point, linear, interfacial, and volume defects, and their importance. Diffusion. Basic terms in the theory of alloys. Pure metals. Solid solutions. Interstitial solid solutions. Substitutional solid solutions. Intermediate compounds. Eutectic reactions. Cooling curves. Characteristics. Basic types of phase diagrams. Unit cell. Miller indices of planes and directions. Behavior of materials in the state of mechanical loading. Stress - deformation: metals. Elastic deformation. Plastic deformation. Phase diagrams of alloys - binary isomorphous systems with complete solid solubility. Phase diagrams of alloys - binary systems with intermediate phases/compounds. Phase diagrams of alloys - binary eutectic systems with limited solid solubility. Characteristics and applications. Metals and alloys. Irons and steels. Nonferrous metals and alloys (Aluminium alloys, Copper alloys, Titanium alloys, other nonferrous metals). Superalloys.

Practical studies:

Exercises that follow the presented materials in lectures.

Literature

Recommended:

1. С. Стојадиновић, А. Љевар, Познавање материјала, Технички факултет Михајло Пупин, Зрењанин, 2004. (*in Serbian*)

2. W.G. Moffatt, G. W. Pearsall, J. Wulff, Структуре и особине материјала, Књига I: Структуре (Structure and Properties of Materials: Structure), – превод са енглеског Д. Трифуновић и М. Јанчић, Технолошко-металуршки факултет, Београд, 1975. (*in Serbian*)

3. Р. Прокић-Цветковић, О. Поповић, Машински материјали 1, Машински факултет Универзитета у Београду, Београд, 2012. (*in Serbian*)

Supplementary:

1. W.D. Callister, D.G Rethwisch, Materials Science and Engineering: An Introduction, 8th Ed., Wiley and Sons, 2010.

2. S.H. Avner, Introduction to Physical Metallurgy, McGraw-Hill, New York, 1964.

3. Р. Алексић, Увод у инжењерске материјале Ауторизована скрипта, Технолошко-металуршки факултет, Београд. (*in Serbian*)

Number of classes per week				Other classes:
Lectures: 2	Practical classes: 1	Other forms of teaching: 1	Study research work:	

Methods of teaching

Lectures and exercises.

Grading system(max. number of points 100)			
Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the		Written exam	

lecture			
Practical classes	10	Oral exam	50
Preliminary exam	40		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: PHYSICAL METALLURGY 1

Lecturer: Dr. Desimir Markovic, full professor

Status of the course: Compulsory course for study program Metallurgical Engineering

ECTS: 6

Prerequisite: Required knowledge of Physics, General Chemistry, Inorganic Chemistry, Physical Chemistry

Course goals:
Providing the basic knowledge in the field of metallography, phase diagrams, and alloys of iron and steel and non-ferrous metals.

Learning outcomes:
Acquiring the theoretical knowledge for successful completion of the courses at higher levels of studies

Course Description:
Theory teaching
Elements of crystallography. Space lattice and crystal lattice. Crystal systems and Bravais lattices. Elements of crystal symmetry. Labeling of crystal planes and directions. Basics of metallography. Microscopy of metals. Methods for determining the transformation points. Equilibrium phase-diagrams. Two-component alloys. Alloys with a break in solubility in a liquid state. Alloys with a total solubility in a liquid and a solid state. Alloys with a break in solubility in solid state. Alloys with an intermetallic compound. Alloys with solid state transformation. Three-component alloy systems. Phase diagram iron-carbon. Iron alloys. Thermal treatment of steel. Alloyed steels. Cast iron and malleable iron. Alloys of non-ferrous metals. Alloys of copper, aluminum, zinc, titanium, magnesium, nickel, tin, lead.
Practical classes:
Exercises, Other forms of teaching
Theoretical classes are followed by laboratory exercises in the field of metallographic analysis of alloys.

Literature
Recommended:
1. H. Šuman, Metalografija (Metallography), Tehnološko-metalurški fakultet, Beograd, 1989. (*in Serbian*)
Supplementary:
1. G. F. Vander Voort, Metalography – Principles and Practice, ASM International, 2007.
2. R. W. Cahn (ed), Physical Metallurgy, North-Holland Pub. Co, Amsterdam, 1985.
3. R. A. Higgins, Engineering Metallurgy, Part I – Applied Physical Metallurgy (sixth edition), Arnold, London, 1999.
4. H. K. D. H. Bhadeshia, R. W. K. Honeycombe, Steels – Microstructure and Properties (third edition), Elsevier Butterworth-Heinemann, 2006.

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching
Classical lectures, exercises

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	
Practical classes	15	Oral exam	50
Preliminary exams	2 x 15 = 30		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: TESTING OF METALS 2

Lecturer: Dr. Desimir Markovic, full professor

Status of the course: Compulsory course for study program Metallurgical Engineering

ECTS: 6

Prerequisite: Required knowledge of Physics, General Chemistry, Inorganic Chemistry, Physical Chemistry

Course goals: Providing the basic knowledge in the field of physical testing of metals, defectoscopy testing, X-ray diffraction analysis and electron microscopy.

Learning outcomes: Acquiring the theoretical and practical knowledge for working in the areas of metal quality control in factories, in specialized laboratories and working in research that is based on physics of metals.

Course description:

Theoretical Studies:

Non-Destructive Testing. Liquid Penetrant Testing, Magnetic Particle Testing, Eddy Current Testing, Ultrasonic Testing, Radiographic Testing. **Internal Friction in Metals**. **X-Ray Diffraction (XRD)**. Bragg's Law, X-Ray Analysis Methods, Powder Diffraction Methods, Procedure for Indexing XRD Paterns, Application of XRD to Metallurgical Science, Qualitative and Quantitative XRD Analysis. **Microscopy Methods**. Transmission Electron Microscopy, Scanning Electron Microscopy, Analitical Electron Microscopy, Scanning Probe Microscopy.

Practical Studies:

Theoretical studies are followed by laboratory exercies in non-destructive testing and X-ray analysis

Literature

Recommended:

1. Д. Марковић, Испитивање метала II, Ауторизована предавања (Metals Testing 2, Manuscript),ТФ Бор, 2012. (*in Serbian*)
2. Б. Сладојевић, Испитивање материјала ултразвуком, Институт Кирил Савић, 1997. (*in Serbian*)
3. М. Јовић, С. Александровић, С. Николић, Магнетна дефектоскопија челичних ужади, Београд, Промеззија, 1999. (*in Serbian*)
4. Т. Ненадовић, Контрола квалитета материјала, Београд, Институт Винча, 2003. (*in Serbian*)
5. Љ. Карановић, Д. Полети, Рентгенска структурна анализа, Београд, Завод за уџбенике и наставна средства, 2003. (*in Serbian*)
6. Ј. Раногајец, Методе карактеризације материјала, Технолошки факултет, Нови Сад, 2005. (*in Serbian*)

Supplementary:

1. Paul E. Mix, Introduction to nondestructive testing, Second edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2005.
2. Charles J. Hellier, Handbook of Nondestructive Evaluation, Mc Graw-Hill, New Yor, 2003.
3. Б. Прелесник, К. Анђелковић, Д. Радановић, Т. Тодоровић, Збирка задатака из кристалографије и рентгенске структурне анализе, Хемијски факултет, Београд, 2007. (*in Serbian*)
4.A. Puškár, Internal Friction of Materials, Cambridge International Science Publishing, 2001
5. V. K. Pecharsky, P. Y. Zavalij, Powder Diffraction and Structural Characterization of Materials, Springer 2005.
5. R. F. Egerton, Physical Principles of Electron Microscopy, Springer, 2005.
6. D. B. Williams, C. B. Carter, Transmission Electron Microscopy, Springer, 2009.

Number of clasess per week				Other classes
Lectures: 3	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Classical lectures, exerises

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Points**
Activity during the lecture	5	Written exam	
Practical classes	15	Oral exam	50
Preliminary exams	2 x 15 = 30		
Indenpendent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: THEORY OF PYROMETALLURGICAL PROCESSES

Lecturer: Dr. Dragan Manasijević, full professor

Status of the course: Elective course

ECTS: 8

Prerequisite: Required knowledge of physical chemistry and metallurgical thermodynamics.

Course goals:

Preparation of students for other professional metallurgical subjects, above all metallurgy of non-ferrous metals, iron metallurgy, steel metallurgy, metallurgy of rare metals, etc.

Learning outcomes:

Acquiring the necessary theoretical knowledge about the thermodynamic and kinetic aspects of basic metallurgical processes.

Course Description:

Theoretical basics of pyrometallurgical processes of drying, calcination, roasting, smelting, reduction, oxidation and refining. Thermodynamic bases of pyrometallurgical processes. Theory of the processes of dissociation of carbonates, oxides, sulfides and halides. Theory of roasting of sulfide minerals. PSD diagrams. Theory of sulfide smelting. Theory of oxidation process. Theory of reduction of oxides and reduction smelting. Ellingham's and Pourbaix-Ellingham's diagrams. Reduction with carbon. Reduction with Carbon Monoxide. Reduction with Hydrogen. Metallothermic reduction. Kinetics of reactions in multicomponent metallurgical systems. Kinetics of heterogeneous reactions in isothermal conditions. Non-isothermal kinetics. Basic methods of thermal analysis. Theory of silicate systems. Slags in metallurgical processes, role and function. Structure of silicate systems. The theory of the refining processes. The theory of liquidation processes. Theory of special processes for obtaining high-purity metals.

Literature

Recommended:

1. D. Manasijević, D. Živković, The Basics of Pyrometallurgical Processes (Part 1), Technical faculty in Bor, Bor, 2011.
2. Ž.Živković, V.Savović: Theory of Pirometallurgical Processes, Bakar, Bor, 1994.
3. D. Živković, Ž.Živković: The Collection of Tasks From Theory of Metallurgical Processes, Part I - Introduction to Metallurgical Thermodynamics, Bakar, Bor, 1994
D. Živković, Ž.Živković: Collection of tasks from the theory of metallurgical processes, II deo - thermodynamics of solution, Thermodynamics of defects in crystals, Kinetics of metallurgical reactions, Grafomed, Bor, 2001.

Supplementary:

1. T. Rosenquist, Principles of Extractive Metallurgy. Tapir Academic Press, Trondheim, 2004.
2. C. K. Gupta, Chemical Metallurgy: Principles and Practice, WILEY-VCH, Weinheim, 2003.
3. F.Habashi, Textbook of Pyrometallurgy, Laval University, Canada, 2002.

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 2	Other forms of teaching: 1	Study research work:	

Methods of teaching

Teaching includes lectures, exercises - computational and experimental.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	20
Practical classes	15	Oral exam	40
Preliminary exam	20		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course:THEORY OF METAL FORMING

Lecturer: Dr. Svetlana Lj. Ivanov, associate professor

Status of the course: Elective course

ECTS: 8

Prerequisite: Requires knowledge in Mathematics 1, Mathematics 2, Introduction to metallic materials

Course goals:

Goal of this course is to teach students how metals behave while being shaped, with methods for investigating the possibility of deformation and with the basic technological processes of metal forming.

Learning outcomes:

Learning outcomes is to train students for analysis, development and control of basic technological processes of metal forming operation.

Course Description:

Theoretical studies:

Stress and strain states. Cauchy stress tensor. Differential equilibrium equations. Definition of deformation tensor. Stress and strain relationship. *Conditions of plasticity*. The influence of the strain state on the deformation forces. The influence of mechanical scheme of deformation on plasticity. *Mechanism of plastic strain and its basics. External friction in metal forming processes.* Role of friction. Friction mechanism. Lubrication. *Non-uniform deformation in metal forming processes.* Interaction between metal and die in metal forming processes. Residual stresses. *Amount of work generated in the metal forming process. Thermo-mechanical treatment of metals. Analytical methods for determining the deformation and its forces.* Solving the differential equilibrium equations and plasticity equations. Experimental methods *for determining the deformation and its forces. Analysis of metal forming processes.* Theory of rolling. Theory of drawing. Theory of extrusion. Theory of forging.

Practical studies:

Calculation exercises on the individual chapters. Exercises are accompanied by material presented in theoretical studies.

Literature

Recommended:

1. Д. Николић, Обрада метала деформисањем, Завод за уџбенике и наставна средства, Српско Сарајево, 2003. (*in Serbian*)
2. М. Чаушевић, Теорија пластичне прераде метала, Свјетлост, Сарајево, 1979. (*in Serbian*)
3. Б. Димитров, Теорија прераде метала у пластичном стању, Збирка задатака са изводима из теорије, Технички факултет, Бор, 1997. (*in Serbian*)
4. С. Блечић, Теорија прераде метала у пластичном стању, Технички факултет, Бор, 1972. (*in Serbian*)

Supplementary:

1. H.S. Valberg, Applied Metal Forming, Cambridge University Press, New York, 2010.
2. G.E.Dieter, Mechanical Metallurgy-SI Metric Ed./adapted by David Bacon, McGraw-Hill Book Co.-Singapore, 1988.
3. В. Стоиљковић, Збирка задатака са теоријским основама из обраде пластичним деформисањем, Машински Факултет, Ниш, 1979. (*in Serbian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 2	Other forms of teaching: 1	Study research work:	

Methods of teaching

Lectures and calculation exercises.

Grading system (max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	
Practical classes	10	Oral exam	40
Preliminary exams	2x20 = 40		

Independent work	5		

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: METALURGICAL OPERATIONS

Lecturer: Dr. Vesna Grekulović, assistant professor

Status of the course: Elective course for study program Metallurgical Engineering

ECTS: 8

Prerequisite: Knowledge in mathematics and physical chemistry is required

Course goals:

The aim of the course is to prepare a student for solving problems in the field of fluid mechanics and dispersion systems, mass transfer and mass transfer operations, transfer and heat transfer operations that occur in metallurgy.

Learning outcomes:

Acquiring theoretical and practical knowledge from the fields mentioned above, necessary for further study of different metallurgical processes.

Course Description:

Lectures:

Mechanics of fluid and dispersion systems. Introduction, transport characteristics of the fluid; basic equations for stagnant and flowing fluids and momentum transfer; engineering aspect of fluid mechanics; transport of fluids. Mechanics of a body obstruction by fluid; movement of particles in the field of force; modes of motion of particles; free and cramped deposition; phase separation operations in the gravitational field of force; thickening, hydraulic transport; phase separation operations in a centrifugal field; electrostatic precipitation. Three-phase systems - gas washing. Fluid flow through a porous media; filtration; filtration of gases. Fluidization.

Mass transfer and mass transfer operation: Molecular mass transfer, transport characteristics; basic mass transfer equations. Convective mass transfer. Similarity criteria of mass transfer; models of mass transfer. Equilibrium in multiphase systems; transfer unit height and number of mass transfer units; separation, concentration and refining; absorption, distillation and rectification; liquid-liquid extraction; leaching; adsorption; drying; membrane processes.

Heat transfer and exchange of heat: Heat transfer mechanisms; transport characteristics; sources and heat carriers. Convective heat transfers with and without change of phase; basic equations of heat transfer with and without change phase. Heat exchange.

Practical classes:

Exercises, Other forms of teaching, Study research work. Computational exercises follow lectures.

Literature

Recommended:

1. V. Stanković, Phenomena of transmission and operations in metallurgy 1, University of Belgrade, Technical Faculty in Bor ,1998. *(in Serbian)*
2. V. Stanković, Phenomena of transmission and operations in metallurgy 2, University of Belgrade, Technical Faculty in Bor ,1998. *(in Serbian)*
3. F. Zdanski, Mechanics of fluid, Faculty of Technology and Metallurgy, University of Belgrade; 1995. *(in Serbian)*
4. S. Šerbula, V. Stanković, Collection of tasks from metallurgical operations - under preparation *(in Serbian)*
5. S.Šerbula, V. Stanković, Practicum for metallurgical operations - in the press *(in Serbian)*

Supplementary:

1. A.G. Kasatkin, Osnovi processi i apparati himiceskoi tehnologii, Himija, Moskva, 1973. *(in Russian)*
2. J. Szekely, N.J. Themelis, Rate Phenomena in Process Metallurgy, John Wiley & Sons, New York; 1971.
3. L. D. Schmidt, The Engineering of Chemical Reactions, Oxford University Press, 1998.

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 2	Other forms of teaching: 1	Study research work:	

Methods of teaching

Lectures and laboratory exercises.

Grading system(max. number of points 100)			
Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	10	Written exam	20
Practical classes	10	Oral exam	20
Preliminary exams	2 x 20 = 40		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: THEORY OF CASTING PROCESS

Lecturer: Dr. Srba Mladenović, associate professor

Status of the course: Elective course

ECTS: 8

Prerequisite: Knowledge from physical metallurgy

Course goals:
Basic knowledge of properties of metals and alloys and phenomena during the production of castings

Learning outcomes:
Students have to be able to recognize the properties of liquid metals and alloys and some specific phenomena in casting production

Course Description: Introduction. Melting of the metals. Viscosity. Surface tension. Fluidity of molten metals and alloys. Basic principles of casting formation. Thermodynamics. Shrinkage of metals and alloys. Cavity. Segregation. Inclusions. Gases in metals. Cracks and stresses in castings. Time and thermal stresses. Stresses causes by phase transitions. Microscopic and submicroscopic stresses. The consequences of late stresses.

Literature
Recommended:
1. Teorija livarstva, B. Kočovski, Naučna knjiga, Beograd, 2000. (*in Serbian*)

Supplementary:
1. А. А. Рижиков, Теорические основи литеинога производство, Машиностроителњнои литераатури, Москва, 1961. (*in Russian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 2	Other forms of teaching: 1	Study research work:	

Methods of teaching
Lectures, exercises and other forms of teaching organized in interactive manner.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	20
Practical classes	15	Oral exam	35
Preliminary exams	15		
Independent work	10		

Study program: Engineering Management, Mining Engineering, Metallurgical Engineering and Technological Engineering

Level of study: Undergraduate Academic Studies

Course: ENGLISH LANGUAGE III

Lecturer: Enisa Nikolić, teacher of English

Status of the course : Compulsory course

ECTS: 2+2

Prerequisite: At least A2 level of the Common European Frame of Reference (CEFR)

Course Goals: Developing all language skills in a professional context in order to enable students to use professional literature and communicate in English (both in oral and written form) for the purpose of studying and further professional development.

Learning outcomes: Upon successful fulfillment of pre-exam and exam obligations students should be able to: a) use professional terminology and grammatical structures characteristic of the field-specific scientific discourse b) understand a professional text at an intermediate or upper- intermediate level as well as take part in discussions on various scientific and engineering topics c) express themselves in writing (short essays, compositions, reports, summaries, abstracts, CVs...)

Course description:

Grammar points: Tenses of the verb (Present Simple/ Continuous, Past Simple/ Continuous, Present Perfect Simple/ Continuous, Past Perfect Simple/ Continuous, Future Simple/ Continuous), The Passive Voice (revision of passive structures, impersonal constructions in the passive, passive questions), Conditionals (zero, first, second and third type), Participles (used adjectivally and to shorten relative clauses), Verbs followed by infinitive or -ing, Modal Verbs (present, future and past), Phrasal Verbs, Extended Nominal Groups, Compounds, Foreign Plurals, Numerals, Linking words, Word formation (common prefixes and suffixes).

Themes: Why English Matters, Science and Engineering, Our Technological World, Environmental Matters, Sustainability Issues, Management Functions, Management Levels in an Organization, Quality Management, Making Decisions, Solving Problems, Plant Operation, Secrets of Successful Presentations, Attending Conferences.

Literature

Recommended:

1. E.Nikolić, English Language III (a collection of texts with lexical exercises)
2. Mark Powell, In Company (second edition), intermediate student's book, Macmillan, Oxford, 2009.
3. John Eastwood, Oxford Practice Grammar- Intermediate, Oxford University Press, Oxford, 2006.

Supplementary:

1. Michael Vince, Intermediate Language Practice, Macmillan, Oxford 2003.
2. Macmillan English Dictionary for Advanced Learners, Macmillan Education, 2002.
3. Oxford English-Serbian Student's Dictionary, Oxford University Press, Oxford 2006

Number of classes per week				Other classes:
Lectures: 1	Practical classes: 1	Other forms of teaching:	Study research work:	

Methods of teaching

Eclectic approach combining the principles and techniques of various methods with a special emphasis on communicative approach.

Grading system (max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Attendance and active participation (lectures and practical classes)	10	Written exam	Taken only by the students who have not taken or passed the tests.
Tests	25+25	Oral exam	30
Presentations	10		

Study program Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: THEORY OF HYDRO AND ELECTROMETALLURGICAL PROCESSES

Lecturers: Dr. Mirjana Rajčić Vujasinović, full professor, Dr. Vesna Grekulović, assistant professor and Dr. Milan Gorgievski, assistant professor

Status of the course: Elective course

ECTS: 8

Prerequisite: Required knowledge in physical chemistry and metallurgical thermodynamics

Course goals:

The aim of the course is to acquire the necessary knowledge in the field of hydro and electrometallurgical processes necessary as a basis for other expert metallurgical subjects, primarily metallurgy of non-ferrous metals, metallurgy of rare metals, hydrometallurgy and wastewater.

Learning outcomes:

Students need to prevail the theoretical knowledge necessary for independent research in the field of hydro and electrometallurgy, and to be familiar with the latest achievements in the field of the theory of hydrometallurgical and electrometallurgical processes.

Course Description:

Theoretical lectures

Physical - chemical basis of hydro and electrometallurgical processes. Theoretical principles of the leaching process of various materials and leaching equipment. Theoretical basis for concentration and purification processes of metal ions from the solution - ion exchange, solvent extraction and adsorption - desorption. Methods for separating the metal compound from the solution. Methods for separating metals from solution - chemical reduction and cementation. The most important hydrometallurgical processes. Thermodynamics of electrometallurgical systems. Conducting electricity through electrolyte solutions. Chemical effect of direct current. Kinetics of electrode processes. Theoretical aspects of electrolysis of solution and melt.

The most important anode and cathode processes in metallurgy (electrolytic separation and metal refining, electrowinning of metal powders, oxides and other products, corrosion and passivation of metals, direct electrochemical oxidation of sulfides).

Practical lectures: Exercises; other forms of lectures; study research work.

Laboratory exercises related to the determination of the mechanism and kinetics of the leaching process, purification and enrichment of the solutions, and obtaining metals and metal compounds by different chemical and electrochemical methods.

Literature

Recommended:

1. N. Pacović, Hidrometalurgija, ŠRIF, Bor, 1980. (*in Serbian*)
2. Z. Stanković, M. Rajčić-Vujasinović, Teorija elektrometalurških procesa, Autorizovana predavanja, TF Bor. (*in Serbian*)
3. M. Rajčić-Vujasinović, V. Zlatković, Teorija hidro i elektrometalurških procesa, Praktikum za vežbe, TF Bor, 2001. (*in Serbian*)

Supplementary:

1. K. I. Popov, S. S. Đokić, B. N. Grgur, Fundamental aspects of electrometallurgy, Kluwer Academic Publishers, New York, Boston, Dordecht, London, Moscow, 2002.
2. C. K. Gupta, Chemical Metallurgy, Wiley-Vch Verlag GmbH and Co, 2003.
3. F. Habashi, A Textbook of Hydrometallurgy, Metallurgy Extractive, Quebec, Enr., 1993.
4. J. O`M. Bockris, Modern Aspects of Electrochemistry, Plenum Press, New York, 1973.
5. A. Despić, Osnove elektrohemije 2000, Zavod za udžbenike, Beograd, 2003. (*in Serbian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Lectures with interactive discussions; experimental exercises; term papers and presentations; consultations.

Grading system(max. number of points 100)			
Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**

Activity during the lecture	5	Written exam	
Practical classes	10	Oral exam	40
Preliminary exams	2 x 20 = 40		
Independent work	5		

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: HEAT TREATMENT

Lecturer: Dr. Svetlana Lj. Ivanov, associate professor

Status of the course: Elective course

ECTS: 8

Prerequisite: Requires knowledge of Physical chemistry and Physical metallurgy

Course goals:

Goal of this course is to provide basic knowledge of the main methods of heat treatment of metals and alloys.

Learning outcomes:

Outcome of this course is to gain the necessary knowledge for studying different processes and technologies in the field of processing metallurgy and metallic materials.

Course Description:

Theoretical studies:

Introduction to heat treatment. History of heat treatment development. Heat treatment of metals and alloys. Thermodynamics of phase transformations. *Annealing.* Annealing without phase transformations. Annealing with phase transformations. Annealing of steel. Annealing of cast iron. Annealing of nonferrous alloys. *Quenching.* Quenching without polymorphism. Quenching with polymorphism. Characteristics of martensitic transformation for carbon steel. Thermodynamics, mechanism and kinetics of martensitic transformation. Thermal stabilization of austenite. Change of the properties of alloys with martensitic structure. Thermoelastic martensitic transformation. Shape memory effect. Bainite transformation. Mechanism and kinetics of bainite transformation. *Aging*. Structural changes, thermodynamics and kinetics of aging. Changes in alloy properties after aging. *Stress relieving.* Stress relieving of steel. Structural changes and processes after stress relieving. Change in properties of steel after stress relieving. Stress relief brittleness. *Case hardening*. Basic processes in case hardening. Diffusion in case hardening processes. Mechanisms of diffusional layer forming. Types of case hardening. Carburization. Nitriding. Carbonitriding. The rest of the case hardening processes. Surface quenching. Heat treatment defects and their remedies. Equipment for heat treatment.

Practical studies:

Laboratory exercises that follow the presented materials in lectures.

Literature

Recommended:

1. Н. Видојевић, Термичка обрада метала, Технолошко-металуршки факултет, Београд, 1981. (*in Serbian*)
2. Б. Перовић, Физичка металургија, Металуршко-технолошки факултет, Подгорица, 1997. (*in Serbian*)
3. С. Иванов, Б. Станојевић, Термичка обрада метала, Ауторизована предавања, Технички факултет, Бор. (*in Serbian*)
4. И. Пантелић, Технологија термичке обраде челика I и II, Раднички универзитет Радивој Ћирпанов, Нови Сад, 1974. (*in Serbian*)

Supplementary:

1. W.D. Callister, Fundamentals of Materials Science and Engineering: An Integrated Approach, 2nd ed., John Wiley and Sons, New Jersey, 2004.
2. И. И. Новиков, Теория термической обработки металлов, Металлургия, Москва, 1978. (*in Russian*)
3. G. Krauss, M. A. Grossmann, Principles of Heat Treatment of Steel, Metal Park Ohio, American Society for Metals, Ohio, 1980.
4. М. Е. Блантер, Теория термической обработки, Металлургия, Москва, 1984. (*in Russian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Lectures and laboratory exercises.

Grading system(max. number of points 100)			
Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**

Activity during the lecture	5	Written exam	
Practical classes	25	Oral exam	50
Preliminary exam	20		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: PHYSICAL METALLURGY 2

Lecturer: Dr. Desimir Markovic, full professor

Status of the course: Compulsory course for study program Metallurgical Engineering

ECTS: 6

Prerequisite: Required knowledge of Physics, General Chemistry, Inorganic Chemistry, Physical Chemistry and Physical Metallurgy 1

Course goals:
Providing the basic knowledge in the field of real crystal structure, lattice defects and their impact on the properties of metals , crystallization of metals, solid state phase transformations, strengthening mechanisms in metals and changes in deformed metals by heating.

Learning outcomes:
Acquiring the theoretical knowledge for successful completion of courses at higher level of studies

Course Description:
Theory teaching
Electronic theory of metals. The theory of energy zones. Electrical properties of metals. Magnetism of metals.
Thermal properties of metals. Structure of alloys. Solid solutions, intermediate phases, ordered solid solutions.
Lattice defects. Diffusion. Crystallization of metals. Phase transformation in solid state. Dislocation and slipping. Movement of dislocations. Elastic properties of dislocations. Multiplication of dislocations. Reactions of dislocations' cutting. Strengthening mechanisms for metals and alloys. Deformation strengthening. Grain refinement strengthening. Solid solutions strengthening. Precipitation and dispersion strengthening. Fiber strengthening. Strengthening by point defects in the lattice. Recovery and recrystallization. Grain growth. Texture. Describing the texture, deformation texture, annealing texture. Influence of texture on metal properties.
Practical classes: Exercises, Other forms of teaching
Theoretical classes are followed by laboratory exercises in the field of crystallography, strengthening of metals and alloys, recrystallization and texture testing.

Literature
Recommended:
1. Boško Perović, Fizička metalurgija (Physical Metallurgy), Metalurško-tehnološki fakultet, Podgorica, 1997. (*in Serbian*)
Supplementary:
1. R. W. Cahn (ed), Physical Metallurgy, North-Holland Pub. Co, Amsterdam, 1985.
2. B. Verlinden, J. Driver, I. Samajdar, R. D. Doherty, Thermo-Mechanical Processing of Metallic Materials, Elsevier Pergamon, 2007.
3. Л. Г. Журавлев, В. И. Филатов, Физические методы исследования металлов и сплавов (Physical Methods for Studying Metals and Alloys), ЮУрГУ, Челябинск, 2004. (*in Russian*)
4. М. И. Михайлович, Лекции по курсу “Материаловедение” (Lectures on the course "Material Science"), Нижегородский государственный технический университет, 1995. (*in Russian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching
Traditional lectures, exercises

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	
Practical classes	15	Oral exam	50
Preliminary exams	2 x 15 = 30		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: HEAT TECHNIQUE AND FURNACES IN METALLURGY

Lecturers: Dr. Aleksandra Mitovski, assistant professor, Dr. Milan Gorgievski, assistant professor

Status of the course: Compulsory course

ECTS: 8

Prerequisite: Knowledge of Metallurgical thermodynamics, Theory of pyrometallurgical processes and Metallurgical operations is required

Course goals:

Introducing students to the basic mechanisms of heat transfer, with the operation principles of traditional and new types of furnace aggregates, as well as the basics of the heat balance calculations of the metallurgical processes.

Learning outcomes:

Students should have the necessary knowledge to calculate the thermal balance of metallurgical processes in a number of furnace aggregates, based on the material balance of the process under consideration, the characteristics of the applied equipment and the heat transfer mechanism.

Course Description:

Lectures:

Basic concepts and initial thermodynamic settings. Basics of heat transfer mechanisms. Conduction. Convection. Heat exchange by radiation. Non-stationary heat conduction. Types and characteristics of fuel. Calculation of the combustion process of solid, liquid and gas fuel. Basics of combustion theory and combustion control in industrial conditions. Refractory materials and furnace lining. Heat characteristics of furnace linings. General settings of the theory of furnaces. Thermodynamic and kinetic bases of furnace operation. Basics of the furnace thermal work calculations. Connections between the heat and material balance and calculation of the furnace batch. Typical conditions of the furnace thermal work and furnaces classification. Dryers. Furnaces for roasting, sintering and calcination. Blast furnaces-shaft furnaces. Converters. Reverberatory furnaces. Electric furnaces. Induction furnaces. Vacuum furnaces. New type of furnaces for melting and converting. Fire refining furnaces. Furnaces for melting of non-ferrous metals and their alloys. Furnaces for the production of rare metals and semiconductors. Furnaces for the production of hard alloys and refractory metals.

Practical classes: Excercises, Other forms of teaching, Study research work.

Calculation excercises follow the lectures.

Literature

Recommended:

1. Ivan Mihajlović, Toplotna tehnika i peći u metalurgiji, Autorizovana predavanja, Bor, 2012.(*in Serbian*)
2. Nikola Colović, Toplotna tehnika, Tehnički fakultet Bor, 1985. (*in Serbian*)
3. Nikola Colović, Peći u metalurgiji, Tehnički fakultet Bor, 1985. (*in Serbian*)

Supplementary:

1. Z.Popović, K.Raić, Energetika metalurških peći, Zbirka rešenih zadataka, TMF, Beograd, 1986. (*in Serbian*)
2. Z.Popović, K.Raić, Peći i projektovanje u metalurgiji, Zbirka rešenih zadataka, TMF, Beograd, 1988. (*in Serbian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 2	Other forms of teaching: 1	Study research work:	

Methods of teaching

Within the theoretical part of teaching, which involves lectures and calculation exercises, carried out in the cabinet, with the application of modern technical aids, students are acquainted with the theoretical bases of the subject so that in the course of the exercise they should be able to apply theoretical knowledge on concrete examples in the form of calculation exercises.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	10	Oral exam	30

Practical classes	10		
Preliminary exam	30		
Independent work	20		

Study program: Metallurgical Engineering, Mining Engineering

Level of study: Undergraduate Academic Studies

Course: FUNDAMENTALS OF THE EXTRACTIVE METALLURGY

Lecturer: Dr. Nada Štrbac, full professor

Status of the course: Elective course for study program Metallurgical Engineering and a compulsory course for study program Mining Engineering

ECTS: 6

Prerequisite: Knowledge of physical chemistry and mineralogy and petrography is required

Course goals:

The objective of the course is introduce students with basic knowledge in the field of metal production from primary and secondary raw materials of ferrous and non-ferrous metallurgy, as a significant industrial branch.

Learning outcomes:

After completing the course, students have the necessary knowledge of the basics of extractive metallurgy of iron and steel, non-ferrous and rare metals.

Course Description:

Lectures:

The concept and division of metallurgy. Metal properties. Basic characteristics of pyrometallurgical, hydrometallurgical and electrometallurgical processes. Metallurgical slags. Refractory materials. Metallurgical fuels. General concepts of technical iron. Classification of iron. Classification of the iron production processes. Raw materials for the production of iron and their preparation. Production of iron in a blast furnace. Manufacturing of iron by other methods. General terms about steel. Classification of steel. Classification of the steel production processes. Raw materials and materials for the steel production. An overview of the processes for the steel production.

Basics of extractive metallurgy of non-ferrous and rare metals (copper, nickel, aluminum, lead, zinc, vanadium, molybdenum, uranium and titanium). Classification of non-ferrous and rare metals. Basic raw materials. Review of the technological procedures for obtaining each metal separately.

Metallurgy of secondary raw materials. Processing of secondary raw materials, collection, sorting, cleaning, melting, refining. Metals and alloys obtained from secondary raw materials.

Environmental protection in extractive metallurgy. Problems of purification of gases, wastewaters and treatment of metallic slags.

Literature

Recommended:

1. N. Štrbac, D. Živković, Osnovi ekstraktivne metalurgije, Autorizovana predavanja, TF Bor, 2012. *(in Serbian)*
2. F. Habashi, Principles of extractive metallurgy, Laval University, Quebec, Canada, 2008.

Supplementary:

1. R.Vračar, Teorija i praksa dobijanja obojenih metala, SIMS, Beograd, 2010. *(in Serbian)*
2. V. Trujić, N. Mitevska, Metalurgija gvožđa, Institut za bakar Bor, 2007. *(in Serbian)*
3. M. Gojić, Metalurgija čelika, Denona, Zagreb, 2005. *(in Serbian)*
4. B. Đurković, D. Đurković, Metalurgija retkih metala, Tehnološko-metalurški fakultet, Beograd, 1991. *(in Serbian)*
5. Ž. Kamberović, D. Sinadinović, M. Korać, Metalurgija zlata i srebra, SIMS, Beograd, 2007. *(in Serbian)*
6. T.Volkov Husović, Vatrostalni materijali, svojstva i primena, SIMS, Beograd, 2007. *(in Serbian)*
7. T.Volkov Husović, K. Raić, Goriva i sagorevanje, SIMS, Beograd 2008. *(in Serbian)*

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

Methods of teaching

Lectures are organized on an interactive basis, with the development of practical examples through group and individual work.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the	10	Written exam	

lecture			
Practical classes		Oral exam	60
Preliminary exam			
Independent work	20		

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: BASICS OF PROCESSING METALLURGY

Lecturers: Dr. Dragoslav Gusković, full professor, Dr. Srba Mladenović, associate professor

Status of the course: Elective course

ECTS: 6

Prerequisite: Basic knowledge of metal materials and metal testing knowledge

Course goals: Providing basic knowledge about concepts in the field of metal and alloy processing by casting, plastic processing, thermal treatment and sintering.

Learning outcomes: Getting basic theoretical knowledge of shaping metals by technological processes present in processing metallurgy

Course Description:

Theoretical study

Basic terms in foundry. Division of foundry according to the type of cast, type and purpose of the product. Preparation of casting alloys. Furnaces and aggregates used in foundries. Impact of the quality of the raw materials on casting process and the quality of the castings. Casting in sand molds. Technology of making molds and cores. Casting in metal molds. Basic concepts of the casting system. Casting characteristics. Alloys of heavy non-ferrous metals - scope of application. Casting alloys of light metals (aluminum, magnesium) and field of application. Special casting methods - basic concepts. Basic types of plastic processing, rolling, forging, extruding pressing, drawing. The first law of plasticity. Grip of metals by rollers. Devices and aggregates that are used in plastic processing. Classification of products obtained by plastic processing. Product quality, the influence of plastic deformation on the mechanical and technological characteristics of the product. The role and importance of thermal processing. Types of thermal processing. Devices and aggregates for thermal treatment. Chemical thermal treatment of steel. General terms from sintermetallurgy. Significance and scope of application of products obtained by sintering. Obtaining metal powders. Obtaining metal oxides. Quality of powders. Sintering-shaping pieces. Thermal processing of sintered form. Plastic processing of sintered pieces.

Literature

Recommended:

1. Љ. Иванић, Ливарство, ТФ, Бор, 2000. (*in Serbian*)
2. М. Пешић, Б. Мишковић, В. Миленковић, Прерада метала у пластичном стању, ТМФ, Београд, 1992. (*in Serbian*)
3. Н. Видојевић, Термичка обрада метала, Технолошко-металуршки факултет, Београд, 1981. (*in Serbian*)
4. М.Митков, Д. Божић, З. Вујовић, Металургија праха, Београд, 1998. (*in Serbian*)

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

Methods of teaching

Traditional lectures with interactive discussions

Grading system(max. number of points 100)			
Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	10	Written exam	
Practical classes		Oral exam	60
Preliminary exam	10		
Independent work	20		

Study program: Mining Engineering and Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: ENVIRONMENTAL MANAGEMENT

Lecturer: Dr. Milovan Vuković, full professor

Status of the course: Elective course

ECTS: 6

Prerequisite: There are no prerequisites.

Course goals: Introducing students of mining and metallurgy with theory and practice of problem solving in the area of environmental protection. The aim also is to teach the students how to create a better environment for people as well to preserve vital ecosystems, relying on the principles of sustainable development.

Learning outcomes: This course consists of lectures aimed to introduce students with different tasks and possible situations in environmental management. A wide scope of lectures covers the nature, origin and role of environmental management, with a focus on the sustainability principles. Perspectives of various participants in environmental management (for instance, scientists, policy makers, citizens) are also examined. The course offers an interdisciplinary set of lectures which explains some of frequently used frameworks and tools for environmental management. This course also considers some issues of environmental management dealing with the issues specific to both mining and metallurgical engineering.

Course Description: Introduction to environmental management. Environmentalism, environmental values, social sciences, economics and environmental management. General concepts on sustainability and environment. Fundamental ecological concepts. Classification of natural resources – the atmosphere and climate change. Water resources and land based resources. Impacts of human activities on the environment. Mining-metallurgical production and the environment. Environmental management approaches. Standards, monitoring, modeling and auditing. Pollution and waste management.

Literature

Recommended:

1. Barrow, C.J., *Environmental Management to the Sustainable Development* (Second Edition), Routledge, London; New York, 2006.
2. M. Vuković, N. Štrbac, *Zaštita životne sredine i održivi razvoj* (monografija), Tehnički fakultet Bor, 2009, Bor. (*in Serbian*)

Supplementary:

1. Murali Krishna Valli Manickam I.V., *Environmental Management Science and Engineering for Industry* (First Edition), Elsevier, 2017.

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

Methods of teaching

Lectures of *ex-cathedra* type.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	10	Written exam	70
Practical classes		Oral exam	
Preliminary exam	20		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: METALLURGY OF IRON

Lecturer: Dr. Ljubiša Balanović, assistant professor

Status of the course: Compulsory course

ECTS: 8

Prerequisite: Required knowledge of the theory of pyrometallurgical processes, heat engineering and furnaces in metallurgy, and metallurgical operations.

Course goals:
The objective of the course is to familiarize students with raw materials and materials for obtaining iron, theoretical foundations and the technological process of obtaining iron in the blast furnace, as well as new processes in the production of iron.

Learning outcomes:
Students have the necessary theoretical and technological knowledge in the field of iron metallurgy and have been trained to calculate the material and heat balance in the processes of obtaining iron.

Course Description:
A brief overview of the historical development of iron metallurgy. Iron. Classification. Basic raw materials and materials for the production of iron. Agglomeration of iron ores and concentrates. Pelletizing. Extraction of iron in a blast furnace. Process diagram and blast furnace profile. Evaporation of moisture and decomposition of carbonates. Reduction of oxides in a blast furnace. Formation of iron. Formation of slag. Behavior of sulfur in a blast furnace. Heat exchange in a high furnace. Movement of mixtures and gases in a blast furnace. Practical work of the blast furnace. Intensification of the high-flow process. Auxiliary devices. Mathematical models and automation of blast-furnace operation. New processes in the production of iron.

Literature
Recommended:
1. B. Trujic, N. Mitevska, Metalurgija gvožđa, Institut za bakar, Bor, 2007. (*in Serbian*)
2. B. Trujić, Savremeni proračuni u metalurgiji gvožđa, Institut za bakar, Bor, 2007. (*in Serbian*)
Supplementary:
1. K. Meyer, Pelletizing of Iron Ores, Springer-Verlag, Berlin – New York, 1980.
2. В.В. Полтавец, Доменное производство, Металлургија, Москва, 1971. (*in Russian*)
3. Е.Ф. Вегман, Металургија чугуна, Металургија, Москва, 1981. (*in Russian*)
4. C. Bodsworth, H.B.Bell, Physical Chemistry of Iron and Steel Manufacture, Second Edition, Longman Group Ltd.,London, 1972.

Number of classes per week				Other classes:
Lectures: 3	Practical exercises: 2	Other forms of teaching:v1	Study research work:	

Methods of teaching
Lectures and calculation exercises.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	30
Practical classes	5	Oral exam	30
Preliminary exam	30		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: METALLURGY OF THE HEAVY NON-FERROUS METALS

Lecturers: Dr. Nada Štrbac, full professor, Dr. Ljubiša Balanović, assistant professor and Dr. Aleksandra Mitovski, assistant professor

Status of the course: Compulsory course for study program Metallurgical Engineering (Module: Extractive metallurgy)

ECTS: 8

Prerequisite: Knowledge in Theory of pyrometallurgical processes, Heat technique and furnaces in metallurgy and Theory of hydro- and electrometallurgical processes is required

Course goals:

The objective of the course is to familiarize students with raw materials and materials for obtaining heavy non-ferrous metals, and with modern technological processes for metallurgical production of copper, nickel, lead, zinc, mercury, cadmium, antimony, indium, precious metals.

Learning outcomes:

Students have the necessary theoretical and technological knowledge in the field of metallurgy of non-ferrous metals and are educated to calculate the material and thermal balance of the metallurgical processes used to obtain them.

Course Description:

Lectures:

The basic classification of non-ferrous metals. The term and definition of ore. Foundations of non-ferrous metals in the world. Metallurgy of heavy non-ferrous metals - modern methods of obtaining and refining. Metallurgy of copper, nickel, lead, zinc, mercury, cadmium. Metallurgy of precious metals - gold, silver and platinum metals.

Practical classes: Excercises, Other forms of teaching, Study research work

Calculation and laboratory excercises follow the lectures.

Literature

Recommended:

1. Ž. Živković, V. Savović, Fizičko-hemijske osnove procesa topljenja i konvertorovanja, Bor, Bakar, 1994. (*in Serbian*)
2. R. Vračar, Metalurgija cinka, Naučna knjiga, Beograd, 1995. (*in Serbian*)
3. R. Vračar, Metalurgija olova, Naučna knjiga, Beograd, 1995. (*in Serbian*)
4. Grupa autora, Zbirka zadataka i metalurgije obojenih metala, TF Bor, 2003. (*in Serbian*)
5. Grupa autora, Zbirka zadataka iz metalurgije obojenih metala, TF, Bor, Grafomed, 2004. (*in Serbian*)

Supplementary:

1. W. G. L. Devenport, M. King, M. Schlesinger, A. K. Biswas, Extractive metallurgy of copper, Oxford, UK: Perfamon press an imprint of elsevir science, 2002.
2. F. Habashi, Extractive Metallurgy Today – Problems and Progress, Laval University, Canada, 2000.
3. F. Habashi, Principles of Extractive Metallurgy, Vol.1, General Principles, Gordon and Breach, Science Publishers Ltd., New York, 1969.
4. F. Habashi, Handbook of extractive metallurgy, VCH Verlagsgesellschaft mbH, Awiley Company, 1997.
5. B. A. Wills, T. J. Napier-Munn, Mineral Processing Technology, Elsevier Science and Technology Books.
6. S. Seetharman, Fundamentals of Metallurgy, Woodhead Publishing Limited and Crc Press LLC, 2005.

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 2	Other forms of teaching: 1	Study research work:	

Methods of teaching

Lectures, calculation and experimental exercises

Grading system(max. number of points 100)			
Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	30
Practical classes	5	Oral exam	30
Preliminary exams	2x15=30		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: METALLURGY OF THE RARE METALS

Lecturer: Dr. Nada Štrbac, full professor

Status of the course: Compulsory course for study program Metallurgical Engineering (Module: Extractive metallurgy)

ECTS: 8

Prerequisite: Knowledge of Chemistry, Theory of pyrometallurgical processes and Theory of hydro and electrometallurgical processes is required.

Course goals:

The objective of the course is to to introduce the students with metallurgy of rare metals, which is a very important field of industry, thanks to the production of new materials with special properties, based on rare metals.

Learning outcomes:

Students have the necessary theoretical and technological knowledge in the field of metallurgy of rare metals and are educated to calculate the material and thermal balance of the metallurgical processes used for obtaining them.

Course Description:

Lectures:

State and tendencies in the field of rare metals metallurgy. Basic properties of metals. Occurrence and classification of rare metals. Basic processes and methods for obtaining rare metals. Processes and methods of metallurgical preparation and concentration of rare metals. Processes and methods for obtaining rare metals. Processes and methods for refining rare metals. Metallurgy of rare metal powders. Smelting and casting of rare metals. Metallurgy of refractory rare metals. Basic properties, field of application, basic characteristics of raw materials. Methods for processing raw materials and obtaining metals: molybdenum, rhenium, vanadium, tungsten, zirconium, hafnium, titanium, niobium and tantalum. Metallurgy of light rare metals. Basic properties, field of application, basic characteristics of raw materials. Methods for processing raw materials and obtaining metals: rubidium, cesium, beryllium. Metallurgy of metals from the group of lanthanides. Basic properties, field of application, basic characteristics of raw materials. Procedures for processing raw materials and obtaining oxides and metals. Metallurgy of radioactive metals. Basic properties, field of application, basic characteristics of raw materials. Procedures for processing raw materials and obtaining technical concentrates, nuclear pure salts and fuel elements. Uranium and thorium. Extraction of rare metals from secondary raw materials. Ecological basics in the processing of primary and secondary raw materials in the production of rare metals.

Practical classes: Exercises, Other forms of teaching, Study research work

Calculation and laboratory exercises.

Literature

Recommended:

1. N. Štrbac, Autorizovana predavanja, TF Bor, 2010. *(in Serbian)*
2. B. Đurković, D. Đurković, Metalurgija retkih metala, Tehnološko – metalurški fakultet, Beograd, 1991. *(in Serbian)*

Supplementary:

1. В.А.Резниченко, Металлургија волфрама, молибдена и ниобија, “Наука” Москва, 1967. *(in Russian)*
2. Г.Е. Каплан, Г.Ф. Силина, Ју. И. Остроушко, Електролиз в металлургии редких металлов, Научнотехническое издателство литератури, Москва, 1963. *(in Russian)*

Number of classes per week				Other classes:
Lectures: 3	Exercises: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Teaching is organized on an interactive basis, and includes: lectures, experimental and calculation exercises. Students also do the independent work and present their results through term papers.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	10	Written exam	

Practical classes	10	Oral exam	40
Preliminary exam	20		
Independent work	20		

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: METALLURGY OF THE LIGHT METALS

Lecturers: Dr. Nada Štrbac, full professor, Dr. Ljubiša Balanović, assistant professor and Dr. Aleksandra Mitovski, assistant professor

Status of the course: Compulsory course for study program Metallurgical Engineering (Module: Extractive Metallurgy)

ECTS: 8

Prerequisite: Knowledge of Theory of pyrometallurgical processes, Heat technique and furnaces in metallurgy and Theory of hydro and electrometallurgical processes is required.

Course goals:
The aim of the course is to introduce students to raw materials and materials for obtaining light non-ferrous metals, as well as to modern technological processes of metallurgical production of aluminum, magnesium, sodium, potassium, calcium and barium.

Learning outcomes:
Students have the necessary theoretical and technological knowledge in the field of metallurgy of non-ferrous metals and are trained to calculate the material and thermal balance of the metallurgical processes used to obtain them.

Course Description:
Lectures:
Metallurgy of light non-ferrous metals - modern methods for obtaining and refining. Metallurgy of aluminum Metallurgy of magnesium Metallurgy of sodium Metallurgy of potassium Metallurgy of calcium Metallurgy of barium
Practical classes: Exercises, Other forms of teaching, Study research work
Calculation and laboratory exercises follow the lectures.

Literature
Recommended:
1. Grupa autora, Zbirka zadataka i metalurgije obojenih metala, TF Bor, 2003. (*in Serbian*)
2. Ž. Živković, R.Vračar,, Ekstraktivna metalurgija aluminijuma, naučna knjiga, Beograd, 1994. (*in Serbian*)
3. Ž. Živković, Ekstraktivna metalurgija magnezijuma, TF, Bor, Bakar, 1994. (*in Serbian*)
4. Grupa autora, Zbirka zadataka iz metalurgije obojenih metala, TF, Bor, Grafomed, 2004. (*in Serbian*)
Supplementary:
1. F. Habashi, Extractive Metallurgy Today – Problems and Progress, Laval University, Canada, 2000.
2. F. Habashi, Principles of Extractive Metallurgy, Vol.1, General Principles, Gordon and Breach, Science Publishers Ltd., New York, 1969.
3. G.Solymar, Light metals, Elsevier, London, 2003.

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 2	Other forms of teaching: 1	Study research work:	

Methods of teaching
Lectures, calculations and experimental excercises

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	30
Practical classes	5	Oral exam	30
Preliminary exams	2x15=30		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: PROCESSING OF METALS IN PLASTIC STATE 1

Lecturer: Dr. Dragoslav Gusković, full professor

Status of the course: Compulsory course Processing metallurgy

ECTS: 8

Prerequisite: Required knowledge in mathematics, physics and physical metallurgy

Course goals:

The course should enable the student to learn processes that take place in a solid metal (alloy) under the influence of stresses that cause the change in shape and dimensions with a constant volume value, with the greatest attention paid to rolling as the most common metal processing process in general.

Learning outcomes:

The student needs to become acquainted with the processes of solid state flow of metals and to master specific rolling technologies in order to be trained for efficient independent and team work in this field.

Course Description:

Theoretical study

Correlation of deformation and structural changes in metal. Characteristics of warm and cold plastic deformation. Strengthening and texture. Recrystallization and fibrous structure. Strengthening diagrams for metals and alloys. The role of crystal structure errors in plastic deformation processing. Thermomechanical metal processing. Diagrams of recrystallization, equilibrium state, deformation resistance, and plasticity of metals. Technological properties and TMR of metal processing. Superplasticity. Rolling of metals and alloys. General scheme of the technological process in rolling mills. Division and purpose of semi-finished products. Types of rolling lines. Technological process of rolling of blums, slabs and billets. Preparation of semi-finished products for further processing. Profile rolling. Types of rolling mills. Calibration. Rolling of wire and profile of small cross sections. Rolling of sheets and strips. Rolling of seamless tubes. Rolling of globesand wheels. Problems and errors in rolled products.

Practical classes, Other forms of teaching, Study research work

Calculating and laboratory practices follow lectures. Determination of TMR of processing for specific alloy, calibration.

Literature

Recommended:

1. М. Пешић, Б. Мишковић, В. Миленковић, Прерада метала у пластичном стању, ТМФ, Београд, 1992. (*in Serbian*)
2. Ђ. Дробњак, Физичка металургија, Физика чврстоће и пластичности, ТМФ, Београд, 1990. (*in Serbian*)
3. М. Чаушевић, Обрада метала ваљањем, В. Маслеша, Сарајево, 1985. (*in Serbian*)
4. Б. Перовић, Физичка металургија, МТФ, Подгорица, 1997. (*in Serbian*)

Supplementary:

1. S. H. Talbert, B. Avitzuk, Elementary Mechanics of Plastic Flow in Metal Forming, John Wiley & Sons, 1996.
2. T. Z. Blazinsky, Plasticity and Modern metal forming Technology, Klower Academic Publishers, London, 1989.
3. P. I. Poluhin, Tehnologija procesov obrabotki metallov, davleniem, Metallurgija, Moskva, 1988.
4. Б. Мишковић, М. Мишовић, Р. Стефановић, Калибровање ваљака у ваљаоницама челика и обојених метала, Савез инжењера металургије Југославије, ТМФ, Београд, 1997. (*in Serbian*)
5. A. Tselikov, Stress and Strain in Metal Rolling, University Press, L.A., 2003.
6. G. E. Dieter, Mechanical Metallurgy, Mc Graw-Hill, London, 1986.

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 2	Other forms of teaching: 1	Study research work:	

Methods of teaching

Lectures, exercises and practical work, organized on an interactive principle, which besides classical lectures and presentations, includes discussions and active participation of students in all aspects of teaching.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**

Activity during the lecture	5	Written exam	20
Practical classes	5	Oral exam	50
Preliminary exam	1x20=20		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: CASTING

Lecturer: Dr. Srba Mladenović, associate professor

Status of the course: Compulsory course

ECTS: 8

Prerequisite:

Course goals:
To prepare students for work in the foundry industry

Learning outcomes:
Students will learn basic technics in pattern making, sand mixing, mould making, core making, metal melting and pouring

Course Description: Introduction. Casting. Cast production technology. Models. Core box. Materials for sand, die, investment and centrifugal casting. The composition and properties of the materials. Heat resistant materials. Production of the sand-clay patterns. Hand and machining production. Gateway system. Calculation of gateway system elements. Riser design. The final operation in production of castings. Classification of metals and alloys. Steel and cast iron. Definition and chemical composition. Construction properties. Production of cast iron. Cupola, blast and electric furnaces. Different types of cast iron. White, gray, malleable and ductile (nodular) cast iron. Production of temper cast iron. Production of alloying cast iron

Literature
Recommended:
1. Иванић Љ., Ливарство, Бор, 2000. (*in Serbian*)
2. М. Томовић, Ливење обојених и лаких метала, ТМФ, Београд, 1976. (*in Serbian*)
Supplementary:
1. Б. Кочовски, Ливено гвожђе, ТФ Бор, 2006. (*in Serbian*)
2. П. Г. Лузин, Основи економики и организации литеинога производства, Металургија, Москва. 1983. (*in Russian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching
Lectures, exercises and other forms of teaching organized in an interactive manner.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	20
Practical classes	15	Oral exam	35
Preliminary exams	10		
Independent work	15		

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: POWDER METALLURGY

Lecturer: Dr. Ivana Markovic, Assistant Professor

Status of the course: Compulsory course for study program Metallurgical Engineering (Module Processing Metallurgy)

ECTS: 8

Prerequisite: Required knowledge of Physical Chemistry, Physical Metallurgy 1 and 2

Course goals:

Introduction of students with the field of powder metallurgy and metal powders characterization

Learning outcomes:

Acquiring knowledge of the methods of obtaining metal powders, forming particles and the sintering process, in order for students to acquire the necessary basis for courses on master and doctoral academic studies in the field of powder metallurgy as well as for application of the acquired knowledge.

Course Description:

Theory teaching

Physical-chemical methods for metal powders obtaining: chemical reduction, electrolysis of aqueous solutions or dissolution of salts of different metals, dissociation of carbonyls, thermo-diffusion saturation, evaporation and condensation. Mechanical methods: powders obtaining by atomization, commercial atomization methods (water atomization, gas atomization); practical aspects of atomization, microstructure of atomized powders. Experimental determination and mathematical calculation of the cooling rate in the process of fast solidification. Nano powders obtaining. Preparation of powders for shaping and compacting processes. Shaping under the pressure at room temperature (double-sided pressing in dies, isostatic pressing, powders rolling, high energy pressing). Shaping using pressure at high temperature. Shaping without pressure. Introduction to the metal powders sintering process. Bases of solid state sintering: Mechanisms for the matter transport during the metal powders sintering. Sintering stages. Forming and growth of contacts. The process and the theory of densification. Kinetics of the structure homogenization. Recrystallization during the sintering and microstructure. Changing the shape of the pores during the consolidation process. Anisotropy of shrinkage. The relationship between shrinkage anisotropy and pore shape. Activated sintering. Liquid phase sintering. Basic mechanisms of liquid phase sintering process. Viscous flow of a solid-liquid system. Contacts forming. Characteristics of microstructure. Processes in the stage of heating and melting. Stage dissolution-deposition. Processes in the final stage. Densification. Grains growth. Microstructure. Sintering under the pressure: Densification mechanisms. Densification rate. The effect of the microstructure. New techniques of sintering. Infiltration. Activated sintering by liquid phase. Protective sintering atmosphere and sintering equipment.

Practical classes: Exercises, Other forms of teaching, Study research work

Laboratory exercises follow the theory teaching and include the testing and characterization of metal powders and pressed samples according to ISO standards for powder metallurgy field.

Literature

Recommended:

1. Mirjana Mitkov, Dušan Božić, Zoran Vujović, Metalurgija praha (Powder Metallurgy), Beograd, 1998. (*in Serbian*)
2. Svetlana Nestorović, Sintermetalurgija, Praktikum (Powder Metallurgy – Practicum), Bor, 2001. (*in Serbian*)
3. Werner Schatt, Klaus Peter Wieters, Powder metallurgy, Processing and Materials, EPMA, 1994.

Supplementary:

1. Г.А. Виноградов и др. Прокатка металическиј порошков (Rolling of Metal Powders), Металургија, Москва, 1969. (*in Russian*)
2. С. С. Кипарисов, Г.А. Либенсон, Порошковаја металургија (Powder Metallurgy), Москва, 1972. (*in Russian*)
3. О.В. Роман, И.Н. Габриелов, Справочник по порошковој металлургии (Handbook of Powder Metallurgy), Минск, 1988. (*in Russian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Lectures, exercises and practical work, organized on an interactive principle, which besides traditional lectures and presentations includes discussions and active participation of students in all aspects of teaching.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	
Practical classes	15	Oral exam	30
Preliminary exam	2 x 25 = 50		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: WELDING METALLURGY

Lecturer: Dr. Svetlana Lj. Ivanov, associate professor

Status of the course: Compulsory course

ECTS: 6

Prerequisite: Required knowledge of Physical Metallurgy 1 and Physical Metallurgy 2

Course goals:

The goal of this course is to provide theoretical knowledge in the field of welding processes, technologies and applicable welding practices.

Learning outcomes:

The outcome of this course is to gain the fundamental theoretical knowledge for investigating different processes and technologies in the field of welding of metallic materials.

Course Description:

Theoretical studies:

Introduction. Physical basics of welding. Chemical reactions during welding. Welding thermal processes. Welding discontinuities and defects. Residual stresses and distortions of welds. Cracking phenomena in welded joints. Structural changes in welded joints. Heat treatment of welded joints. Application of CCT diagrams. Introduction to welding metallurgy of steels. Welding of cast irons and steels. Welding of nonferrous materials: Al, Cu, Ni, Ti, Mg, Zr, Ta and their alloys. Joining of dissimilar materials.

Practical studies:

To complement the theoretical concepts covered in this course, laboratory exercises are included, where students can experiment with some of the concepts covered.

Literature

Recommended:

1. Д. Сеферијан, Металургија заваривања, Грађевинска књига, Београд, 1969. (*in Serbian*)
2. Р. Прокић-Цветковић, О. Поповић, Заваривање и сродни поступци, Завод за уџбенике, Београд, 2011. (*in Serbian*)
3. А.Седмак, В. Шијачки-Жеравчић, А. Милосављевић, В. Ђорђевић, М. Вукићевић, Машински материјали II, Машински факултет, Београд, 2000. (*in Serbian*)
4. K. Easterling, Introduction to the Physical Metallurgy of Welding, 2nd ed., Butterworth-Heinemann Ltd, Oxford, 1992.

Supplementary:

1. S. Kou, Welding Metallurgy, A John Wiley and Sons, Inc., Publication, New Jersey, 2003.
2. D. Smith, Welding skills and technology (Вештине заваривања и технологије), 1984. by Mc Grow-Hill, New York, са енглеског превео: др инж. Ратко Лукић, Београд, 1994. (*in Serbian*)
3. B. Lundqvist, Sandvik Welding Handbook, Sandvik AB, Sandviken, Sweden, 1977.

Number of classes per week				Other classes:
Lectures: 2	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Lectures, laboratory exercises.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	/
Practical classes	15	Oral exam	40
Preliminary exam	40		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: METALLURGY OF STEEL

Lecturers: Dr. Dragan Manasijević, full professor, Dr. Milan Gorgievski, assistant professor

Status of the course: Compulsory course

ECTS: 6

Prerequisite: Required knowledge of the theory of pyrometallurgical processes, heat engineering and furnaces in metallurgy, and iron metallurgy

Course goals:
The aim of the course is to acquaint students with the principles of steel production and the contemporary technological processes of obtaining steel.

Learning outcomes:
Students possess the necessary theoretical and technological knowledge in the field of steel metallurgy and are trained to calculate the material and heat balance in the process of obtaining steel.

Course Description:
Definition, properties and types of steel. The influence of impurities on the properties of steel. A brief overview of the historical development of steel metallurgy: Bessemer, Thomas, Open Hearth processes. Theoretical principles of steel production. Basic reactions in steelmaking: Si, Mn, C, S, P in steel. Slag in steel metallurgy. Gases and non-metallic inclusions in steel. Processes for steel production – Basic Oxygen Converter Process, Electric Arc Furnace (EAF) Process. Stainless steelmaking processes. Deoxidation and alloying of steel. Secondary metallurgy. Synthetic slag processing of steel. Desulphurization. Degassing. Control of non-metallic inclusions. Casting of steel and solidification of the ingot. New processes in steel metallurgy.

Literature
Recommended:
1. D. Manasijević, D. Živković, Metallurgy of steel, Technical faculty in Bor, Bor, 2014. (*in Serbian*)
2. M. Gojić, Metallurgy of steel, Faculty of Metallurgy, Sisak, 2005. (*in Serbian*)
Supplementary:
1. A. Ghosh and A. Chatterjee, Ironmaking and Steelmaking: Theory and Practice, PHI Learning Pvt. Ltd., 2011.
2. A. Ghosh, Secondary Steelmaking: Principles and Applications, CRC Press, 2001.
3. Turkdogan, E.T., Ironmaking and Steelmaking, 15, 1988.

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 2	Other forms of teaching: 1	Study research work:	

Methods of teaching
Lectures and calculation exercises.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	30
Practical classes	5	Oral exam	30
Preliminary exam	30		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: VACUUM METALLURGY

Lecturers: Dr. Dragan Manasijević, full professor, Dr. Aleksandra Mitovski, assistant professor

Status of the course: Elective course (module Extractive Metallurgy)

ECTS: 6

Prerequisite: Required knowledge of metallurgical thermodynamics, heat engineering and furnaces in metallurgy, metallurgical operations, metallurgy of iron and steel, and metallurgy of rare metals.

Course goals:

To make students familiar with the application of vacuum in the field of metallurgical production and in the production of modern metallurgical materials, given the wide application and importance of vacuum treatment in modern processes.

Learning outcomes:

The outcome of this elective course is to acquaint students with more detailed information on metallurgical processes under vacuum.

Course Description:

Basic terms. History of vacuum application in metallurgy. Vacuum classification. Measurement of vacuum. Types of vacuum pumps. Work under vacuum. The influence of vacuum on some important properties of metal and alloys. Theoretical basics of vacuum-metallurgical processes. Thermodynamics of vacuum-metallurgical processes. Vacuum-metallurgy processes kinetics. Application of vacuum techniques in extractive metallurgy. Vacuum technologies in preliminary stages of metallurgical reduction processes. Metal reduction processes under vacuum: carbothermic and metalothermic processes. Refining of metal under vacuum. Separation of the metal by vacuum distillation. Deoxidation and decarburization of the metals under vacuum. Zone melting. Vacuum degassing of metals in liquid and solid state. Plasma deposition of protective coatings.

Literature

Recommended:

1. D. Manasijevic, Vakuum metalurgija, Autorizovana predavanja, Tehnički fakultet u Boru, 2014. (*in Serbian*)

Supplementary:

1. O.Winkler, R.Bakish, Vacuum metallurgy, Elesevier Publishing Company, Amsterdam, 1971.
2. A.Choudhury, Vacuum metallurgy, ASM Intl., New York, 1990.

Number of classes per week				Other classes:
Lectures: 2	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Lectures, computational and laboratory exercises.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	10	Written exam	20
Practical classes	10	Oral exam	30
Preliminary exam			
Term paper	30		

Study program: Metallurgical Engineering, Mining Engineering and Technological Engineering

Level of study: Undergraduate Academic Studies

Course: METALLURGY OF THE SECONDARY RAW MATERIALS

Lecturer: Dr. Nada Štrbac, full professor

Status of the course: Elective course for study program Metallurgical Engineering (Modul: Extractive metallurgy), compulsory course for study program Mining Engineering (Modules: PMS and RTiOR) and Elective course for study program Technological Engineering (Module: Environmental protection engineering)

ECTS: 6

Prerequisite: Knowledge of general technological disciplines is required.

Course goals:

The goal of the course is to introduce students with the knowledge in the field that deals with the problem of the formation and processing of secondary raw materials of ferrous and non-ferrous metallurgy.

Learning outcomes:

After studying the subject and calculation and experimental exercises, students have the necessary knowledge to calculate the material and thermal balance of metallurgical processes, which are applied in metallurgy of secondary raw materials, as well as theoretical knowledge that enable them to choose the right technology for the processing of secondary raw materials.

Course Description:

Lectures:

Raw materials in secondary metallurgy and their usage. Sources of production of secondary raw materials. Classification of secondary raw materials. Determination of resources of secondary raw metal materials. Organization of collection and preparation of metal scrap and waste. Primary treatment: sorting, magnetic separation, separation, cutting, crushing and grinding, degreasing and drying, packing and briquetting, electrostatic separation, etc. Processing of metal waste. Production of secondary copper and copper alloys. Nickel based scrap and waste processing. Processing of secondary lead and alloys. Obtaining tin from secondary raw materials. Collecting, preparation and metallurgical processing of iron scrap. Processing of secondary raw materials containing zinc. Processing of secondary aluminum. Collection, primary treatment of scrap and waste and metallurgical processing of other non-ferrous metals and alloys (Sb, Hg, Co, etc.). Non-metallic waste processing. Hydrometallurgical processing of raw materials containing zinc. Obtaining precious metals from scrap and waste. Ecological bases for processing secondary raw materials. The economic effects of complex processing of secondary raw materials. Perspectives of the development of secondary metallurgy.

Practical classes: Exercises, Other forms of teaching, Study research work

Laboratory and calculation exercises follow lectures related to raw materials in secondary metallurgy.

Literature

Recommended:

1. N. Štrbac, Autorizovana predavanja, Bor, 2010. *(in Serbian)*
2. I. Ilić, Z. Gulišija, M. Sokić, Reciklaža metaličnih sekundarnih sirovina, ITNMS, Beograd, 2010. *(in Serbian)*

Supplementary:

1. I. Ilić i dr., Resursi i reciklaža sekundarnih sirovina obojenih metala, Institut za bakar, Bor, 2002. *(in Serbian)*
2. R.Vračar, LJ. Jakšić, Sekundarna metalurgija olova, Fakultet tehničkih nauka Kosovska Mitrovica, 2001. *(in Serbian)*
4. A. Čavić i dr., Čelični otpadak, Poslovna škola Megatrend, Beograd, 1998. *(in Serbian)*
5. И. Хайдуков, Металургија вторичних цветних металов, Москва, Металургија, 1987. *(in Russian)*

Number of classes per week				Other classes:
Lectures: 2	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Lectures, laboratory and calculation exercises

Grading system(max. number of points 100)

Pre-examination obligations	Number of points	Final examination	Number of points
Activity during the lecture	10	Written exam	
Practical classes	10	Oral exam	30
Preliminary exams			
Independent work	50		

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: METAL PLATING

Lecturers: Dr. Mirjana M. Rajčić Vujasinović, full professor, Dr. Vesna Grekulović, assistant professor,

Status of the course: Elective course

ECTS: 6

Prerequisite: Required knowledge of the theory of hydro and electrometallurgical processes and metallurgical operations

Course goals:

The aim of the course is to acquaint students with theoretical principles and practical methods of metal plating.

Learning outcomes:

Training students to independently deal with the processes of obtaining metal coatings at the engineering level, as well as setting the parameters for obtaining the coating of choice.

Course Description:

Types of metal coatings. Theoretical aspects of chemical deposition of metals. Fundamental principles in electrochemistry. Basic electrolysis laws. Types of solutions used in galvanotechnics. Mechanism of precipitation and dissolution of metals. Electro crystallization of metals. Kinetics of precipitation and dissolution of metals. Electrochemical evolution of hydrogen. Anode reactions. Preparation of surface for application of metal coatings. Copper coatings. Nickel coatings. Chromium coatings. Tin coats. Iron coatings. Coatings of precious metals. Coating of alloys. Galvanic coatings on aluminum and its alloys. Metallic coatings obtained by thermic methods. Coatings obtained by diffusion processes. Electrolyte control. Control of metal coatings. Practical classes include laboratory exercises based on the fundamental laws of electrolysis, demonstrate electrochemical evolution of hydrogen, surface preparation, application of different coatings from metals and alloys, anodizing and control of metal coatings and electrolytes.

Literature

Recommended:

1. Спасоје Ђорђевић, Миодраг Максимовић, Миомир Павловић, Константин Попов, Галванотехника, НИДД „ Техничка књига“, Београд, 1998. (*in Serbian)*
2. С. Ђорђевић, Металне превлаке, Саврмена администрација, Београд, 1970. (*in Serbian)*
3. А. Деспић, Основе електрохемије 2000, Завод за уџбенике и наст. Средства, Београд, 2003. (*in Serbian)*
4. З. Станковић, М. Рајчић-Вујасиновић, Теорија електрометалуршких процеса, Ауторизована предавања, ТФ Бор, 2005. (*in Serbian)*

Supplementary:

1. М. Рајчић-Вујасиновић, В. Златковић, Теорија хидро и електрометалуршких процеса, Практикум за вежбе, ТФ Бор, 2001. (*in Serbian)*
2. В. Мишковић-Станковић, Металне и неметалне превлаке, Практикум за вежбе, ТМФ, 2001. (*in Serbian)*
3. М. Рајчић-Вујасиновић, З. Станковић, Практикум за вежбе из Физичке хемије, ТФ Бор. (*in Serbian)*

Number of classes per week				Other classes:
Lectures: 2	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Theoretical teaching, laboratory exercises, extensive term paper work requiring students to learn the methods of searching literature and the Internet, setting parameters and conquering the application of the coating of choice.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	10	Written exam	
Practical classes	10	Oral exam	30
Preliminary exam			

Independent work	50		

Study program: Mining Engineering, Metallurgical Engineering, Technological Engineering

Level of study: Undergraduate Academic Studies

Course: ECONOMICS AND ORGANIZATION OF BUSINESS

Lecturer: Dr. Dejan Riznić, full proffesor

Status of the course: Compulsory course

ECTS: 6

Prerequisite: Knowledge of general technical and technological disciplines and functioning of the business system

Course goals:

The aim of the course is to gain necessary knowledge on the current state of economy and businesses organization, the economy of capital and labor, investments in reproduction, operating expenses, financial result and basic economic principles. The course is conceived with aim to provide student's acquisition of fundamental theoretical and practical knowledge and skills in the area of enterprise organization. Fundamentals of organization will prepare future managers for the challenges of today's business world.

Learning outcomes:

Fundamentals of business economics and organization is a microeconomic scientific discipline that ensures gaining the basic knowledge about the operation of enterprises. Getting acquainted with basic economic laws and organization of business. Fundamentals of organization will prepare future managers for the challenges of today's business world. Students will discover the most progressive thinking about organizations in real world. Mastering the basic ones economic principles of modern business.

Course Description:

Introduction - the subject, objective of studying economics and business organization as an economic discipline. Methods of studying economics and business organization as an economic discipline. Organization of business economy - forms of organization of economic entities. Classification and termination of business entities. Business functions -vertical and horizontal. Economics of funds of business entities - basic and working capital, investments in reproduction, sources of business assets. Liquidity of business entities. Investments. Economics of Labor. Operating costs - price and division, natural costs, cost of reproduction dynamics. Cost dynamics and revenues, cost accounting. Determination and distribution of business results. Basic economic principles. Final Test

Literature

Recommended:

1. Gregory Mankiw (2017): "Principles of Microeconomics", Harvard University,
2. Milgrom, Paul and John Roberts (1992): "Economics, Organization and Management", Published by Prentice Hall,
3. Wilson, D. C., & Rosenfeld, R. H. (1990): "Managing organizations": Text, readings, and cases. McGraw-Hill

Supplementary:

1. Richard L Daft (2010): "Organization theory and design", Mason, Ohio : South-Western Cengage Learning
2. Begg David and Ward Damian(2006): "Economics for Business", Published by McGraw-Hill Higher Education
3. Edwin Mansfield (2005): "Managerial Economics 6th ", Publisher: W. W. Norton & Company

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

Methods of teaching

Theoretical teaching with practical applications within the group, individual and combined teaching methods.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the	20	Written exam	15

lecture			
Practical classes		Oral exam	35
Preliminary exam	30		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: PROCESSING OF METALS IN PLASTIC STATE 2

Lecturers: Dr. Dragoslav Gusković, full professor, Dr. Saša Marjanović, associate professor

Status of the course: Elective course (Processing metallurgy module)

ECTS: 6

Prerequisite: Required knowledge of mathematics, physics and physical metallurgy.

Course goals:

The course should enable the student to learn the process of metal processing in a solid state such as hot and cold pressing, drawing, forging and deep forming.

Learning outcomes:

The student needs to become acquainted with the processes of metal shaping in solid state and to master the specific pressing, drawing, forging and deep forming technologies in order to be able for efficient independent and team work in this field.

Course Description:

Theoretical study

Pressing of metals and alloys by extrusion. Pressing procedures. Metal flow in the pressing process. Extrusion pressing technology. Starting material for pressing. Assortment of pressed products. Presses and press tools. Characteristics of structure and properties of pressed products. Technoeconomic indicators of the pressing process by extrusion. Drawing of metals and alloys. Preparation of material and drawing tool. The role of lubricants. Assortment of drawing products. General scheme of the technological process. Drawing of wires, rods, tubes and profiles. Drawing machines. Selection and layout of reductions at drawing. Drawing tool. Thermal processing of products and control of their quality. Technoeconomic indicators of the drawing process. Forging and forging pressing. Free forging and forging in molds. Forging and pressing technology. Deep forming.

Practical classes, Other forms of teaching, Study research work

Calculating and laboratory practices follow lectures. Determination of TMR of processing for specific alloy.

Literature

Recommended:

1. М. Пешић, Б. Мишковић, В. Миленковић, Прерада метала у пластичном стању, ТМФ, Београд, 1992. (*in Serbian*)
2. Б. Мусафија, Обрада метала пластичном деформацијом, Светлост, Сарајево, 1985. (*in Serbian*)
3. М. Пешић, В. Миленковић, Извлачење жица, шипки и цеви, ТК, Београд, 1965. (*in Serbian*)
4. Д. Гусковић, Б. Станојевић, С. Стевић, Савремени поступци добијања бакарних жица, ТФ, Бор, 1997. (*in Serbian*)

Supplementary:

1. G. E. Dieter, Mechanical Metallurgy, Mc Graw-Hill, London, 1986.
2. Ju. F. Sevakin, Presovanie tjazelyh cvetnyh metallov I splavov, Metallurgija, Moskva, 1989. (*in Russian*)
3. М. З. Ерманок, Л. С. Ватрусин, Волоцение Цветних металлов, Металлургија, Москва, 1982. (*in Russian*)
4. Е. И. Семенов, Ковка и стамповка, Масиностроение, Москва, 1983. (*in Russian*)
5. В. С. Парсин, Холодное, волоценуе труб, Металлургуја, Москва, 1979. (*in Russian*)
6. A. H. Fritz, G. Schulze, Fertigungstechnic, Springer Verlag, Berlin, 2001.

Number of classes per week				Other classes:
Lectures: 2	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Lectures, exercises and practical work, organized on an interactive principle, which besides classical lectures and presentations, includes discussions and active participation of students in all aspects of teaching.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	20
Practical classes	5	Oral exam	50

Preliminary exam	1x20=20		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: CONTACT MATERIALS

Lecturer: Dr. Ivana Markovic, Assistant Professor

Status of the course: Elective course for study program Metallurgical Engineering (Module Processing Metallurgy)

ECTS: 6

Prerequisite: Required knowledge of Physical Chemistry, Metallography and Powder Metallurgy

Course goals:

During the course students study the obtaining, characterization and application of electrical contacts obtained by powder metallurgy procedures.

Learning outcomes:

Training of students for independent work in the field of testing and characterization of sintered contacts based on precious and other metals and alloys obtained by powder metallurgy technology.

Course Description:

Theory teaching

Operation of electrical contacts. Materials for electrical contacts. Materials based on metals with a high melting point. Manufacture of materials. Sintered tungsten. Sintered molybdenum. Sintered rhenium. W-Cu composite material. W-Ag composite material. Materials for contacts for inclusion in vacuum. Dispersed hardened silver-based materials. Production processes. Metal-graphite composites. Silver-graphite composites. Copper-graphite composites. Contact materials of precious metals: gold alloys for contacts, silver alloys for contacts, platinum alloys for contacts, standard shapes and dimensions of contact materials based on precious metals. Materials for electrical contacts based on copper alloys hardened by annealing.

Practical classes: Exercises, Other forms of teaching, Study research work

Lectures, exercises and practical work, organized on an interactive principle, which in an addition to classical lectures and presentations, includes discussions and active participation of students in all aspects of teaching.

Literature

Recommended:

1. Werner Schatt, Klaus Peter Wieters, Powder Metallurgy, Processing and Materials, EPMA, 1994.
2. Svetlana Nestorović, Sintermetalurgija, Praktikum (Powder Metallurgy – Practicum), Bor, 2001. (*in Serbian*)
3. Pavle Gertik, Plemeniti metali, svojstva, prerada, primena (Precious Metals, Properties, Processing, Application), Beograd, 1997. (*in Serbian*)

Supplementary:

1. В.А. Ивенсен, Кинетика уплотненија металическиј порошков при спекании (Kinetics of Compacting of Metal Powders During Sintering). Металлургија, Москва, 1971. (*in Russian*)
2. Standard Test Methods for Metal Powders and Powder Metallurgy Products, Metal Powder Industries Federation, Princeton, New Jersey, U.S.A. 1999.
3. О.В. Роман, И.Н. Габриелов, Справочник по порошковој металлургии (Handbook of Powder Metallurgy), Минск, 1988. (*in Russian*)

Number of classes per week				Other classes:
Lectures: 2	Exercises: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Lectures, exercises and practical work, organized on an interactive principle, which besides classical lectures and presentations includes discussions and active participation of students in all aspects of teaching.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	
Practical classes	15	Oral exam	30
Preliminary exams	2 x 25 = 50		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: SINTERED METALLIC MATERIALS

Lecturer: Dr. Ivana Markovic, Assistant Professor

Status of the course: Elective course for study program Metallurgical Engineering (Module Processing Metallurgy)

ECTS: 6

Prerequisite: Required knowledge from Physical Metallurgy 1 and 2 and Powder Metallurgy

Course goals:

Students should approve knowledge obtained from course Powder Metallurgy and to learn about basic methods for synthesis of sintered metallic materials in order to acquire necessary knowledge for further study in the field of powder metallurgy and the technology of obtaining metallic materials.

Learning outcomes:

The expected Learning outcomes is that students acquire basic knowledge from the synthesis of sintered metallic materials in order to had the necessary basis to apply them in the field of powder metallurgy in order to characterization and obtaining of sintered metallic materials.

Course Description:

Theory teaching

Iron based sintered materials. Sintered materials based on copper and copper alloys. Sintered materials based on light metals: sintered aluminum alloys, sintered titanium alloys. Sliding materials and bearings. Friction materials. Highly porous materials and filters. Materials for electrical contacts. Sintered materials of refractory metals. Hard materials and composites of hard materials (Cermets). Sintered magnets. High temperature sintered materials: super alloys,

Nickel-based super alloys. Intermetallic compounds - aluminides based on nickel. Composite materials.

Composite layered materials - laminates. Composites based on light metals and alloys - aluminum based composites. Composites obtained from ultrafine powders. Hardened sintered materials based on copper:

Dispersion hardened copper alloys, multi-hardened copper alloys. Dispersion hardened sintered alloys based on aluminum. Sintered materials based on precious metals - dispersion hardened silver, dispersion hardened gold, dispersion hardened platinum. Materials obtained from nano powders.

Practical classes: Exercises, Other forms of teaching, Study research work

Lectures are followed by laboratory classes: testing and characterization of pressed and sintered materials using ISO standards for powder metallurgy.

Literature

Recommended:

1. Werner Schatt, Klaus Peter Wieters, Powder Metallurgy, Processing and Materials, EPMA,1994.
2. Svetlana Nestorović, Sintermetalurgija, Praktikum (Powder Metallurgy – Practicum), Bor, 2001. (*in Serbian*)
3. Mirjana Mitkov, Dušan Božić, Zoran Vujović, Metalurgija praha, (Powder Metallurgy), 1998. Beograd. (*in Serbian*)

Supplementary:

1. Е.Б. Ложечников, Прокатка в порошковој металургии, (Deformation in Powder Metallurgy), Москва, 1987. (*in Russian*)
2. О.В. Роман, И.Н. Габриелов, Справочник по порошковој металлургии (Handbook of Powder Metallurgy), Минск, 1988. (*in Russian*)

Number of classes per week				Other classes:
Lectures: 3	Practical classes: 1	Other forms of teaching: 2	Study research work:	

Methods of teaching

Lectures, exercises and practical work, organized on an interactive principle, which besides classical lectures and presentations includes discussions and active participation of students in all aspects of teaching.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	
Practical classes	15	Oral exam	30
Preliminary exams	2 x 25 = 50		
Independent work			

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Cours: DESIGNING IN METALURGY

Lecturers: Dr. Nada Štrbac, full professor, Dr. Saša Marjanović, associate professor, Dr. Srba Mladenović, associate professor, Dr. Ljubiša Balanović, assistant professor

Status of the course: Elective course

ECTS: 6

Prerequisite: Required knowledge of ferrous and non-ferrous metallurgy (for the elective module Extractive metallurgy), that is, the foundry and metal processing (for the elective module Processing metallurgy)

Course goals:
Introducing students with the principles of plant design and equipment selection in metallurgy and the development of teamwork skills in project tasks.

Learning outcomes:
Acquiring basic knowledge in designing plants and equipment selection in metallurgy, as well as initial experience of working in an engineering project team.

Course Description:
Theoretical study
Design of plants for standard processes and new, specific processes. Basic Prerequisites for successful design - raw material conditions, energy conditions, transport conditions, personnel base, location conditions, auxiliary raw materials, market. Specificity of design in black metallurgy and design specificities in non-ferrous metallurgy. Specificity of design in processing metallurgy. Plant design for new processes. Phases in the development of a single process, starting idea, theoretical elaboration of the idea, laboratory tests, evaluation of research results, previous technical studies, prototype plant, semi-industrial plant. Design of industrial plant, selection of production cycle based on research results, qualitative process scheme, quantitative process scheme, material balance, energy balance, technical schemes. Selection of equipment for certain metallurgical processes. Spatial arrangement of basic devices. Spatial arrangement of auxiliary devices. Preparation of the construction site. Economic assessment of the project. Economic analysis.
Practical classes, Other forms of teaching
Examples of calculation of devices, technology and technological processes in metallurgy (smelting, refinings, foundry, forgings, rolling mills, thermal processings). Development of projects and parts of projects through seminar papers (elaborates).

Literature
Recommended:
1. Ђ. Зрнић, Пројектовање фабрика, Машински факултет, Београд, 1993. (*in Serbian*)
2. Ђ. Зрнић, М. Прокић, П. Миловић, Пројектовање ливница, МФ Београд, 1998. (*in Serbian*)
Supplementary:
1. Ђ. Зрнић, Д. Петровић, Збирка решених задатака из фабричких постројења, МФ Београд, 1992. (*in Serbian*)
2. З. Поповић, К. Раић, Пећи и пројектовање у металургији – збирка решених задатака, Технолошкометалуршки факултет, Београд, 1988. (*in Serbian*)
3. Законска регулатива у области пројектовања (*in Serbian*)
4. В. А. Авдеев, В. М. Друян, Б. И. Кудрин, Основы проектирования металлургических заводов, Интермет инжиниринг, Москва, 2002. (*in Russian*)

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

Methods of teaching
Theoretical teaching organized on an interactive basis, with the development of practical examples through group and individual work.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	5	Written exam	

Practical classes	15	Oral exam	60
Preliminary exams			
Independent work	20		

Study program: Metallurgical Engineering , Engineering Management

Level of study: Undergraduate Academic Studies

Course: QUALITY MANAGEMENT

Lecturer: Dr. Predrag Đorđević, assistant professor

Status of the course: Obligatory course or elective course

ECTS: 6

Prerequisite: Mathematics, Probability & Statistics

Course goals:

This course is designed to provide a comprehensive coverage of quality management with special emphases on the statistical tools for quality control.

Learning outcomes:

During the course students will acquire knowledge regarding the principles of quality management.

Course Description:

1. Introduction to Quality Management 2. Concepts of probability and statistics in quality control 3. Tools and techniques of Quality Control 4. Tools and techniques of Quality Control continued 5. Tools and techniques of Quality Control continued, Benchmarking 6. Process capability 7. Control Charts for Variables 8. Control Charts for Attributes 9. Midterm Exam 10. Taguchi loss function, Kano model, Product reliability 11. Acceptance Sampling 12. Quality standards 13. TQM, excellence models, characteristics of Japanese QC, Kaizen 14. Introduction to Six Sigma philosophy, DMAIC Process.

Literature

Recommended:

1. D. Hoyle, Quality Management Essentials, Elsevier, 2007.
2. D. L. Goetsch and S. B. Davis, Quality Management for Organizational Excellence: Introduction to Total Quality, Prentice Hall, 2010.
3. S. T. Foster, Managing Quality: Integrating the Supply Chain, Prentice Hall, 2012.
4. V. K. Omachonu, J.E Ross, Principles of Total Quality, Third Edition, University of Miami, 2004.

Supplementary:

1. F. Gryna, R. C. H. Chua and J. A. De Feo, Juran's Quality Planning and Analysis for Enterprise Quality, McGraw-Hill Education, 2007. 2. C. W. Kang and P. H. Kvam, Basic Statistical Tools for Improving Quality, Wiley, 2011.

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

Methods of teaching

Theoretical teaching with practical applications within the group, individual and combined teaching methods.

Grading system(max. number of points 100)

Pre-examination obligations	**Number of points**	**Final examination**	**Number of points**
Activity during the lecture	10	Written exam	
Practical classes		Oral exam	60
Preliminary exam	20		
Seminar work	10		

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: PROFESSIONAL PRACTICE

Lecturers: Dr. Vesna Grekulović, assistant professor, Dr. Ljubiša Balanović, assistant professor and Dr. Aleksandra Mitovski, assistant professor

Status of the course: Obligatory course

ECTS: 3

Prerequisite: Certified VII semester

Course goals:

The aim of the professional practice is that after finishing theoretical lectures, the student is practically acquainted with the application of theory in practice in the production conditions. In the course of professional practice, the student needs to study in more detail the production and processing technology of metals, and to compare it with theoretical knowledge from various subjects examined and laid out.

Learning outcomes:

After the practice and the seminar work done, the student will be able to compare the success of applying theoretical knowledge in given practical conditions. In the seminar work, on the concrete case, which the subject teacher entrusts should consider and display positive and negative elements in the technology of production and processing of metals.

Course Description:

Teachers in charge of organizing professional practice, in agreement with colleagues from the appropriate company in which practical work is carried out, determine the content and dynamics of the performance of professional practice, and define a concrete case that will be considered in the seminar work.

Number of classes per week	Other classes: 4

Methods of teaching

Practical work or professional practice in an enterprise or institution is carried out according to a predefined program task that consists of data collection - measurement and analysis, in consultation with experts from the company where professional practice is being conducted and teacher-coordinator of professional practice. Upon completion of the professional practice, the student submits to the coordinator of the professional practice a written journal with a description of the activities and activities that he performed during the professional practice. The teacher-coordinator of professional practice with his signature in the index confirms that the student has successfully completed the professional practice which enables the student to verify the semester with other signatures.

Grading system(max. number of points 100)	
Professional practice attendance	50
Independent work	50

Study program: Metallurgical Engineering

Level of study: Undergraduate Academic Studies

Course: FINAL WORK

Lecturer: All teachers in the study program are potential mentors

Status of the course: Compulsory course

ECTS: 3

Prerequisite:
Passed all exams included in the program of undergraduate academic studies of metallurgical engineering

Course goals:
The goals of the final work are to train students for independent work after the completion of undergraduate academic studies, as well as to enable them to acquire the basis necessary for master academic studies.

Learning outcomes:
The expected results of the final work are familiarization with the subject matter and the way of solving it, along with the practical application of the knowledge acquired in the study program, which enables the student to independently solve the engineering tasks within the framework of the study program.

Course description:
The final work is a research paper formulated for each student separately in which he is introduced to the methodology of research in the field of metallurgical engineering. The mentor leads the candidate in his work and provides him with assistance in the entire process of preparation of final paper: the choice of the topic of final paper, formulation of the title of work, setting the course goals of work, engineering methods and ways of solving it, approach to the problem, the choice of the way of problem processing, collection, processing analysis and verification by applying engineering methods, design of final work.
After completion of the research, the student prepares final work in the form that contains the following chapters: introduction (defining the goal of the task and the expected results); theoretical part (an overview of the most important theoretical bases, which are the basis for certain research); experimental, practical part (concrete processing of a given engineering problem), results and discussion (presentation of obtained results in the unfinished technical form, with necessary comments and conclusions given in order to solve the current problem), and literature review. Upon completion of work, the student hands over the work, followed by a public defense. This student qualifies for independent presentation and defense of acquired engineering knowledge and experience.

Methods of teaching
The methods of performing the final work consist of a theoretical introduction to the problem and independent laboratory work under the supervision of teachers. During final work preparation, all necessary research methods will be applied. Upon completion of his work and receiving a positive assessment by the mentor, the candidate orally defends the work in front the commission.

Grading system(max. number of points 100)

Preparation of the final work	70
Presentation and defense of final work	30