SVEUČILIŠTE U ZAGREBU
METALURŠKI FAKULTET

UNIVERSITY OF ZAGREB
FACULTY OF METALLURGY

SISAK

UNDERGRADUATE STUDY PROGRAM

„METALLURGY“

NOTE: revised study program in application from academic year 2017/2018

PROGRAM OF THE COURSES

Sisak, July, 2017

CONTENT

MATHEMATICS 1	5
PHYSICS	8
GENERAL CHEMISTRY	11
INTRODUCTION TO METALLURGY	13
INTRODUCTION TO INDUSTRIAL ECOLOGY	16
ETHICS AND COMMUNICATION SKILLS	19
ENGLISH LANGUAGE 1	21
MATHEMATICS 2	24
INORGANIC CHEMISTRY	27
ENGINEERING DRAWING AND COMPUTER GRAPHICS	30
MINERALOGY AND ORE DEPOSITS	33
FUNDAMENTALS OF ELECTRICAL ENGINEERING	36
QUALITY MANAGEMENT	39
ECOTOXICOLOGY	42
FUNDAMENTALS OF INDUSTRIAL PRODUCTION	45
ENGLISH LANGUAGE 2	48
PHYSICAL CHEMISTRY	51
FUNDAMENTALS OF PHYSICAL METALLURGY	54
FUNDAMENTALS OF METALLURGICAL PROCESSES	57
ENGINEERING THERMODYNAMICS	60
ENGINEERING MECHANICS	63
COMPUTER APPLICATION	66
ORGANIC CHEMISTRY	69
METALLURGY OF IRON	72
METALLURGY OF NON-FERROUS METALS	75
FUNDAMENTALS OF HEAT TREATMENT AND WELDING	79

CHEMICAL ANALYSIS TECHNIQUES 82
FUNDAMENTALS OF THEORY OF METAL FORMING 85
MACHINERY ELEMENTS 88
COMPUTER AIDED DESIGN 90
PRODUCTION OF IRON AND STEEL 93
HAZARDOUS SUBSTANCES IN THE ENVIRONMENT 96
AIR POLLUTION AND PROTECTION 99
METALLURGY OF STEEL 101
HEAT AND MASS TRANSFER 104
FUNDAMENTALS OF METAL CASTING 107
MATERIALS TESTING 109
REFRACTORY AND CARBON MATERIALS 112
FUELS AND COMBUSTION 114
INTRODUCTION TO ENTREPRENEURSHIP 116
SUSTAINABLE WASTE MANAGEMENT 118
INDUSTRIAL PROCESSES AND ENVIRONMENT 121
METAL FORMING TECHNOLOGIES 124
FUNDAMENTALS OF METAL SOLIDIFICATION 127
THERMODYNAMICS OF MATERIALS 130
WATER POLLUTION AND PROTECTION 133
POLLUTION AND PROTECTION OF SOIL 135
MATERIALS RECYCLING 138
COMPUTER PROGRAMMING 141
HEALTH AND ENVIRONMENT 143
LABELING OF PRODUCTS AND PACKAGING 146
RECYCLING OF ELECTRICAL AND ELECTRONIC WASTE 149
SUSTAINABILITY OF FOUNDRY PROCESSES 152
WASTE CHARACTERIZATION 154
RATIONAL USE OF ENERGY 156

MODERN PROCEDURES OF MATERIALS PROCESSING 158
INTRODUCTION TO NUMERICAL SIMULATIONS 160
METALLURGY OF FERROALLOYS 162

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169456
1.1. Course teacher	Assist.Prof. Ivan Ivec, PhD	1.6. Year of study	1
1.2. Name of the course	**MATHEMATICS 1**	1.7. Credit value (ECTS)	6
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+45+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	55
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	1) Use the derivative as a tool to analyze the growth rate in solving the problem of quantitative analysis in engineering. 2) Determine the features of planar curves by using the tools of differential calculus. 3) Explain how differential calculus combines the ideas of the slope in geometry, growth in the practical problems and analytical term of derivation as a unified set of tools for quantitative analysis.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	1) Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. 2) Apply logical conclusion and precision in data processing.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1) Analyze the similarity and differences between real and complex numbers and carry out mathematical operations with them. 2) Explain the term of real functions and their basic features. 3) Define the concept of series and examine the convergence. 4) Explain the concept of growth rate of functions on selected examples in engineering or natural sciences. 5) Sketch the graph of real functions of one variable and discuss the local behavior in the interval around specific points.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	1) Sets and operations on sets, real numbers. 2) Complex numbers, vectors in the plane, trigonometry of the right-angled triangle. 3) Functions, graphs of functions, graphs of elementary functions. 4) Linear, quadratic, exponential and logarithmic functions. 5) Determination of the domain of functions. 6) Composition of functions, inverse function. 7) Repetition, 1st test. 8) Arrays, limit of an array. 9) Limit of a function. 10) Definition of derivatives, table of derivatives. 11) Differentiation rules. 12) Tangent and normal to the graph of a function, local extrema and intervals of monotonicity . 13) Drawing graphs of functions.

	14) Points of inflection and intervals of convexity / concavity , L'Hospital rule. 15) Repetition, 2nd test.					
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities						
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	1	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	2	Oral exam	1	(Other—describe)	
	Written exam	2	Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Written exam: 80% Oral exam: 20%					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Ivan Slapničar, Matematika 1, Fakultet elektrotehnike, strojarstva i brodogradnje u Splitu, Split, 2002.	20	
	Ivan Slapničar, Josipa Barić i Marina Ninčević, Matematika 1 – zbirka zadataka, Fakultet elektrotehnike, strojarstva i brodogradnje u Splitu, Split, 2010.	20	
	B. P. Demidovič, Zadaci i riješeni primjeri iz više matematike s primjenom na tehničke nauke, Tehnička knjiga, Zagreb, 1986.	7	

2.12. Optional literature (at the time of the submission of the study programme proposal)	V. P. Minorski, Zbirka zadataka iz više matematike, Tehnička knjiga, Zagreb, 1971.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey on the level of the University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Analyze the similarity and differences between real and complex numbers and carry out mathematical operations with them.	1. colloquium, written and oral exam
2	Explain the term of real functions and their basic features.	1. colloquium, written and oral exam
3	Define the concept of series and examine the convergence.	1. colloquium, written and oral exam
4	Explain the concept of growth rate of functions on selected examples in engineering or natural sciences.	2. colloquium, written and oral exam
5	Sketch the graph of real functions of one variable and discuss the local behavior in the interval around specific points.	2. colloquium, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169458
1.1. Course teacher	Assoc.Prof. Robert Pezer, PhD	1.6. Year of study	1
1.2. Name of the course	**PHYSICS**	1.7. Credit value (ECTS)	6
1.3. Associate teachers	Ivana Ivanić, PhD	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+45+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	55
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2., 10%
2. COURSE DESCRIPTION			
2.1. Course objectives	Learn how to use quantitative mathematical skills and fundamental laws of nature in the field of mechanics, waves and vibrations in the technical disciplines. Explain the elements of understanding of the many-body system in the context of the state of matter, interactions and the wave phenomena. Acquire natural science competencies and skills that enable quantitative analysis and description of the phenomenon within the overall complexity of nature (abstraction, simplification and modeling). Learn how to carry out basic laboratory work: measurement, preparation and execution of the experiment, analysis and presentation of results in the form of a written report.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Explain the physical-chemical fundaments of phenomena characteristic for the technical profession. Apply logical conclusion and precision in data processing. Use the skills and knowledge of qualitative and quantitative analysis.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Define, describe and interpret basic physical quantities and their relations to natural phenomena. Analyze and quantitatively describe the motion of the material point and rigid body in space and time by applying Newton's laws. Apply basic mathematical methods in solving different dynamic problems. Describe and quantitatively analyze the strain of simple material using the theory of elasticity. Quantitatively analyze periodic motion and waves. Define and explain wavelength, frequency and amplitude of the wave. Use conservation laws for the study of natural phenomena, and in particular to apply the work–energy principle. Demonstrate skills in preparing and executing measurement, quantitative processing and presentation of experimental results in the field of mechanics and wave phenomena.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Mathematics supplement. Kinematics: position, speed and acceleration. (4) Vectors and position of the material point in 2D and 3D. The concept of speed and acceleration in 3D. (4) Motion with constant acceleration. Projectile motion and limiting cases (vertical and horizontal). Inertial frames of reference. The observation in physics. (4) The force as an vector. The physics terms of impulse, momentum and energy. (5) Newton's laws: an explanation of each law with a detailed description of the meaning and consequences. Presentation of the		

	laws on several standard example systems that promote conceptual understanding. The free body diagram. (5) The laws of motion and mechanics: friction (static and dynamic), variety of incline motion situations, simple machines and connected bodies, centripetal force, gravity, the movement of satellites, angular velocity, moment of inertia. (7) 1st exam The application of the laws of motion: collisions, the conservation of momentum and energy, circular motion (kinematics and moment of inertia), momentum, angular momentum and description of the body rotation. The work–energy principle. (6) Equilibrium and elasticity: mechanical equilibrium - without external force and torque, elastic force, Hooke's law, microscopic structure of substances, stress and strain, tension, compression, torsion. (5) The periodic motion: periodic phenomena, oscillations, the study of the mass-elastic spring system, motion equations as differential equations, harmonic oscillator, quantities, relationship with uniform circular motion. (6) Analysis of oscillation damping (friction impact). small oscillations of the pendulum, physical pendulum, analogies. (4) Periodic motion and waves: periodic phenomena, oscillations and waves, examples from nature regarding the role of energy transfer, the harmonic oscillator and the relation with the waves, description of the propagation speed, pulses, types and mathematical description. (5) Measurement and data processing: the scientific method, experiment, statistical analysis, basic quantities, treating of errors, regression. (4) Laboratory exercises (16) 1. Measuring length 2. Measurement of the mass 3. Examination of the second Newtons law 4. Spiral spring and elasticity 5. Physical pendulum 6. Torsion pendulum and moment of inertia 7. Elective 8. Elective 2nd exam
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work ☐ independent study ☐ multimedia and the internet ☒ laboratory ☐ work with the mentor ☐ (other) 2.7. Comments:
2.8. Student responsibilities	Attendance, performed obligations in LAB.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
Class attendance	0.6	Research		Practical training		
Experimental work	0.9	Report	0.9			
Essay		Seminar essay		(Other--describe)		
Tests	2.7	Oral exam	0.9	(Other—describe)		
Written exam		Project		(Other—describe)		

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	LAB exercises 30% Class attendance 10% Written exam 45% Oral exam 15%

	Title	Number of copies at the library	Availability via other media
2.11. Required literature (available at the library and via other media)	P. Kulišić i sur., Mehanika i toplina, Školska knjiga, Zagreb, 1996.	25	
	N. Cindro, Fizika 1, Školska knjiga, Zagreb, 1988.	14	
	J. Dobrinić, Fizika (mehanika, titranje, toplina), Tehnički fakultet, Rijeka, 1998.	15	
	P. Kulišić i sur., Riješeni zadaci iz mehanike i topline, Školska knjiga, 2007.	16	
2.12. Optional literature (at the time of the submission of the study programme proposal)	Stubičar, M. i sur., Riješeni zadaci iz opće fizike: mehanika, elektricitet i magnetizam, Školska knjiga , Zagreb, 1979. A. Halpern, Begining Physics I i II, Schaum outline, 1995. C. Kittel, W. D. Knight, M. A. Ruderman, Mehanika 1. - Udžbenik fizike Sveučilišta u Berkeleyu Skupina autora, Ivo Alfirević, Inženjerski priručnik 1, Temelji inženjerskih znanja, Školska knjiga, 1996.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	"Student survey by LMS: entry and exit. Course online forum for discussion (within LMS). Survey on the level of the university. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University. "		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Define, describe and interpret basic physical quantities and their relations to natural phenomena.	1st colloquium, written and oral exam
2	Analyze and quantitatively describe the motion of the material point and rigid body in space and time by applying Newton's laws.	1st colloquium, written and oral exam
3	Apply basic mathematical methods in solving different dynamic problems.	1st and 2nd colloquium, written and oral exam
4	Describe and quantitatively analyze the strain of simple material using the theory of elasticity.	2nd colloquium, written and oral exam
5	Quantitatively analyze periodic motion and waves. Define and explain wavelength, frequency and amplitude of the wave.	2nd colloquium, written and oral exam
6	Use conservation laws for the study of natural phenomena, and in particular to apply the work–energy principle.	2nd colloquium, written and oral exam
7	Demonstrate skills in preparing and executing measurement, quantitative processing and presentation of experimental results in the field of mechanics and wave phenomena.	2nd colloquium, seminar paper, laboratory exercises, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169470
1.1. Course teacher	Full Prof. Damir Hršak, PhD	1.6. Year of study	1
1.2. Name of the course	**GENERAL CHEMISTRY**	1.7. Credit value (ECTS)	6
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+30+0
1.4 Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	55
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION			
2.1. Course objectives	Course objective is acquiring of basic knowledge and understanding of basic principles in the field of general chemistry. Introduction with the division and structure of substances and types of chemical bonds. Understanding of the structure of the periodic table of elements. Good knowledge and understanding of the principles of chemical reaction.		
2.2. Enrolment requirements and required entry competences for the course	Chemistry subject matter from secondary school.		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Explain the physical-chemical fundaments of phenomena characteristic for the technical profession. Use the skills and knowledge of qualitative and quantitative analysis. Identify processes and connect obtained results with theoretical models. Apply logical conclusion and precision in data processing.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Classify of each substance that occurs in nature. Explain the position of each element in the periodic table. Interpret the electronic structure of atoms. Identify the type of chemical bond. Describe the types of chemical reactions. Formulate chemical equilibrium in chemical reactions.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Substances (2), Structure and properties of pure substances (2), Elements and periodic table (4), Electronic structure of atom (3), First colloquium (1), Chemical Bonds (6), Complex compounds (2), Second colloquium (1), Solutions (3), Chemical reactions (3), Chemical Equilibrium (2), Third colloquium (1). SEMINAR (15): Stoichiometry with application in laboratory exercises: Gases (5), Solutions (7), Redox reactions (3). EXERCISES (30): Processing of laboratory glass (2), Separation of components in heterogeneous mixture (4), Separation of components in homogeneous mixture (8), Determination of relative atomic mass (6), Preparation of complex compound (4), Neutralization titrations (6).		
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning	☐ independent study ☐ multimedia and the internet ☒ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:

	☐ field work					
2.8. Student responsibilities	Attendence a minimum of 70% lectures. Passed colloquium of stoichiometry. Successfully finished laboratory exercises.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	1	Research		Practical training	
	Experimental work	1	Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	2	Oral exam	2	(Other—describe)	
	Written exam		Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Evaluation of student activity in class and laboratory, evaluation of laboratory exercises, tests and oral exam.

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	I. Filipović, S. Lipanović, General and Inorganic Chemistry, Part I. – General Chemistry, Školska knjiga, Zagreb, 1995.	27	

2.12. Optional literature (at the time of the submission of the study programme proposal)	M. S. Silberberg, Chemistry – The Molecular Nature of Matter and Change, Mc Graw Hill, Boston, 2003. F. A. Cotton, G. Wilkinson, P. L. Gaus, Basic Inorganic Chemistry, John Wiley & Sons, Inc., New York, 1995.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Analysis of tests and exams. Survey on the level of the University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	Classify of each substance that occurs in nature.	1st colloquium, laboratory exercises, oral exam
2	Explain the position of each element in the periodic table.	1st colloquium, oral exam
3	Interpret the electronic structure of atoms.	1st colloquium, oral exam
4	Identify the type of chemical bond.	2nd colloquium, laboratory exercises, oral exam
5	Describe the types of chemical reactions.	3rd colloquium, laboratory exercises, oral exam
6	Formulate chemical equilibrium in chemical reactions.	3rd colloquium, oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169708
1.1. Course teacher	Full Prof. Mirko Gojić, PhD	1.6. Year of study	1
1.2. Name of the course	**INTRODUCTION TO METALLURGY**	1.7. Credit value (ECTS)	3
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+0+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	55
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Get acquainted of students with history important of metallurgy and with their effects on development civilization. Examine of metallurgy professional and describe fundamental of metallury fields. Get acquainted of students with classification of metallurgy, their important fields of activity and meaning. Getting knowledge about metallic (and following non-metallic) materials, their importance, characteristics and useful. Getting knowledge of chronology flow of materials in cycle of metallurgy production.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Explain the physical-chemical fundaments of phenomena characteristic for the technical profession. Identify processes and connect obtained results with theoretical models. Describe the material production, select their types and explain their properties for a specific area of application. Get acquainted with new metallic materials and technologies and be able to apply them in practice.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Explain fields using of metallurgy, basis contents which metallurgy can give. Explain metallic characteristics as important material for application in current and future. Define basis mineral raws for production of the most important black and colour metals as well as source of energy. Define fundamental metallurgy processes, agregates and energents for melt during production of base metallic materials (crude iron, steel, cast iron, colour metals and their alloys) as well as their application.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Week 1: Metallurgy-fundamental terms, definition etc. (1 hour). Metallurgy as professional and as science (1 hour). Week 2: Historic and current important of metallurgy as economy activity (2 hours). Week 3 and 4: Properties and basic characteristics of metals (iron, cooper, aluminium, nickel, titanium etc.) (4 hours). Week 5: Mineral raws in metallurgy (2 hours). Week 6: Review of production of crude iron (2 hours). Week 7 and 8: Current steelmaking processes (4 hours). Week 9: The first colloquium (parts from 1st to 8th week) (1 hour). Base cast iron (1 hour). Week 10: Energents in metallurgy (2 hours). Week 11: Metallurgy semi-products, products and nus-products (2 hours). Week 12: Followings of materials (steel, cooper, aluminium, etc.) in metallurgy production (cycles of metallurgy production) (2 hours). Week 13: Finish treatment of metallurgy products (heat treatment, surface engineering etc.) (2 hours). Week 14: Effect of metallurgy on environmental (2 hours).

	Week 15: Video film about metallurgy production (1 hour). The second colloquium (parts from 9th to 14th week) (1 hour).					
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ independent study ☐ multimedia and the internet ☐ laboratory ☒ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities	Students must attend over 70% of lectures.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	0.5	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	2.5	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Evaluation of students activities in course, Evaluation of written colloquiums (I and II colloquium) through continuous monitoring or final examination (written and oral).					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	M. Gojić, Metalurgija čelika, Faculty of Metallurgy University of Zagreb, II. unchanged edition, Sisak, 2006.	15	
	V. Grozdanić, A. Markotić, Metalurgija željeza i čelika, Book of solved tasks, Faculty of Metallurgy University of Zagreb, Sisak, 2006.	13	
	Z. Glavaš, N. Dolić, Metalurgija željeza, teacher manuscript of lectures set on www page of Faculty of Metallurgy, Sisak, 2014.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/3-godina-preddiplomskog-studija/metalurgija-zeljeza/view

2.12. Optional literature (at the time of the submission of the study programme proposal)	S. Muhamedagić, Metalurgija gvožđa, Faculty of metallurgy and materials, University of Zenica, Zenica, 2006. V. Trujić, Suvremeni proračuni u metalurgiji gvožđa, Institute for cooper Bor, Bor, 2007.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Input and output of students ankets. Survey on the level of the University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain fields using of metallurgy, basis contents which metallurgy can give.	1st colloquium, written exam, oral exam
2	Explain metallic characteristics as important material for application in current and future.	1st colloquium, written exam, oral exam
3	Define basis mineral raws for production of the most important black and colour metals as well as source of energy.	2nd colloquium, written exam, oral exam
4	Define fundamental metallurgy processes, agregates and energents for melt during production of base metallic materials (crude iron, steel, cast iron, colour metals and their alloys) as well as their application.	2nd colloquium, written exam, oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169709
1.1. Course teacher	Assoc.Prof. Ivan Brnardić, PhD	1.6. Year of study	1
1.2. Name of the course	**INTRODUCTION TO INDUSTRIAL ECOLOGY**	1.7. Credit value (ECTS)	3
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+0+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	25
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%
2. COURSE DESCRIPTION			
2.1. Course objectives	1. To introduce students with basic principles of ecology and laws of nature. 2. To explain and connect ecosystems with industrial systems. 3. To familiarize students with the basic of industrial ecology and sustainability, and to point out their importance in society.		
2.2. Enrolment requirements and required entry competences for the course	High school curriculum and work on computers.		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply teamwork-oriented, ethical principles and encourage the development of communication and social skills. Explain the present situation and define developmental trends of metallurgy as a profession and its impact on the entire economy. Describe the present situation and developmental trends of modern industrial ecology.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Explain the basics concepts in ecology. 2. Connect the sources of pollution with consequences for the ecosystem and the biogeochemical cycles. 3. Describe and analyze the similarities and differences between ecosystems and industrial systems. 4. Explain the concept of industrial ecology and sustainable development. 5. Explain why industrial ecology is important and where can be applied. 6. Search and analyze data from the literature on industrial ecology.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	PREDAVANJA (30): Ecology as a scientific discipline. Classification of ecology. Chosen notions from ecology. Environmental factors. The biosphere, atmosphere, hydrosphere, lithosphere and agrosphere. 3 hours Ecosystems. Aquatic and terrestrial ecosystems. Forests. Biogeochemical cycles. Circulation of water, carbon, oxygen, nitrogen, phosphorus and sulfur. 2 hours Pollution of air, water and soil - sources and consequences. Poisons. 3 hours The history of the concept of industrial ecology and sustainable development. Examples of industrial ecology. The flows of materials, energy and information, linking industrial systems with ecosystems. 3 hours Linking of subjects to create closed flows. The starting point - information. The study feasibility of linking. Status of waste and regulations. 4 hours Feasibility criteria of linking: qualitative, technical, quantitative, legal and economic. Dynamic cooperation and example. 3 hours Tools that helps in subject linking. 3 hours		

	The impact of industrial ecology to the environment. Introduction with diagnostic tools: life cycle assessment (LCA), input-output analysis, ecological footprint. 4 hours Eco-design and industrial ecology. The application of industrial ecology in metallurgy and transport. Life cycle assessment. Literature searching on industrial ecology. 5 hours					
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☒ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:			
2.8. Student responsibilities	Regular attendance of lectures (70% of the lectures) and solving of independent task.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	0.5	Research	0.5	Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests		Oral exam	1	(Other—describe)	
	Written exam	1	Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Attendance on classes, research, continous monitoring – 2 preliminary exams or written and oral exam.					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	I. Brnardić, Lectures from Introduction to industrial ecology, Sisak, 2016.		Internet – Merlin system for e-learning
	C. Adoue, Implementing Industrial Ecology, Enfield, USA, 2011.	1	
	A. Rastovčan, Uvod u ekologiju, Skripta, Metalurški fakultet, Sisak, 2009.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/1-godina-preddiplomskog-studija/UVOD%20U%20EKOLOGIJU-%20INTERNET.pdf/view

2.12. Optional literature (at the time of the submission of the study programme proposal)	T. E. Graedel, B. R. Allenby, Industrial Ecology, Pearson Education, Inc., New Jersey, USA, 2003. D. Bourg and S. Erkman, Perspectives on Industrial Ecology, Scheffielc, UK, 2003. O. P. Springer, D. Springer, Otrovani modrozeleni planet, Merdijani, Samobor, 2008.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey on the level of the University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain the basics concepts in ecology.	1st colloquium, written and oral exam
2	Connect the sources of pollution with consequences for the ecosystem and the biogeochemical cycles.	1st colloquium, written and oral exam
3	Describe and analyze the similarities and differences between ecosystems and industrial systems.	1st colloquium, written and oral exam
4	Explain the concept of industrial ecology and sustainable development.	2nd colloquium, written and oral exam
5	Explain why industrial ecology is important and where can be applied.	2nd colloquium, written and oral exam
6	Search and analyze data from the literature on industrial ecology.	2nd colloquium, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169710
1.1. Course teacher	Full Prof. Damir Hršak, PhD	1.6. Year of study	1
1.2. Name of the course	**ETHICS AND COMMUNICATION SKILLS**	1.7. Credit value (ECTS)	2
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	15+15+0+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	55
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION						
2.1. Course objectives	Course objective is introduce students to the philosophy and ethics of Greek civilization as the only one in which the philosophical movement goes together withscientific tradition, because this approach disigned today's civilization of the Western world. Provide historical overview of ethics as a philosophical discipline. Introduce students with fundamental communication skills.					
2.2. Enrolment requirements and required entry competences for the course	-					
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply teamwork-oriented, ethical principles and encourage the development of communication and social skills. Apply logical conclusion and precision in data processing.					
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Interpret Socrates Aristotle and Plato's ethics. Define what is democracy, pluralism, human rights, women rights, environmental protection and global warming. Formulate social problems through communication. Use communication skills for analysis of actual ethical end ecological problems.					
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (15): Relationship of philosophy and ethics, as well as philosophy and science (2), Ancient Greeks – the founders of ethics (1), The ethics from ancient Greece to the present days (4), Ecological ethics and bioethics (3), Communication and mass media (3), Postmodernism and media (2). SEMINAR (15): Oral presentation and defended seminar papers from students in ethical questions.					
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:			
2.8. Student responsibilities	Attendence a minimum of 70% lectures. Defended seminar paper.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number	Class attendance		Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	1	(Other--describe)	

of CTS credits is equal to the credit value of the course)*:*	Tests		Oral exam	1	(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Evaluation of student activity in class, evaluation of seminar paper and oral exam.					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	M. Kangrga, Ethics, Golden marketing – Tehnička knjiga, Zagreb, 2004.	5	
	H. Jurić, Ethics of responsibility of Hans Jonas, Pergamena, Zagreb, 2010.	10	

2.12. Optional literature (at the time of the submission of the study programme proposal)	P. Singer, Practical ethics, KruZak, Zagreb, 2003. M. Haralambos, M. Holborn, Sociology – topics and perspectives, Golden marketing, Zagreb, 2002.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Students questionnaire. Analysis of tests and exams.

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	Interpret Socrates Aristotle and Plato's ethics.	Oral exam
2	Define what is democracy, pluralism, human rights, women rights, environmental protection and global warming.	Oral exam
3	Formulate social problems through communication.	Seminar paper, oral exam
4	Use communication skills for analysis of actual ethical end ecological problems.	Seminar paper, oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169711
1.1. Course teacher	Maja Ivanković, Mphil, lecturer	1.6. Year of study	1
1.2. Name of the course	**ENGLISH LANGUAGE 1**	1.7. Credit value (ECTS)	2
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	15+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	55
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Application of the basics of grammatical and lexical content enabling elementary everyday communication in the foreign language. Developing reading, writing, listening and speaking skills in the foreign language. Introduction to the foundations of professional vocabulary of relevant scientific branches in the foreign language
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply the teamwork-oriented, ethical principles and encourage the development of communication and social skills. Explain the present situation and define the developmental trends of metallurgy as a profession and its impact on the entire economy. Describe the present situation and developmental trends of modern industrial ecology.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	To be able to express oneself in the everyday language and recognize and use professional language at a beginner level. To compare and recognize general language vs. the professional language in selected text excerpts. To recognize and apply grammatical and lexical structures typical for everyday language, language of science and professional language (verb tenses, nouns, adjective, adverbs, prepositions, numbers, measurements, etc.) To apply grammatical principles in written and oral exercises evoking everyday communicative situations. To recognize and apply lexical structures specific to the English language (collocations, idioms, phrasal verbs).
2.5. Course content broken down in detail by weekly class schedule (syllabus)	- Course content is devised so as to represent equally all four skills: reading, writing, listening and speaking. 1 The first lecture is designed as introduction to parts of speech, punctuation and lexical structures specific to the English language (collocations, idioms, phrasal verbs). At the very beginning a poll is conducted on initial knowledge of English and then the students are acquainted to their obligations. Oral and written exercises regarding the content covered at the previous lecture. 2 The second lecture is designed as introduction to verb tenses for the present. Oral and written exercises regarding the content covered at the previous lecture. 3 The third lecture is designed as introduction to verb tenses for the present continued. Oral and written exercises regarding the content covered at the previous lecture. 4 The fourth lecture is designed as introduction to verb tenses for the past. Oral and written exercises regarding the content covered at the previous lecture. 5 The fifth lecture is designed as introduction to verb tenses for the past continued. Oral and written exercises regarding the content covered at the previous lecture. 6 The sixth lecture is designed as introduction to verb tenses for the future. Oral and written exercises regarding the content

	covered at the previous lecture. 7 The seventh lecture is designed as introduction to verb tenses for the future continued. Oral and written exercises regarding the content covered at the previous lecture. 8 The eighth lecture is devised as synthesis of all verb tenses. Oral and written exercises regarding the content covered at the previous lecture. 9 The ninth lecture is devised as introduction to the rules for application and forms relating to nouns, adjectives, adverbs and prepositions. Oral and written exercises regarding the content covered at the previous lecture. 10 The first preliminary exam evaluated content and units covered to this point. 11 The second part of the course is devised so as to introduce the language of sciences (mathematics, physics, chemistry, biology)… 12 … practicing the linguistic analysis of text excerpts and… 13 …the use of structures and vocabulary in oral and written situations evocative of real-life setting. 14 The third part of the course is designed as a linguistic analysis of text excerpts specific to metallurgy and industrial ecology. 15 The second preliminary exam covers the second and third parts of the course content. - Throughout the course acquisitions is checked via pop quizzes, self-evaluation, pair work, group work and homework. Students possessing more advanced previously acquired skills in English are offered a possibility of an oral presentation of a relevant professional topic.

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☒ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:

2.8. Student responsibilities	Attendance (min. 70 %), regular homework, participation in class. Insofar as the student fails to fulfil his/her obligation, they are offered to make up for content missed via a translation of a professional text from English to Croatian.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
Class attendance		Research		Practical training		
Experimental work		Report				
Essay		Seminar essay		(Other--describe)		
Tests		Oral exam	1	(Other—describe)		
Written exam	1	Project		(Other—describe)		

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Attendance is treated as condition for signature. If a student passes both preliminary exams, he/she is exempt from the written part of the exam. Homework is treated as condition for signature. Oral presentation of a professional topic may raise the final grade by up to 20 %.

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	L. Šestić, English for Metallurgists, Zenica, 1985.	21	
	J. Eastwood, Oxford Guide to English Grammar, OUP, 2000.		Electronic form
	P. Emmerson, Essential Business Grammar Builder, MacMillan, 2010.		Electronic form
	M. Ibbotson, Cambridge English for Engineering, CUP, 2012.		Electronic form
	S. Campbell, English for the Energy Industry, CUP, 2013.		Electronic form

	M. Swan & C. Walter, The Good Grammar Book, UOP, 2013.		Electronic form
2.12. Optional literature (at the time of the submission of the study programme proposal)	Grammar textbook approved by course teacher.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Internal poll. Survey on the level of the University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	To be able to express oneself in the everyday language and recognize and use professional language at a beginner level.	Written and oral exam
2	To compare and recognize general language vs. the professional language in selected text excerpts.	Written and oral exam
3	To recognize and apply grammatical and lexical structures typical for everyday language, language of science and professional language (verb tenses, nouns, adjective, adverbs, prepositions, numbers, measurements, etc.)	Written and oral exam
4	To apply grammatical principles in written and oral exercises evoking everyday communicative situations.	Written and oral exam
5	To recognize and apply lexical structures specific to the English language (collocations, idioms, phrasal verbs).	Written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169714
1.1. Course teacher	Assist.Prof. Ivan Ivec, PhD	1.6. Year of study	1
1.2. Name of the course	**MATHEMATICS 2**	1.7. Credit value (ECTS)	6
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+45+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	55
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	1) Use integrals as a tool to analyze abstract problem of cumulation in solving problems of quantitative analysis in engineering. 2) Solve simple differential equations. 3) In addition to computational skills, students will connect a series of fundamental results of integration, visualization and elementary linear algebra as a tool for studying the cumulation in the engineering problems.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	1) Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. 2) Apply logical conclusion and precision in data processing.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1) Define the terms of the indefinite and definite integrals and use them to solve the problem of cumulation. 2) Interpret the definite integral (area of planar figures, the arc length of the curve, the volume of the rotating bodies)on the example of the problems that are important in the engineering applications. 3) Define and describe the concepts of order, convergence of of the order and apply them to selected engineering applications. 4) Define and solve basic types of first order differential equations that arise in engineering mathematics. 5) Describe and apply a Gaussian elimination method for solving linear systems of equations (argue the existence and uniqueness of solutions).
2.5. Course content broken down in detail by weekly class schedule (syllabus)	1) Definition of definite and indefinite integrals, table of integrals. 2) Differentiation rules, application of derivatives (repetition). 3) Method of substitution, partial integration. 4) Integration of rational functions, repetition. 5) The use of integrals in calculating areas. 6) The use of integrals in calculating volumes, approximate calculation of definite integrals. 7) Repetition, 1st test. 8) Differential equations with separated variables. 9) Linear differential equations. 10) Solving linear systems by means of substitution. 11) Matrices, solving linear systems by Gaussian elimination method. 12) Determinants, solving linear systems by Cramer's rule .

	13) Series of real numbers, convergence criteria. 14) Power series, Taylor series. 15) Repetition, 2nd test.					
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities	Conditions for signature: a student must attend at least 70% of lectures and exercises.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	1	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	2	Oral exam	1	(Other—describe)	
	Written exam	2	Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Written exam: 80% Oral exam: 20%					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	I. Slapničar, Matematika 2, Fakultet elektrotehnike, strojarstva i brodogradnje u Splitu, Split, 2008.		http://lavica.fesb.hr/mat2/PDF/predavanja.pdf
	I. Slapničar, N. Jakovčević Stor, J. Barić, I. Mirošević, Matematika 2 – zbirka zadataka, Fakultet elektrotehnike, strojarstva i brodogradnje u Splitu, Split, 2012.		http://lavica.fesb.hr/mat2/vjezbe/
	B. P. Demidovič, Zadaci i riješeni primjeri iz više matematike s primjenom na tehničke nauke, Tehnička knjiga, Zagreb, 1986.	7	

2.12. Optional literature (at the time of the submission of the study programme proposal)	V. P. Minorski, Zbirka zadataka iz više matematike, Tehnička knjiga, Zagreb, 1971.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey on the level of the University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Define the terms of the indefinite and definite integrals and use them to solve the problem of cumulation.	1st colloquium, written and oral exam
2	Interpret the definite integral (area of planar figures, the arc length of the curve, the volume of the rotating bodies)on the example of the problems that are important in the engineering applications.	1st colloquium, written and oral exam
3	Define and describe the concepts of order, convergence of of the order and apply them to selected engineering applications.	Written and oral exam
4	Define and solve basic types of first order differential equations that arise in engineering mathematics.	2nd colloquium, written and oral exam
5	Describe and apply a Gaussian elimination method for solving linear systems of equations (argue the existence and uniqueness of solutions).	2nd colloquium, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169717
1.1. Course teacher	Full Prof. Ankica Rađenović, PhD	1.6. Year of study	1
1.2. Name of the course	**INORGANIC CHEMISTRY**	1.7. Credit value (ECTS)	6
1.3. Associate teachers	Assoc.Prof. Anita Štrkalj, PhD	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	75
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION			
2.1. Course objectives	Acquiring fundamental knowledge of inorganic chemistry. Application of acquired knowledge in metallurgy and industrial ecology. Ability to solve interdisciplinary problems.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. Explain the physical-chemical fundaments of phenomena characteristic for the technical profession.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Compare the elements and their compounds on the basis of similarities and differences in the periodic system. Select the procedures to obtain depending on the feedstock characteristics of elements. Explain the reaction in the process of obtaining metals and nonmetals. Knowing the impact of harmful elements and their compounds in the living environment. Verify the characteristic properties of the metals, non-metals and their compounds by experiments.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Chemical elements in the history and in the nature (2); General properties of the metals and nonmetals, their change in the periodic system (2); Halogens and halcogens (3); Nitrogen (2), boron (2) and carbon (2) groups; Alkali and alcaline earth metal groups (3); Transition elements (4); Iron, steel, alloying (3); Obtaining of metals (3); Lanthanides and actinides (2); Hidrogen (1); Noble gases (1). EXERCISES (30): Differences between metals and nonmetals (4); Types of chemical reactions: protolytic, redox; generation and stability of complexes (6); Obtaining of metals and nonmetals (4); Chemical properties of iron, aluminium, copper, chromium and silver (8); Chemical properties of sulphur, nitrogen and chlorine (6); Chemical reaction rate (2) SEMINAR (15): Preparation and presentation of seminar paper on a given theme.		
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety	☐ independent study ☐ multimedia and the internet ☒ laboratory ☐ work with the mentor	2.7. Comments:

	☐ mixed e-learning ☐ field work		☐ (other)			
2.8. Student responsibilities	Conditions for access to the exam: completed exercises and submitted seminar paper.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance		Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	1	(Other--describe)	
	Tests	1	Oral exam	2	(Other—describe)	
	Written exam	2	Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Continuous monitoring through three colloquiums or written and oral exam.					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	I. Filipović, S. Lipanović, Opća i anorganska kemija, II. dio, Školska knjiga, Zagreb, 1995.	19	
	A. Rađenović, Anorganska kemija, Metalurški fakultet, Sisak, 2009.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/1-godina-preddiplomskog-studija/anorganska_kemija_predavanja%20.pdf/view
	A. Rađenović, A. Štrkalj, Vježbe iz anorganske kemije, Metalurški fakultet, Sisak, 2008.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/1-godina-preddiplomskog-studija/anorganska_kemija_vjezbe.pdf/view

2.12. Optional literature (at the time of the submission of the study programme proposal)	A. Holleman, N. Wiberg, Inorganic Chemistry, Water de Gruyter, New York, 1995.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Analysis of the preliminary exams, exercises and exams at the level of the course. Survey on the level of the University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Compare the elements and their compoundson the basis of similarities and differences in the periodic system.	1st colloquium, laboratory exercises, written exam, oral exam
2	Select the procedures to obtain depending on the feedstock characteristics of elements.	2nd colloquium, laboratory exercises, oral exam
3	Explain the reaction in the process of obtaining metals and nonmetals.	Laboratory exercises, written exam
4	Knowing the impact of harmful elements and their compounds in the living environment.	Oral exam, seminar paper
5	Characteristic properties of the metals, non-metals and their compounds to verify by experiments.	3rd colloquium, laboratory exercises

1. COURSE DECRIPTION – GENERAL INFORMATION			**ISVU CODE:** 169720
1.1. Course teacher	Assist.Prof. Martina Lovrenić-Jugović, PhD	1.6. Year of study	1
1.2. Name of the course	**ENGINEERING DRAWING AND COMPUTER GRAPHICS**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	55
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION			
2.1. Course objectives	1. Acquire knowledge necessary to understand and create technical documentation. 2. Acquire knowledge which are strictly necessary for further learning as well as in engineering practice. 3. Acquire the knowledge needed to perform specialized tasks in the domain of the profession.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Apply norms in the technical profession. 2. Apply acquired IT knowledge in engineering practice.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Define the basic concepts related to engineering drawing and creation of technical documentation. 2. Use the acquired knowledge to develop new and read or develop existing technical documentation. 3. Determine type and quality of the surface treatment. 4. Know how to properly determine required shape or fit tolerance. 5. Use the acquired knowledge to prepare technical documentation using computer graphics.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30) AND EXERCISES (30): 1. Standardization and standards (2) 2. Types of lines, Drawing scales, Drawing formats, Technical letters (6) 3. Orthogonal projecting rules (12) 4. 1st preliminary exam: includes the units 1-3 5. Cross sections (4) 6. Dimensioning (4) 7. Processing and surface roughness (4) 8. Geometric tolerances (2) 9. Dimension tolerances and fits (6) 10. 2nd preliminary exam: includes the units 5-9 11. Basics of computer graphics (8) 12. Preparing the technical documentation using of computer graphics (12) Program task – production of technical documentation using computers		
2.6. Type of instruction	☒ lectures	☐ independent study	2.7. Comments:

	☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	

2.8. Student responsibilities	Conditions for signature: - attendance on Lectures and Exercises > 70% - program task Conditions for taking: -

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
	Class attendance	0.5	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	2.5	Oral exam	1.0	(Other—describe)	
	Written exam	1.0	Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Homework – 10% Exercises –10% Laboratory exercises – 10% Attendance – 10% Written exam – 40% Oral exam – 20%

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	B. Kovač, Tehničko crtanje, Školska knjiga, Zagreb, 1967.	15	-
	L. Lazić, Elementi strojeva, Sveučilišni udžbenik, 2001.	13	-
	T. Galeta, V. Galzina, M. Kljajin, AutoCAD osnove za tehničko crtanje, Slavonski Brod, 2005.	-	http://fizika.unios.hr/~tgaleta/kpr/materijal/AutoCADv504.pdf

2.12. Optional literature (at the time of the submission of the study programme proposal)	Inženjerski priručnik IP1, Temelji inženjerskih znanja, Školska knjiga, Zagreb. M. Opalić, M. Kljajin, S. Sebastijanović, Tehničko crtanje, 2007. M. Opalić, M. Kljajin, Inženjerska grafika, FSB/SFSB, 2010.

2.13. Methods of monitoring quality that ensure acquisition of exit competences	Internal: Student survey input. Numerical analysis of tests and exams according to scoring task by task at the level of course. External: Survey at the level of faculty and University. Analyses provided in the system of quality assurance of the institution. Analyses provided in the system of quality assurance and an authorized office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Define the basic concepts related to engineering drawing and creation of technical documentation.	Colloquiums, oral exam
2	Use the acquired knowledge to develop new and read or develop existing technical documentation.	Program task, oral exam
3	Determine type and quality of the surface treatment.	2nd colloquium
4	Know how to properly determine required shape or fit tolerance.	2nd colloquium
5	Use the acquired knowledge to prepare technical documentation using computer graphics.	Program task

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169721
1.1. Course teacher	Assoc. Prof. Natalija Dolić, PhD	1.6. Year of study	1
1.2. Name of the course	**MINERALOGY AND ORE DEPOSITS**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	55
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5 %

2. COURSE DESCRIPTION	
2.1. Course objectives	1. Introduce students to the basic features of minerals, their classifications and valuation of minerals. 2. Acquiring knowledge about the basic oxide, sulphide, carbonate, silicate and sulphate minerals and their basic properties and sites, essential mineral fuels, and the importance of self-melting minerals. 3. Ability to define the basic methods of mining and metallurgical enrichment of minerals. 4. Enable students to recognize the basic minerals by visual method.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Choose the most convenient form of energy from the perspective of sustainable development. Apply teamwork-oriented, ethical principles and encourage the development of communication and social skills. Explain the present situation and define developmental trends of metallurgy as a profession and its impact on the entire economy.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Define properties of basic group of minerals (oxide, sulphide, carbonate, silicate, sulphate), self-melting minerals, their deposits and reserves. 2. Explain the crystal structure of minerals. 3. Enumerate basic minerals to obtain iron, manganese, copper, zinc, lead, mercury, calcium, magnesium, arsenic, antimony, molybdenum, nickel, silver. 4. Explain and choose the basic ways of enrichment ores. 5. Identify basic minerals visually in existing collection of minerals in Faculty of Metallurgy.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction to the plan course and the time schedule for the colloquium. Minerals. Metals in minerals. Non-metals in minerals (gangue) (1). Chemical properties of minerals (2). Physical properties of minerals (1). The structure of minerals. The crystal structure and the basic system structure of minerals (3). Metal, non-metal and energy mineral resources (2). Oxide minerals: classification, names, properties, deposits. Oxide minerals of iron, aluminium, manganese and copper (3). Sulphide minerals: classification, names, properties, deposits. Sulphide minerals of copper, iron, zinc, lead, mercury, arsenic, antimony, molybdenum, nickel and silver (3). I TEST

	Carbonate minerals: classification, names, properties, deposits. Carbonate minerals of iron, manganese and copper (3). Fluxes - minerals of basic fluxes. (1). Sulphate minerals: classification, names, properties, deposits. Sulphate minerals of calcium, barium, copper and magnesium (1). Silicate minerals: classification, names, properties, deposits. Nesosilicates, sorosilicates, cyclosilicates, inosilicates, phyllosilicates, tectosilicates (3). Evaluation of minerals, metallurgical assessment (1). Renewable and non-renewable energy sources (2). Mine, mining, reserves (1). Basic processes of enrichment mineral raw materials: mining and metallurgical (3). II TEST EXERCISES (15): The crystal structure and the basic system structure of minerals (2). Distinguishing the basic oxide, sulphide, carbonate, sulphate and silicate minerals. Review collection of minerals (8). Basic processes of enrichment mineral raw materials (3). I, II TESTS (2).

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities	**Conditions for signature:** regular attendance (> 70 %)		

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
Class attendance		Research		Practical training		
Experimental work		Report				
Essay		Seminar essay		Identifying minerals	0.5	
Tests		Oral exam	1.5	(Other—describe)		
Written exam	2.0	Project		(Other—describe)		

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	**Continuous monitoring and evaluation of student:** The exam could be passed through TESTS (written + oral). In case it is not passed one of the two tests, the student has the right to take not passed test one more time. Both positive evaluation tests release the student of laying the final exam. At each tests student can achieve a maximum of 10 points for the question, number of questions is 5. For satisfactory accomplishment in each tests student must collect more than 30 % of points for each question. If student fails the examination by tests, laying the final exam (written + oral). *Continuous monitoring and evaluation of student:* Tests (I + II), written + oral: 3.5 ECTS Identifying minerals: 0.5 ECTS

2.11.Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**

	M. Vrkljan, V. Babić, J. Takšić, Mineralogija, Školska knjiga, Zagreb, 1998.	11	
	J. Mesec, Mineralne sirovine vrste i načini dobivanja, University of Zagreb Faculty of Geotehnical Engineering, Varaždin, 2009.	3	
	M. Vrkljan, Uvod u mineralogiju i petrologiju, University of Zagreb Faculty of Mining, Geology and Petroleum Engineering, Zagreb, 2012.	1	
2.12.Optional literature (at the time of the submission of the study programme proposal)	D. Slovenec, Sistematska mineralogija-mineralogija silikata, Udžbenici Sveučilišta u Zagrebu, Denona d.o.o., Zagreb, 2003. M. Vrkljan, Mineralogija i petrologija, osnove i promjena, University of Zagreb Faculty of Mining, Geology and Petroleum Engineering, Zagreb, 2001.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Examination of students who have finished study. Survey on the level of the University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Definirati svojstva osnovnih skupina minerala (oksidi, sulfidi, karbonati, silikati, sulfati), samotaljivi minerali; njihova nalazišta i rezerve.	1. kolokvij, 2. kolokvij, pismeni i usmeni ispit
2	Objasniti kristalnu građu minerala.	1. kolokvij, pismeni i usmeni ispit
3	Nabrojiti osnovne minerale iz kojih se dobivaju željezo, mangan, bakar, cink, olovo, živa, kalcij, magnezij, arsen, antimon, molibden, nikal, srebro.	1. kolokvij, 2. kolokvij pismeni i usmeni ispit
4	Objasniti te izabrati osnovne načine oplemenjivanja ruda.	2. kolokvij, pismeni i usmeni ispit
5	Prepoznati osnovne minerale vizualnom metodom u postojećoj zbirci minerala na Metalurškom fakultetu.	Auditorne vježbe

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169727
1.1. Course teacher	Assoc.Prof. Robert Pezer, PhD	1.6. Year of study	1
1.2. Name of the course	**FUNDAMENTALS OF ELECTRICAL ENGINEERING**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	30
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2., 10%

2. COURSE DESCRIPTION	
2.1. Course objectives	Learn how to use quantitative mathematical skills and fundamental laws of nature in the field of electromagnetics, waves in the engineering problems. Acquire natural science competencies and skills that enable quantitative analysis and description of the phenomenon within the overall complexity of nature (abstraction, simplification and modeling). Learn how to carry out basic laboratory work: measurement, preparation and execution of the experiment, analysis and presentation of results in the form of a written report.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Explain the physical-chemical fundaments of phenomena characteristic for the technical profession. Apply logical conclusion and precision in data processing. Use the skills and knowledge of qualitative and quantitative analysis.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Quantitatively describe simple electrodynamic systems. Qualitatively explain the electrical and magnetic properties of substances. Quantitative analysis of simple DC and AC electric current circuits . Demonstrate skills in preparing and executing measurement, quantitative processing and presentation of experimental results in the field of electromagnetic phenomena.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Electricity and magnetism: charges, fields, currents, electric and magnetic field, Kirchoff laws, circuits, work and power of electric current, magnetostatic. (5) Direct current: Basic circuitry DC - application of Ohm's Law for the quantification of serial and parallel combination of resistance in circuits. 1st Kirchhoff's law - the application in the analysis of simple circuits. II Kirchhoff's law - the application in the analysis of simple circuits. Electric current circuits with: Ohms resistance, capacitor and inductance. (5) Electrical power and energy, electric motors. (5) 1st exam Basic concepts (periodic changes, harmonic changes, graphical representation, the effects of alternating current, R, L, C circuit. The power and energy of alternating current, complex RLC circuits, vectors, three phase current, star-delta transformation. (5) Electrical and magnetic properties of materials: electrical properties of conductors, dielectrics and semiconductors, magnetic properties of matter. (5)

	Electromagnetic radiation: electromagnetic induction, Maxwell's equations and electromagnetic spectrum. The application to the various measurement techniques. (5) LABORATORY EXERCISES (15): Preparation 1. Ohms law. 2. Charging and discharging of capacitors. 3. Power and resistance in the AC circuit. 4. Optional 2nd exam					
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ independent study ☐ multimedia and the internet ☒ laboratory ☐ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities	-					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	0.4	Research		Practical training	
	Experimental work	1.2	Report	0.8		
	Essay		Seminar essay		(Other--describe)	
	Tests	1.6	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	LAB exercises 30% Class attendance 10% Written exam 30% Oral exam 30%					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	V. Pinter, Osnove elektrotehnike I. i II. dio, Tehnička knjiga, Zagreb, 1994.	10	
	N. Cindro, Fizika 2, Školska knjiga, Zagreb, 1988.	11	

2.12. Optional literature (at the time of the submission of the study programme proposal)	A. Halpern, Begining Physics II, Schaum outline 1995. B. Juzbašić, Elektronički elementi, Školska knjiga, Zagreb, 1984.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	"Student survey by LMS: entry and exit. Course online forum for discussion (within LMS). Survey on the level of the university. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University. "

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Quantitatively describe simple electrodynamic systems.	1st and 2nd colloquium, written and oral exam
2	Qualitatively explain the electrical and magnetic properties of substances.	1st colloquium, written and oral exam
3	Quantitative analysis of simple DC and AC electric current circuits	1st and 2nd colloquium, written and oral exam
4	Demonstrate skills in preparing and executing measurement, quantitative processing and presentation of experimental results in the field of electromagnetic phenomena.	2nd colloquium, seminar paper, laboratory exercises, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169728
1.1. Course teacher	Full Prof. Stoja Rešković, PhD	1.6. Year of study	1
1.2. Name of the course	**QUALITY MANAGEMENT**	1.7. Credit value (ECTS)	3
1.3. Associate teachers	Tin Brlić, mag. ing. met.	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	30
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Ability to apply quality management systems in practice.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. 2. Apply norms in the technical profession. 3. Identify material properties and technological process parameters and adjust them in order to achieve the desired product quality.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Define the basic concepts of quality assurance and quality management (planning, monitoring, improvement). 2. Analyze quality features of processes, products and services. 3. Explain the cost of quality. 4. Interpret features of ISO standards. 5. Apply the basic tools of quality assurance. 6. Analyze the results of statistical process control. 7. Apply and customize documentation in quality management system.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): · Introduction, standardization and standards. 2 h · ISO standards, Croatian standards. 2 h · Quality management systems: definition of quality, quality management principles, general objectives and tasks. 4 h · Construction of a quality management system: mission, vision, strategy, quality policy, resources, basic documents and documentation, quality costs, accreditation and certification. 6 h · Quality management in industrial practice. 2 h · Documentation of quality management, prospects of quality, customer-supplier relationship. 2 h · Entrance control, process control, final control, the definition of inconsistent products, improvement of process. 2 h · Methods of quality management systems and choice of priorities. 1 h · Deming`s cycle of quality. 1 h · Shewhart approach, Ishik diagram. 2 h · Pareto analysis, Control charts, Six sigma. 2 h

<table>
<tr><td></td><td colspan="6">· Assessing process capability. 2 h
· Measure of customer satisfaction. 2 h

EXERCISES (15):

· The differences in construction of quality management systems for different processes. 2 h
· Plans of quality. 2 h
· Use of control charts. 4 h
· Pareto analysis. 2 h
· Measurable indexes of process capability. 2 h
· The application of SPC (Statistical Process Control) software packages. 3 h</td></tr>
<tr><td>2.6. Type of instruction</td><td colspan="2">☒ lectures
☐ seminars and workshops
☒ exercises
☐ online in entirety
☐ mixed e-learning
☐ field work</td><td colspan="2">☒ independent study
☐ multimedia and the internet
☐ laboratory
☒ work with the mentor</td><td colspan="2">2.7. Comments:</td></tr>
<tr><td>2.8. Student responsibilities</td><td colspan="6">Attendance at lectures min. 70%, individual work on all exercises and preparation and submission of reports from field of colloquium before writing the colloquium or the written exam.</td></tr>
<tr><td rowspan="5">2.9. Screening of student’s work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course):</td><td>Class attendance</td><td></td><td>Research</td><td></td><td>Practical training</td><td></td></tr>
<tr><td>Experimental work</td><td></td><td>Report</td><td>0.5</td><td></td><td></td></tr>
<tr><td>Essay</td><td></td><td>Seminar essay</td><td>0.5</td><td>(Other--describe)</td><td></td></tr>
<tr><td>Tests</td><td>1.0</td><td>Oral exam</td><td>1.0</td><td>(Other—describe)</td><td></td></tr>
<tr><td>Written exam</td><td></td><td>Project</td><td></td><td>(Other—describe)</td><td></td></tr>
<tr><td>2.10. Grading and evaluation of student work over the course of instruction and at a final exam</td><td colspan="6">During the course it is evaluated the presence and activity of students in class.
Score of written colloquium through continuous monitoring (or final written exam) and oral exam.</td></tr>
<tr><td rowspan="4">2.11. Required literature (available at the library and via other media)</td><td colspan="3">Title</td><td>Number of copies at the library</td><td>Availability via other media</td></tr>
<tr><td colspan="3">S. Rešković, Upravljanje kvalitetom, Interna skripta, Sveučilište u Zagrebu Metalurški fakultet, Stručni studij Ljevarstvo, Sisak, 2012.</td><td>0</td><td>10</td></tr>
<tr><td colspan="3">S. Rešković, Ispitivanje materijala, recenzirana predavanja, Metalurški fakultet Sveučilišta u Zagrebu, Sisak, 2009.</td><td></td><td>https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/2-godina-preddiplomskog/web1.pdf/view</td></tr>
<tr><td colspan="3">F. Dusman, Osiguranje kvalitete u industrijskoj proizvodnji, FSB, internal script, Zagreb, 2000.</td><td>2</td><td></td></tr>
</table>

	ISO 9000 sustavi upravljanja kakvoćom, Hrvatska zajednica tehničke kulture, Zagreb 1996.	3	
2.12. Optional literature (at the time of the submission of the study programme proposal)	International standard ISO 9001: 2000 International standard ISO 14001: 2001		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey on the level of faculty and University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized office of the University.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Define the basic concepts of quality assurance and quality management (planning, monitoring, improvement).	1st colloquium, auditory exercises, written and oral exam
2	Analyze quality features of processes, products and services.	2nd colloquium, auditory exercises, independent task, written and oral exam
3	Explain the cost of quality.	independent task, oral exam
4	Interpret features of ISO standards.	1st colloquium, auditory exercises, seminar paper, written and oral exam
5	Apply the basic tools of quality assurance.	3rd colloquium, auditory exercises, independent task, written and oral exam, project task
6	Analyze the results of statistical process control.	auditory exercises, independent task, oral exam, project task
7	Apply and customize documentation in quality management system.	independent task, oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169722
1.1. Course teacher	Assist.Prof. Tahir Sofilić, PhD Assoc.Prof. Tamara Holjevac Grgurić, PhD Assoc.Prof. Ivan Brnardić, PhD	1.6. Year of study	1
1.2. Name of the course	**ECOTOXICOLOGY**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.1. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.2. Expected enrolment in the course	25
1.5. Status of the course	compulsory	1.3. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5 %

2. COURSE DESCRIPTION	
2.1. Course objectives	Introduction to basic concepts in ecotoxicology, pollutants, their sources, and impact on the ecosystem. Distribution of natural and anthropogenic pollutants in the environment and the risks for the environment and people. Introduction to the risks of toxic pollutants on human health and other living organisms in the environment.
2.2. Enrolment requirements and required entry competences for the course	Audit a courses: General Chemistry and Introduction to Industrial Ecology
2.3. Learning outcomes at the level of the study programme to which the course contributes	Recognize the eco-toxicological effects on the environment. Recognize the connection of health and ecological risks. Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Recognize the important long-term and current phenomena of environmental pollution as well as possible ecotoxicological effects. Compare ecotoxicological data relating to the presence of industrial pollutants or their groups in the water, air and soil. Identify ecotoxicological risks associated with the distribution of anthropogenic pollutants in different parts of the environment. Describe the appearance of pollutants in samples of food and change their possible impact on human health.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction to the subject curriculum and the time schedule for lectures and seminars. (1) Anorganic pollutants in the environment (metals, non-metals and their compounds). (2) Organic pollutants in the environment (hydrocarbons, PCB, PCDD and PCDF, OCP, OP). (2) Clasiffication of toxic substances in the environment. (2) Organometallic compounds in the environment. Apllication of organometallic compounds. Toxicity of organometallic compounds. Radionuclides in the environment. Toxicity of radionuclides. (2) Sampling in eco-toxicology studies. (2) Input of pollutants in ecosystems. Emission of pollutants into the air. Transfer of pollutants through the air. Effects of air pollution on human health. Monitoring of air quality in the Republic of Croatia. Methods of sampling. (4) Emission of pollutants into the water. Transfer of pollutants through the water. Effects of pollutants in water on human health. Monitoring of water quality in the RH. Methods of water analysis. (2) Emission of pollutants into the soil. Transfer of pollutants through the soil. Effects of pollutants in the soil to human health.

	Monitoring of soil quality in RH. (4) Toxic substances and poisons. Harmful effects. (2) Absorption of toxins in the body. The impact of toxic substances on the absorption. The impact of the body to absorption. The impact of external factors on the absorption. (3) The input of toxins through the digestive system, respiratory system and the skin. (2) The biological conversion, extraction and accumulation of toxic substances in the body. (2) EXERCISES (15): Auditory exercises - Input of pollutants in ecosystems, biomonitoring and bioindicators. (12) Field work- visit to laboratory for testing of the content of pollutants in biological samples. (3) PRELIMINARY EXAMS: 1.preliminary exam. Toxicology and ecotoxicology; Pollutants in the environment; Metals in the environment; Non-metals in the environment; Organic pollutants in the environment; Organometallic compounds in the environment; Radionuclides in the environment; The toxicity of pollutants in the environment; The input of pollutants into the environment; Pollutants input by air; Pollutants input by water; Inut of pollutants by the soil. 2.preliminary exam. Toxic substances and poisons; Harmful effects; Absorption of toxins in the body; The impact of toxic substances on the absorption; The impact of the body to absorption; The impact of external factors on the absorption; The input of toxins through the digestive system, respiratory system and the skin; The biological conversion, extraction and accumulation of toxic substances in the body. 3.preliminary exam. The risks of environmental pollution and their evaluation; Meteorological monitoring; Technological monitoring; Biological monitoring; Ecomonitoring; Human biomonitoring; Bioindicators; biomarkers; Effects of pollutants on population, communities and ecosystems; Disasters and accidents with toxic substances in the world; Exotoxicology risks in RH.
2.6.Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work ☒ independent study ☐ multimedia and the internet ☐ laboratory ☒ work with the mentor ☐ (other)
2.7. Comments:	
2.8. Student responsibilities	Attendance to lectures min 70 %.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
Class attendance		Research		Practical training		
Experimental work	1	Report				
Essay		Seminar essay		(Other--describe)		
Tests	3	Oral exam		(Other—describe)		
Written exam		Project		(Other—describe)		

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Continuous monitoring through three preliminary exams or written and oral exam.

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the**	**Availability via other media**

	T. Sofilić, Ecotoxicology, Faculty of Metallurgy, Sisak, 2014.	**library**	https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija
2.12. Optional literature (at the time of the submission of the study programme proposal)	F. Moriarity, Ecotoxicology, Academic Press, UK, Cornwall, 1999. C. H. Walker, S. P. Hopkin, R. M. Sibly, D. B. Peakall, 3. rd Ed., Principles of ecotoxicology, Taylor & Francis, 2006. D. A. Wright, P. Welbourn, Environmental toxicology, Cambridge University Press, 2002. F. Plavšić, R. Pervan Špiranec, A. Wolf-Čoporda, F. Marović, K. Capak, Priručnik o toksikologiji, Korunić d.o.o., Zagreb, 1998. D. Connell, P. Lam, B. Richardson, R. Wu, Introduction to ecotoxicology, Blackwell, Oxford, 1999.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Internal student survey. Analysis of attendance to lectures and exercises, results of preliminary exams as well as oral exams. Survey on the level of faculty and University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized office of the University		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Recognize the important long-term and current phenomena of environmental pollution as well as possible ecotoxicological effects	1st colloquium, auditory exercises, written and oral exam
2	Compare ecotoxicological data relating to the presence of industrial pollutants or their groups in the water, air and soil	2nd colloquium, auditory exercises, written and oral exam
3	Identify ecotoxicological risks associated with the distribution of anthropogenic pollutants in different parts of the environment	3rd colloquium, auditory exercises, written and oral exam
4	Describe the appearance of pollutants in samples of food and change their possible impact on human health	3rd colloquium, auditory exercises, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169723
1.1. Course teacher	Full Prof. Mirko Gojić, PhD Assoc.Prof. Stjepan Kožuh, PhD	1.6. Year of study	1
1.2. Name of the course	**FUNDAMENTALS OF INDUSTRIAL PRODUCTION**	1.7. Credit value (ECTS)	3
1.3. Associate teachers	Ivana Ivanić, mag.ing.met.	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+0+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	25
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%
2. COURSE DESCRIPTION			
2.1. Course objectives	To introduce of students to the basics of modern industrial production of material goods. Clarification and compliance with the requirements of sustainable development and acceptable conditions of work.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply teamwork-oriented, ethical principles and encourage the development of communication and social skills. Explain of present situation and define developmental trends of metallurgy as a profession and its impact on the entire economy. Describe and explain of modern technologies in the metallurgical practice.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Define the type of manufacturing technology and industrial products. Explain the characteristics of industrial products in industrial sectors. Explain certain raw materials for industrial production. Express the performance of production systems and subsystems. Handle certain segments or sectors of industrial production.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Week 1: Definition of the industrial production (2 hours). Week 2: Production systems and subsystems (2 hours). Weeks 3 and 4: The process of industrial production: obtaining of the raw materials, production of finished products and parts and assembly (4 hours). Weeks 5 and 6: Overview of basic manufacturing industries: metallic, chemical, etc. (4 hours). Weeks 7 and 8: Preparation of the production: structural, technological and operational. Forms of the production: single, serial, massive (4 hours). Weeks 9 and 10: Production technologies: primary production, processes of deformation, joining and cutting technology, surface engineering (4 hours). Week 11: Main indicators of industrial production (2 hours). Week 12: The application of informatic technologies in planning, designing and processing of products (2 hours). Week 13: The role of science in industrial production (2 hours). Week 14: Production system with sustainable development. Quality assurance in industrial production (2 hours). Week 15: Strategic determinants of industrial production in the Republic of Croatia (2 hours).		

	SEMINAR (15): The selection of topics and seminar work in writing form by a mentor system (10 hours). Preparation and presentation of the seminar and discussions related to the topic of the present paper (5 hours).

2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☒ work with the mentor ☐ (other)	2.7. Comments:

2.8. Student responsibilities	Students must attend over 70% of lectures and are required to complete a seminar in writing form and orally present.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
	Class attendance	0.3	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	0.5	(Other--describe)	
	Tests	2.2	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	- evaluation of students activities in course, - evaluation of written examination (two colloquiums) through continuous monitoring or final examination (written and oral), - evaluation of seminar paper.

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Hrvatska razvojna politika za gospodarstvo znanja (ur. J. Božičević), HATZ, Zagreb, 2000.	3	
	M. Gojić, Tehnike spajanja i razdvajanja materijala, Metalurški fakultet, Sisak, 2003.	10	
	M. Gojić, Metalurgija čelika, Metalurški fakultet, Sisak, 2006.	15	
	Industrijska strategija RH 2014-2020.pdf, NN 126/14		http://narodne-novine.nn.hr/clanci/sluzbeni/dodatni/433381.pdf

2.12. Optional literature (at the time of the submission of the study programme proposal)	M. Gojić, Površinska obrada materijala, Metalurški fakultet, Sisak, 2010. Scientific and professional papers in refereed journals and conference proceedings.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Input and output of students ankets. Survey on the level of the University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Define the types of manufacturing technologies and industrial products.	2nd colloquium seminar paper, written and oral exam
2	Explain the characteristics of industrial products in industrial sectors.	1st colloquium, written and oral exam
3	Explain certain raw materials for industrial production.	2nd colloquium, written and oral exam
4	Express the performance of production systems and subsystems.	1st colloquium, written and oral exam
5	Handle certain segments or sectors of industrial production.	1st colloquium, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE: 169724
1.1. Course teacher	Maja Ivanković, Mphil, lecturer	1.6. Year of study	1
1.2. Name of the course	**ENGLISH LANGUAGE 2**	1.7. Credit value (ECTS)	2
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	15+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	55
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Application of intermediate-level grammatical and lexical content enabling everyday and formal communication in the foreign language. Developing reading, writing, listening and speaking skills in the foreign language. Development of professional vocabulary of relevant scientific branches in the foreign language. The ability to differentiate between informal, formal and academic registers and the use of linguistic structures specific to them.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply the teamwork-oriented, ethical principles and encourage the development of communication and social skills. Explain the present situation and define the developmental trends of metallurgy as a profession and its impact on the entire economy. Describe the present situation and developmental trends of modern industrial ecology.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	To be able to express oneself in the everyday language and recognize and use professional language at an intermediate level. To compare and recognize general language vs. the professional language in selected text excerpts. To recognize and apply grammatical and lexical structure specific to informal, formal and academic registers, the language of science and the professional language (conditional clause, reported speech, relative pronouns and clauses, passive). To apply grammatical principles in written and oral exercises evoking everyday communicative situations. To write an effective formal letter (e-mail) and CV. To become acquainted with the rules for writing and essay, a paper, a scientific paper and an abstract. To successfully present a professional topic in the foreign language.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	- Course content is devised so as to represent equally all four skills: reading, writing, listening and speaking. 1 The first lecture is designed as introduction to the rules of informal, formal and academic registers. 2 The second lecture is designed as introduction to the linguistic structures required for appropriate use of language in the formal and academic registers. - The first part of the course is devised as introduction to grammatical structures and forms required for appropriate use of language in the formal and academic registers (conditional clause, reported speech, relative pronouns and clauses, passive). The students practice the use of these in oral and written situations evocative of real-life setting and through homework. (5 lectures, 5 exercises) 3 Conditional clauses.

	4 Reported speech. 5 Relative pronouns and clauses. 6 Passive Voice. 7 The first preliminary exam evaluated content and units covered to this point. - In the second part of the course students are presented with rules on successful writing of a formal letter, business and academic correspondence, CV, essay, paper, scientific paper and abstract. The students practice the use of these by writing a business letter and CV for imaginary situations evocative of real-life setting and guided linguistic analysis of essays and scientific papers, as well as abstracts. The students are also introduced to rules on how to deliver a successful oral presentation and the basis of making a good PowerPoint presentation. (5 lectures, 5 exercises) 8 Formal letters. Business and academic correspondence. 9 CV 10 Essay, paper, scientific paper, abstract. 11 Oral presentation. 12 The second preliminary exam covers the second part of the course content. - In the third part of the course the students deliver their own presentations in the foreign language on a professional topic. Following the presentation, other students (as well as the course teacher) provide feedback, thus conducting review of the contents covered in the second part of the course. (3 lectures, 3 exercises) 13 Students' presentations. 14 Students' presentations. 15 Students' presentations.

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☒ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities	Attendance (min. 70 %), regular homework, participation in class. Insofar as the student fails to fulfil his/her obligation, they are offered to make up for content missed via a translation of a professional text from English to Croatian.		

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
	Class attendance		Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests		Oral exam	1	(Other—describe)	
	Written exam	1	Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Attendance is treated as condition for signature. If a student passes both preliminary exams, he/she is exempt from the written part of the exam. Homework is treated as condition for signature. Throughout the duration of the course, the students compile a portfolio of homework and hand it in upon course completion. The portfolio comprises real-life examples of grammatical structures, a formal letter, CV and abstract. In the third part of the course the students deliver their own presentations in the foreign language on a professional topic, which constitutes a quarter of the final grade.

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	L. Šestić, English for Metallurgists, Zenica, 1985.	21	

	J. Eastwood, Oxford Guide to English Grammar, OUP, 2000.		https://www.uop.edu.jo/download/research/members/oxford_guide_to_english_grammar.pdf
	P. Emmerson, Essential Business Grammar Builder, MacMillan, 2010.		CD
	M. Ibbotson, Cambridge English for Engineering, CUP, 2012.		Electronic form
	S. Campbell, English for the Energy Industry, CUP, 2013.		Electronic form
	M. Swan & C. Walter, The Good Grammar Book, UOP, 2013.		Electronic form
2.12. Optional literature (at the time of the submission of the study programme proposal)	Grammar textbook approved by course teacher.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Internal poll. Survey on the level of the University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	To be able to express oneself in the everyday language and recognize and use professional language at an intermediate level.	Written and oral exam
2	To compare and recognize general language vs. the professional language in selected text excerpts.	Written and oral exam
3	To recognize and apply grammatical and lexical structure specific to informal, formal and academic registers, the language of science and the professional language (conditional clause, reported speech, relative pronouns and clauses, passive).	Written and oral exam, portfolio
4	To apply grammatical principles in written and oral exercises evoking everyday communicative situations.	Written and oral exam, portfolio
5	To write an effective formal letter (e-mail) and CV.	Written and oral exam, portfolio
6	To become acquainted with the rules for writing and essay, a paper, a scientific paper and an abstract.	Written and oral exam, portfolio
7	To successfully present a professional topic in the foreign language.	Presentation

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Anita Begić Hadžipašić, PhD	1.6. Year of study	2
1.2. Name of the course	**PHYSICAL CHEMISTRY**	1.7. Credit value (ECTS)	6
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	45
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Introducing students to the pysical-chemistry basis of complex systems in nature and basic thermodynamic principles of conducting the processes. Train students to solve problems of thermodynamics and kinetics of pysical and chemical processes.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Explain the physical-chemical fundaments of phenomena characteristic for the technical profession. Apply thermodynamic laws on production processes. Identify processes and connect obtained results with theoretical models.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Apply the laws of thermodynamics to the 1-component and multicomponent systems. Predict the p-V-T relations in solid-liquid-gas systems. Calculate thermodynamic parameters that describe the equilibrium states of complex systems. Predict changes in thermodynamic properties of various physico-chemical processes by calculation (heat capacity, enthalpy, Gibbs energy, entropy). Design the experiments in which the obtained results can be connected with the theory models.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30) AND SEMINARS (15): 1. The terminology/nomenclature in describing physical-chemistry systems and processes according to international convention. 3h 2. Ideal and real gases: high-temperature dissociation of gases, equations of state of real gases. 3h 3. Thermodynamics: 0., I., II. and III. law of thermodynamics. 5h 4. Phase equilibrium: one-component systems (gases, liquids, solids). 3h 5. Two-component systems (solutions and colligative properties, partial molar quantities, phase diagrams). 4h 6. Three-component systems. 3h 7. 1. colloquium. 1h 8. Chemical equilibrium: enthalpy changes of chemical reactions, temperature dependance of equilibrium constant. 3h 9. Equilibrium in electrochemical systems: ion equilibrium, galvanic couples, electrodes and electrode potentials. 4h 10. Equilibrium at interfacial boundary: surface tension, adsorption and adsorption isotherms. 3h 11. 2. colloquium. 1h 12. Kinetics of physical processes: viscosity, diffusion, electrolyte conductivity. 4h 13. Kinetics of chemical reactions: reactions of 0., I. and II. order. 4h

	14. E_a and temperature dependance of reaction rate: Arrhenius theory. Theory of activated complex (of transition state) and E_a. 3h 15. 3. colloquium. 1h LABORATORY EXERCISES (30): 1. Partial molar quantities (2h) 2. Molar mass by cryoscopy (2h) 3. Changes in enthalpy calorimetrical (2h) 4. Phase equilibrium solid-liquid (3h) 5. Three-component system (3h) 6. Ion equilibrium (2h) 7. Surface tension (2h) 8. Adsorption in solutions (2h) 9. Electrochemical couples (2h) 10. Molar mass viscosimetrical (2h) 11. Transmission number (2h) 12. Changes in enthalpy electrochemical (2h) 13. Inversion of sucrose (2h) 14. Hydrolysis of ethyl acetate (2h)

2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☒ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities	Attendance min 70% to lectures and seminars, completed laboratory exercises, submitted work diary, submitted seminar essay.		

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
Class attendance		Research		Practical training		
Experimental work	1.0	Report	0.5			
Essay		Seminar essay	0.5	(Other--describe)		
Tests	2.0	Oral exam	2.0	(Other—describe)		
Written exam		Project		(Other—describe)		

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Passed three colloquiums through continuous monitoring or final examination (written and oral).

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	P. W. Atkins, Načela fizikalne kemije, Školska knjiga, Zagreb, 1996.	2	
	W. J. Moore, Fizička hemija, Naučna knjiga, Beograd, 1967.	6	
	J. Malina, A. Begić Hadžipašić, Fizikalna		https://www.simet.unizg.hr/nastava/predavanja/preddiplo

	kemija, zbirka riješenih zadataka, prvi dio, Metalurški fakultet, Sisak, 2012.		mski-sveucilisni-studij-metalurgija/2-godina-preddiplomskog/fizikalna-kemija-zbirka-rijesenih-zadataka-prvi-dio/view
	J. Malina, A. Begić Hadžipašić, Fizikalna kemija, zbirka riješenih zadataka, drugi dio, Metalurški fakultet, Sisak, 2012.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/2-godina-preddiplomskog/fizikalna-kemija-zbirka-rijesenih-zadataka-drugi-dio/view
	A. Begić Hadžipašić, Fizikalna kemija, predavanja, Metalurški fakultet, Sisak, 2016.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/2-godina-preddiplomskog/fizikalna-kemija-predavanja/view
	G. Bogdanić, I. Štern, Obrada rezultata mjerenja, skripta, Sisak, 1979.		Merlin system for e-learning
2.12. Optional literature (at the time of the submission of the study programme proposal)	P. Atkins, J. De Paula, ATKINS Physical Chemistry, 8th Edition, Oxford University Press, New York, 2006. R. Brdička, Osnove fizikalne kemije, Školska knjiga, Zagreb, 1969. S. Glasstone, Udžbenik fizičke kemije, Naučna knjiga, Beograd, 1967. J. Malina, Upute za vježbe iz fizikalne kemije I i II, interna skripta, Metalurški fakultet, Sisak, 2004.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey on the level of the University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Apply the laws of thermodynamics to the 1-component and multicomponent systems.	1st colloquium, laboratory exercises, written and oral exam
2	Predict the p-V-T relations in solid-liquid-gas systems.	1st colloquium, laboratory exercises, oral exam
3	Calculate thermodynamic parameters that describe the equilibrium states of complex systems.	2nd colloquium, laboratory exercises, written exam
4	Predict changes in thermodynamic properties of various physico-chemical processes by calculation (heat capacity, enthalpy, Gibbs energy, entropy).	2nd colloquium, seminar paper, laboratory exercises, written exam
5	Design the experiments in which the obtained results can be connected with the theory models.	3rd colloquium, laboratory exercises, oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Ljerka Slokar, PhD	1.6. Year of study	2
1.2. Name of the course	**FUNDAMENTALS OF PHYSICAL METALLURGY**	1.7. Credit value (ECTS)	6
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	45
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%
2. COURSE DESCRIPTION			
2.1. Course objectives	Adoption of basic theoretical and practical knowledge of metals Introduction to the internal structure of metals Introduction to the equilibrium diagrams, transformation processes and microstructure, as well as its influence on the properties of metals and alloys		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Explain the physical-chemical fundaments of phenomena characteristic for the technical profession. Use the skills and knowledge of qualitative and quantitative analysis. Describe the material production, select their types and explain their properties for a specific area of application.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Present the basic crystal structure of metals Analyze and compare the crystal lattice defects Present and explain the phase diagrams and principles of alloying Analyze the microstructure of alloys using optical microscopy Compare the physical-chemical properties and microstructure of metals		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): The structure of atoms and interatomic bonds (2): ionic and covalent bond, metal bond. Basic concepts of crystallography (2): elementary cell and crystalline systems, crystal classes and space groups. Crystal structures of metals and alloys (4): basic types of crystal structures of metals, a solid solutions or solid solutions, intermetallic compounds. Determination of the crystal structure (2): X-rays and diffraction, and X-ray diffraction techniques. Crystal lattice defects (2): point defects, line defects, surface defects. State of matter of metals (2): gaseous, liquid, solid, transitions of aggregate states, solidification and crystal growth. Phase diagrams (4): construction of diagrams and phase rule, equilibrium and non-equilibrium diagrams, binary diagrams, ternary diagrams. Metallographic techniques and their applications (2): Sample preparation. Optical microscopy. Electron microscopy. Diffusion in metals (2): Stationary diffusion, non-stationary diffusion. Factors of diffusion. Phase diagrams of the iron (4): The stable and metastable iron-carbon diagram. Phase changes at equilibrium and nonequilibrium cooling (2): ITT and KTT diagrams. More important binary diagrams of iron.		

	Mechanical properties of metals (2): Elastic deformation. Plastic deformation. Determination of the most important mechanical properties of metals. LABORATORY EXERCISES (15): The melting and solidification of metals. Preparation of alloys. Preparation of samples for metallographic examination (5). Light microscopy (6), X-ray diffraction analysis (2), micro hardness testing (2). AUDITORY EXERCISES (15): Solving numerical problems related to the exposed theory.					
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ independent study ☐ multimedia and the internet ☒ laboratory ☐ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities	Attendance to classes (at least 70%) and successful completion of exercises and seminars.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	0.5	Research		Practical training	
	Experimental work	0.5	Report			
	Essay		Seminar essay	1.0	(Other--describe)	
	Tests	2.0	Oral exam	1.0	(Other—describe)	
	Written exam	1.0	Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Grade of three colloquiums, exercises as well as seminar essay and a final oral exam determine the final grade.					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	T. Matković, P. Matković, Fizikalna metalurgija I, Metalurški fakultet, Sisak, 2009.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/2-godina-preddiplomskog/Fizikalna%20metalurgija%20I.pdf/view
	T. Matković, P. Matković, Lj. Slokar, Znanost o metalima - Zbirka riješenih zadataka, Metalurški fakultet, Sisak, 2010.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/2-godina-preddiplomskog/Zadaci%20iz%20FM%20re-TNR-Boja-1.pdf/view
	W. D. Callister, Materials Science and Engineering, J. Wiley& Sons, New York, 1996.	1	
2.12. Optional literature (at the time of the submission of the study programme proposal)	H. Schumann, Metallographie, Springer Verlag, Berlin, 1987. R. E. Smallman, R. J. Bishop, ModernPhysical Metallurgy& Materials Engineering, Butterworth- Heinemann, Oxford, 1999. H. J. Bargel, G. Schulze, Werkstoffkunde, Springer Verlag, Berlin, 2005.		
2.13. Methods of monitoring quality that	Anonymous survey on the level of the Faculty and University.		

ensure acquisition of exit competences	Analysis provided by system of quality assurance institutions. Analyses provided by quality assurance system and authorized offices of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Present the basic crystal structure of metals.	1st colloquium, seminar paper, auditory exercises, laboratory exercises, written and oral exam
2	Analyze and compare the crystal lattice defects.	1st colloquium, seminar paper, auditory exercises, laboratory exercises, written and oral exam
3	Present and explain the phase diagrams and principles of alloying.	2nd colloquium, seminar paper, auditory exercises, laboratory exercises, written and oral exam
4	Analyze the microstructure of alloys using optical microscopy.	3rd colloquium, seminar paper, laboratory exercises, written and oral exam
5	Compare the physical-chemical properties and microstructure of metals.	3rd colloquium, seminar paper, auditory exercises, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Vladimir Grozdanić, PhD Assoc.Prof. Anita Begić Hadžipašić, PhD	1.6. Year of study	2
1.2. Name of the course	**FUNDAMENTALS OF METALLURGICAL PROCESSES**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	45
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	1.Inform students with basic fundamental laws of teory of metallurgy and metallurgical processes. 2.Acquaint students with possibilities of adoption theoretical objectives, and principles of technological processes in metallurgy. 3.Adoption of the most important ideas and principles of metallurgical processes – laws of metallurgical thermodynamics. 4.Acquaint of theory of metallurgical processes like basis of tehnological processes in metallurgy – basic premise. 5.Idea of theoretical calculations of flow of basic processes of metal obtain.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	1.Apply thermodynamic laws on production processes. 2.Apply acquired IT knowledge in engineering practice. 3.Calculate material and thermal balance of metallurgical processes.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1.Calculate balance of metallurgical processes (consuption of energy, products). 2.Explain of forming, property and role of slag. 3.Calculate activity of components in system. 4.Comparison behaviour of gases in liquid metal.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	1. L: Fundamentals of thermodinamics. Principles of theory of metallurgical processes. S+E: Thermodinamics of multicomponent systems. 2.L: I. thermodynamics law. Entalphy. Continuity of energy. S+E: Partial molar values. 3.L: II. Law of thermodynamics. Entrophy. Direction of reactions. S+E: Excess values. 4.L: Affinity of reactions. Stability. Free Gibbs energy. S+E: Calculation of concentration: mass percent, number of moles, mol and ionic fractions. 5. L: Melting. Reduction. Kind of reduction. Bell and Boudoard equilibrium. S+E: Activity of pure mater (Raoult law), infinity dilute (Henry law) and saturated state. 6. L: Nernst law. Gibbs rule. Invariant points. S+E: Calculation of activity from the data for diagram of state (simple eutectic system and ideal solubility in solid and liquid phase). 7. L: Chemical balances in metal and slag. Boundary melt slag-metal. S+E: Calculation of activity from the data for distribution

	of components between two phase. 8. L: Reduction, Direct and indirect reduction. Reducents. S+E: Calculation of activity from partial molar values. 9. L: Systems. Systems Me-O. C-O. Me-C-O. Si-O. Me-Mn-O. Me-Mn-Si-O. Me-P. Me-S. S+E: Derivation of activities from the data for EMS. 10. L: Gases in metal. Tension of vapour. Molar fraction. Activity. S+E: Calculation of activity of one component if is known activity of second (graphical and analytical). 11. L: Raoult and Henry laws. S+E: II. Fick law (unstationary diffusion for semiinfinite media). 12. L: Free entalphy of elements reduced in metal. S+E: Classical derivation of solution by means of error function, which is presented with analitical functions and tables. 13. L: Slag. Molecular theory of slag. Oxides and distribution. S+E: Derivation of solution by means of Laplace and Fourier transformations. 14. L: Slag. Ionic theory of slag. Kind of ions. Definition of ion concretation. S+E: Calculate diagrams for system Fe-FeO-Fe_3O_4-CO-CO_2 and Boudoar equilibrium. 15. L: Sulphur in metals. Distribution of sulphur. Diffusion. Desulaphurization of metal. S+E: Calculation diagrams for system Fe-FeO-Fe_3O_4-H_2-H_2O, and connect this two systems.

2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities	-		

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
Class attendance	0.5	Research		Practical training		
Experimental work		Report				
Essay		Seminar essay	0.5	(Other--describe)		
Tests		Oral exam	2.0	(Other—describe)		
Written exam	2.0	Project		(Other—describe)		

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Exercises: 10%, Class attendance: 10 %, Written exam: 40%, Oral exam: 40%.

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	A. Rosina, Teorija metalurških procesov, Ljubljana, 1994.	1	
	Ž. Živković, V. Savović, Principi metalurške termodinamike, Bor, 1997.	1	
	Ž. Živković, V. Savović, Teorija metalurških procesa, Bor, 1994.	1	

2.12. Optional literature (at the time of the submission of the study programme proposal)	1. B. Dobovišek, Metalurške žlindre,NTF, Ljubljana, 1983. 2. D.M. Laptev, Zadači i upražnenija po termodinamike rastvorov, Moskva, 1965.
2.13. Methods of monitoring quality that ensure acquisition of exit	Inquiry of graduated students. Survey on the level of the University.

competences	Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Calculate balance of metallurgical processes (consumption of energy, products).	Seminar paper, written exam
2	Explain of forming, property and role of slag.	Oral exam
3	Calculate activities of components in system.	Written exam
4	Comparison behaviour of gases in liquid metal.	Oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Full Prof. Ladislav Lazić, PhD	1.6. Year of study	2
1.2. Name of the course	**ENGINEERING THERMODYNAMICS**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	Full Prof. Damir Hršak, PhD	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	45
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5 %

2. COURSE DESCRIPTION	
2.1. Course objectives	1. Acquire knowledge from the basic laws of thermodynamics, which are necessarily required for further studies as well as in engineering practice. 2. Acquire the ability to solve problems in the field of thermodynamics. 3. Develop in students a simple and logical way of thinking in the analysis of a technical problem.
2.2. Enrolment requirements and required entry competences for the course	Completed courses of Mathematics 1 and Mathematics 2.
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Apply thermodynamic laws on production processes. 2. Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. 3. Choose the most convenient form of energy from the perspective of sustainable development. 4. Calculate material and thermal balance of metallurgical processes.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Define and explain the thermodynamic quantities depend on the condition and on the process. 2. Apply the laws of thermodynamics to the quantitative analysis of the process. 3. Determine the energy efficiency of a thermal engineering process. 4. Explain the cycle process. 5. Quantitatively analyze of the mass phase change.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): 1. The characteristic properties of the thermodynamic state or state functions (pressure, temperature) and the process properties (heat, shaft work) (2). 2. The total energy of the system: kinetic energy, potential energy, internal energy, enthalpy (2). 3. The law of energy conservation, Mathematical formulation of the First Law of Thermodynamics, Expansion and compression work in a cylinder, p, v - diagram (2). 4. Ideal gas: Laws of ideal gases (Gay Lussac law, Boyle and Mariotte law), Thermal equation of state of ideal gases,Heat capacity, Calculation of internal energy and enthalpy (2). 5. Mixtures of ideal gases, Dalton law, Mass fraction, Mole (volume) fraction, Conversion from one to another fractions, Specific gas constant, Heat capacity, Internal energy and enthalpy for ideal-gas mixtures (2). 6. Processes for ideal gases: Isothermal, Isobaric, Isometric or isochoric, Isentropic (Equilibrium adiabatic) and Polytropic process (4). 7. Cycle processes: Carnot cycle, Joule cycle, Diesel cycle, Otto cycle, Sabathe cycle, Stirling cycle,Ericsson cycle (2).

	1st colloquium 8. The Second Law of Thermodynamics: Reversible and irreversible processes, Thermal efficiency, Carnot principle, Mathematical formulation of the Second Law of Thermodynamics (4). 9. Entropy, Entropy change of ideal gases, real gases and incompressible substances, Display of polytropic processes in T, s-diagram (2). 10. Maximum work, Technical work, Available useful work (Exergy) (4). 11. Vapor: Evaporation, Properties of vapor, Diagrams of state for system vapor / water (p, v -, T, s -, h, s - diagram) (4). 2nd colloquium EXERCISES (30): Solving calculation examples which facilitates understanding of the course material at lectures. Examples are chosen so that they expand the presented theory or they illustrate application of the theory on real problems.

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:	

2.8. Student responsibilities	Attendance on Lectures and Exercises > 70 %.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	0.5	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	2.5	Oral exam	2.0	(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Class attendance – 10% Written exam – 50 % Oral exam – 40%					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	F. Bošnjaković, Nauka o toplini I, Tehnička knjiga, Zagreb, 1978.	32	
	A. Galović, Termodinamika I, Zagreb, 2008.	11	
	I. Turk, Nauka o toplini I, Sveučilište u Zagrebu, 1975.	1	

2.12. Optional literature (at the time of the submission of the study programme proposal)	B. Halasz, Zbirka zadataka iz nauke o toplini I, Sveučilište u Zagrebu, 1978. J. P. Holoman, Thermodinamics, McGraw-Hill Book Company, Singapore, 1980.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey on the level of the University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Define and explain the thermodynamic quantities depend on the condition and on the process.	1st colloquium and oral exam
2	Apply the laws of thermodynamics to the quantitative analysis of the process.	1st colloquium and oral exam
3	Determine the energy efficiency of a thermal engineering process.	2nd colloquium and oral exam
4	Explain the cycle process.	2nd colloquium and oral exam
5	Quantitatively analyze of the mass phase change	2nd colloquium and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assist.Prof. Martina Lovrenić-Jugović, PhD	1.6. Year of study	2.
1.2. Name of the course	**ENGINEERING MECHANICS**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	25
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	1. Acquire knowledge of the basic principlesof Static, Dynamic and Strength of Materials that are necessary for further learning in majority of the courses of Department of Mechanical Metallurgy. 2. Acquire the ability to solve problems in the field of Static, Dynamics and Strength of Materials. 3. Developing of simple and logical way of thinking in students in the analysis of technical problem.
2.2. Enrolment requirements and required entry competences for the course	Attended Mathematics 1
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Apply norms in the technical profession. 2. Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. 3. Use the skills and knowledge of qualitative and quantitative analysis.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Explain and define basic terms in mechanics: space, time, mass, etc. 2. Analyse the activity forces in structures or machines. 3. Analyse the solid motion using the principles of kinematics. 4. Apply laws of dynamics engineering calculations. 5. Analyse state of stress and strain. 6. To distinguish types and means of load. 7. Determine the allowed stresses.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30) AND EXERCISES (30): 1. Task and the division of mechanics, Newton's law (2). 2. Static of rigid bodies: Definition of basic concepts, Axioms of static, General rules, Competitive system of forces, Coplanar system of forces (4). 3. Equilibrium conditions, types and reactions of connections, isolation of mechanical system (4). 4. Beams: Beams, Truss (8). 5. 1st preliminary exam: includes the units 1-4 6. Friction: Sliding friction, rolling friction (3). 7. Geometric characteristics of straight sections: Centre of gravity, Moments of inertia, Section modulus (3). 8. Kinematics: The basics of the motion of particle and rigid body (4).

	9. Dynamics: The basics of the dynamics of particle and rigid body (4). 10. 2nd preliminary exam: includes the units 6-9 11. Strength of materials: Tasks and Methods (2). 12. Stress, Mohr's circle of stress (4). 13. Deformation, Interdependence of stress and strain, Cyclic stresses, Fatigue, Fatigue strength, Smith's chart (4). 14. Stresses in rods and beams: Tension and compression, Shear (4). 15. Bending stresses in straight beams (4). 16. Torsional stresses in rods of circular cross-section and tubes (2). 17. Complex stresses and equivalent stress: Bending and axial load, Bending and torsion, Axial load and torsion (4). 18. Strength theories: Maximum normal stress theory, Maximum strain energy theory, Maximum shear stress theory, Maximum distortion energy theory (4). 19. 3rd preliminary exam: includes the units 11-18

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:

2.8. Student responsibilities	Conditions for signature: - attendance on Lectures and Exercises > 70% Conditions for taking: -

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
	Class attendance	0.5	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	1.0	Oral exam	1.0	(Other—describe)	
	Written exam	2.5	Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Homework – 10% Exercises –10% Attendance – 10% Written exam – 50% Oral exam – 20%

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	O. Muftić, Mehanika i statika, Tehnička knjiga, Zagreb, 1991.	1	-
	S. Jecić, Mehanika II Kinematika i dinamika, Tehnička knjiga, Zagreb, 1989.	1	-
	I. Alfirević, Nauka o čvrstoći I, Tehnička knjiga, Zagreb, 1989.	1	-
	Z. Kulenović, Tehnička mehanika I, Pomorski fakultet u Splitu, Split, 2013.	-	http://www.pfst.unist.hr/uploads/TM%20I%20%20-%20skripta%20BS.pdf

2.12. Optional literature (at the time of the submission of the study programme proposal)	F. Matejiček, D. Semenski, Z. Vnučec, Uvod u statiku sa zbirkom zadataka, Golden marketing-Tehnička knjiga, Zagreb, 2005. Various books and exercise books in the field of statics, dynamics and science of strength.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Internal: Student survey input. Numerical analysis of tests and exams according to scoring task by task at the level of course. External: Survey at the level of faculty and University. Analyses provided in the system of quality assurance of the institution. Analyses provided in the system of quality assurance and an authorized office of the University.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain and define basic terms in mechanics: space, time, mass, etc.	1st olloquium, oral exam
2	Analyse the activity forces in structures or machines.	1st colloquium, oral exam
3	Analyse the solid motion using the principles of kinematics	1st colloquium, oral exam
4	Apply laws of dynamics engineering calculations.	1st colloquium, oral exam
5	Analyse state of stress and strain.	2nd colloquium, oral exam
6	To distinguish types and means of load.	2nd colloquium, oral exam
7	Determine the allowed stresses.	2nd colloquium, oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Robert Pezer, PhD Assist.Prof. Ivan Ivec, PhD	1.6. Year of study	2
1.2. Name of the course	**COMPUTER APPLICATION**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+24+6
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	45
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2., 10%

2. COURSE DESCRIPTION	
2.1. Course objectives	1) Introduce a wide range of spreadsheets opportunities in commercial and open source based systems. 2) Enable students to design and code simple computer programs. 3) Realize the fundamentals of programming computers in C programming language and for the spreadsheet applications.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	1) Apply acquired IT knowledge in engineering practice. 2) Create simple computer applications and use them within existing in metallurgical processes.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1) Enter the data, design the table and perform basic manipulations with data: sorting by selected key, filtering by selected criteria and a summary. 2) Perform an effective search of data in different sorted or unsorted tables. 3) Using spreadsheet program perform processing and graphic visualization of the data obtained by measurements in the lab. 4) Write a computer program using appropriate elements of the programming language/spreadsheet structure and syntax. 5) Develop a computer program that includes an arbitrary number of repetitions, the branching structure, working with strings and arrays in order to solve engineering numerical analysis problem.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	1) Basics of programming: the programming process; algorithmic structure of computer programs; data types; complex commands, control flow; defining function prototypes; development of simple algorithms. (4) 2) Expressions and syntax of C language: arithmetic, logical and relational expressions; rules of priority and associativity; operators; automatic and explicit conversion of the data types; typedef key word. (4) 3) Simple and structural C language commands: unconditional jump; types of loops and infinite loops. (4) 4) Arrays: one-dimensional arrays; initialization strings; multidimensional arrays; transfer array data in the functions. (4) 5) Working with pointers: pointer types; operations with pointers; transfer data in the function. Working with files. (4) 6) Strings: standard functions for string manipulations; input output operations with strings; conversion of the strings; arrays of strings. Reading, recording and processing of data from the file. (4) 7) Introduction to the spreadsheet application - the structure of a document, working with data types, application features at an

	elementary level - generally work with tables and connection to the databases. (4) 8) Working with cells and ranges. Enter and processing data in the cells. The mathematical operators. Working with formulas in cells. (4) 9) Graphical representation of data. (4) 10) Use functions and formulas in table calculator. (4) 11) An example of search of sorted and unsorted data using library functions. (4) 12) The basics of programming for the application. User functions, information managment. An example from engineering practice with graphical data representation. (4) 13) Applying elementary tools for numerical optimization in physical problems relevant to engineering. (4) 14) Engineering numerical analysis: interpolation, solving systems of equations, statistical analysis, numerical integration. (4) 15) The basics of modeling and integration tools available in the application. Preparing for a class project. (4)

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☒ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:

2.8. Student responsibilities	Conditions for signature: attendence at lectures and exercises min. 70%					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	1	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests		Oral exam	1	(Other—describe)	
	Written exam		Project	2	(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Project: 60% Class attendance: 10% Oral exam: 30%					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	M. Jurak, Programski jezik C, 2003. god.		https://web.math.pmf.unizg.hr/~singer/Prog_Add/c.pdf
	Excel 2010 Introduction: Part I and II		http://www.stat.ualberta.ca/statslabs/stat235/files/excel-2010-introduction.pdf https://books.google.hr/books?id=rFpC55CmUT8C&pg=PA4&lpg=PA4&dq=Excel+2010+Introduction:+Part+II&source=bl&ots=YdbZMdmfyN&sig=LY5yYUHSWTsHK6gpGY9kFgC4P-4&hl=hr&sa=X&ved=0ahUKEwjR4f796PfNAhVBsRQKHTfBAIYQ6AEIMjAD#v=onepage&q=Excel%202010%20Introduction%3A%20Part%20II&f=false
	Damir Vučina: Primjena računala u inženjerskoj analizi, Fakultet elektrotehnike, strojarstva i brodogradnje u Splitu, Split, 2007.	1	

2.12. Optional literature (at the time of the submission of the study programme proposal)	
2.13. Methods of monitoring quality that ensure acquisition of exit competences	"Student survey by LMS: entry and exit. Course online forum for discussion (within LMS). Survey on the level of the university. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized Office of the University. "

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Enter the data, design the table and perform basic manipulations with data: sorting by selected key, filtering by selected criteria and a summary.	2nd project task and oral exam
2	Perform an effective search of data in different sorted or unsorted tables.	1st and 2nd project task and oral exam
3	Using spreadsheet program perform processing and graphic visualization of the data obtained by measurements in the lab.	2nd project task and oral exam
4	Write a computer program using appropriate elements of the programming language/spreadsheet structure and syntax.	1st and 2nd project task and oral exam
5	Develop a computer program that includes an arbitrary number of repetitions, the branching structure, working with strings and arrays in order to solve engineering numerical analysis problem.	1st project task and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Tamara Holjevac Grgurić, PhD	1.6. Year of study	2
1.2. Name of the course	**ORGANIC CHEMISTRY**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5 %

2. COURSE DESCRIPTION	
2.1. Course objectives	To introduce students with basics of Organic Chemistry. To accept knowledge of structure, nomenclature, synthesis and properties of organic compounds. To overwhelm with mechanisms of organic reactions. To approach application of organic chemistry in industry and to qualify students for solving engineering problems in view of ecology.
2.2. Enrolment requirements and required entry competences for the course	Audit a courses: General chemistry and Anorganic chemistry
2.3. Learning outcomes at the level of the study programme to which the course contributes	Explain the physical-chemical fundaments of phenomena characteristic for the technical profession. Use the skills and knowledge of qualitative and quantitative analysis. Describe the present situation and developmental trends of modern industrial ecology.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	To clasify organic compounds. To use basic terminology - nomenclature of organic compounds. To define constitutional isomerism. To understand reactions of synthesis, characteristics and application of different organic groups. To describe mechanisms of basic types of organic reactions. To select appropriate technique of characterization. To plan simple recations of synthesis. To apply knowledge on solving of engineering problems in view of ecology.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction to Organic Chemistry. Hydrocarbons. (2) Nomenclature and reactions of organic synthesis. Acids. Bases. (2) Alkanes - structure, reactivity, synthesis and properties. (2) Alkenes, Alkynes - structure, reactivity, synthesis and properties. (2) Stereochemistry: Conformational changes, optical activity, crystallinity, isomers, stereoisomers. (2) 1.preliminary exam Nucleophilic substitution reactions. (2) Elimination reactions. (2) Functional groups. Structure, nomenclature, synthesis and properties. Alcohols. Aromatic compounds. Fenols. (2) Ethers. Epoxides. (2)

	2.preliminary exam Aldehydes. Ketones. (2) Carboxylic Acids. Functional derivatives. Organosulphur compounds. (2) Amines. Heterocyclic compounds. Synthetic and natural polymers. (2) Chemistry of organic pollutants. (2) Sources of pollution and application of new technologies. (2) Characterization of organic compounds. (2) 3.preliminary exam EXERCISES (30): Filtration. Extraction. Simple distillation. Synthesis of 2-chloro-2-methylpropane. Synthesis of 1-bromobutane. Synthesis of carboxylic acid salts. Benzoic acid and benzyl alcohol. Proving of functional groups.

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☒ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☒ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:

2.8. Student responsibilities	Attendance to lectures min 70 %. Attendance to lab practice 100 % (compensation of 2 exercises). Lab reports. Attendance to auditory exercises min 70 %.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	1	Research		Practical training	
	Experimental work	1	Report			
	Essay		Seminar essay		(Other--describe)	
	Tests		Oral exam	1	(Other—describe)	
	Written exam	1	Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Lab reports, results of preliminary exams as well as written and oral exams. Written exam could be replaced with successful preliminary exams.		
2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	S. H. Pine (translation: I. Bregovec, V. Rapić), Organska kemija, Školska knjiga, Zagreb, 1994.	5	
	H. Vančik, Basic Organic Chemistry, TIVA-IuHV, Varaždin, 2012.	1	
	V. Rapić, Nomenclature of Organic Compounds, 3. izdanje, Školska knjiga, Zagreb, 2004.	1	
2.12. Optional literature (at the time of	W. H. Brown, C. S. Foote, B. L. Iverson, E. V. Anslyn, Organic Chemistry, Brooks/Cole, USA, 2009.		

the submission of the study programme proposal)	
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Internal student survey. Analysis of attendance to lectures and exercises, results of preliminary exams as well as oral exams. Student survey of University of Zagreb. Analysis of course`s results according to the Rules of quality assurance at Faculty of Metallurgy.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	To classificate organic compounds.	1st colloquium, written and oral exam
2	To use basic terminology - nomenclature of organic compounds.	1st, 2nd, 3rd colloquium, exercises, written and oral exam
3	To define constitutional isomerism.	1st colloquium, written and oral exams
4	To understand reactions of synthesis, characteristics and application of different organic groups.	2nd and 3rd colloquium, lab exercises, written and oral exam
5	To describe mechanisms of basic types of organic reactions.	2nd and 3rd colloquium, lab exercises, written and oral exam
6	To select appropriate technique of characterization.	3rd colloquium, written and oral exams
7	To plan simple reactions of synthesis.	1st, 2nd, 3rd colloquium, lab exercises, written and oral exam
8	To apply knowledge on solving of engineering problems in view of ecology.	3rd colloquium, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Zoran Glavaš, PhD Assoc.Prof. Natalija Dolić, PhD	1.6. Year of study	2
1.2. Name of the course	**METALLURGY OF IRON**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	25
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Introduce students with the types and production processes of iron. Introduce students with the basic profile of blast furnace, charging of blast furnace, the processes inside the blast furnace and fundamental reactions. Introduce students with production technologies of iron without blast furnace. Introduce students with the basic calculations for assessment of metallurgical value of the ore, coke and fluxes, material and thermal balance of blast furnace and electric furnace; calculation of the degree of direct and indirect reduction in blast furnace.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Compare and choose individual technological process. Calculate material and thermal balance of metallurgical processes. Explain and apply the technology of metals' production, treatment and forming.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Explain fundamental reactions inside the blast furnace. Make the balance of components in pig iron production. Explain processes of direct reduction and smelting reduction processes. Analyze ecological aspects of input and output components and processes of their remediation and treatment.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Iron ores: types, characteristics, enrichment processes – today. (2); Metallurgy of pig iron. Classification - types of pig iron and basic principles of production. (2); Blast furnace: profile - description of basic components and functions. (2); Physical-chemical changes in blast furnace - charge flow - reduction. (3); Processes in blast furnace - pig irons and slags. Blast furnace gas. (2); Reduction of iron, silicon, manganese and phosphorous. Carburization of pig iron. (2); Sulphur in pig iron. Distribution of sulphur. Desulphurization. (2); Test I; Preheating of air for blast furnace. Modern equipments for preheating of air. (2); Gas in blast furnace. Composition and properties. Purification of gas. (2); Blast furnace closing devices. Types and characteristics. Charging the blast furnace. (2); Oxygen in blast furnace. Hydrocarbons blowing. Combined operation. (2); Electroreduction furnaces for pig iron production. (2); Direct reduction of iron. Fundamentals and the most important processes. (2); Smelting reduction. Fundamentals and the most important processes. (2); Plasma and the use of plasma technology in iron melting. (1); Test II. SEMINAR (15): Basic factors for assessment of metallurgical value of the ore (1). Basic factors for assessment of metallurgical coke, the role of the coke in iron production (1). Influence of ash composition on coke quality (1). Basic factors for assessment

	of limestone (1). Balance equation of carbon, volume and caloric value of blast furnace gas (1). Analysis of blast furnace gas (1). Calculation of the degree of direct and indirect reduction in blast furnace (1). Indicators that characterize the development of direct and indirect reduction in blast furnace (1). Test I (1). Material balance of blast furnace (1). Thermal balance and indicators of heat influence on blast furnace operation (1). Rankin-Wright's diagram, McCaffery's diagram, sulphur control according to Oelsen's nomogram (1). The most important processes of direct reduction of iron (1). The most important processes of smelting reduction (1). Test II (1). EXERCISES (15): All these are computational tasks. Rating (evaluation) of ore (1). Assessment of metallurgical value of the coke (2). Assessment of metallurgical value of limestone (1). Utilization of fuel in the blast furnace (1). Analysis of blast furnace gas (1). Calculation of the degree of direct and indirect reduction in a furnace (3). Material balance of blast furnaces (1). The thermal balance of the blast furnace (1). Determination of melting point and viscosity of slag, sulphur control according to Oelsen's nomogram (1). Production of pig iron in electric furnaces (3).

2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☒ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:

2.8. Student responsibilities	Conditions for signature: Students must attend lectures (> 70 %), seminars (> 70 %) and exercises (> 70 %), made a computational task.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
	Class attendance	0.5	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	1.0	(Other--describe)	
	Tests	3.5	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Exam of the course: Through continuous monitoring - student needs to pass four colloquium. If the student has passed all colloquiums, the final score is determined as the average score of the colloquiums. Through the final exam: written and oral exam for students who have not passed the exam through continuous monitoring or are not satisfied with the success from the exam that are achieved through continuous monitoring, or have not decided on this method of examination. Conditions for access to the exam: -

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Z. Glavaš, N. Dolić, Metalurgija željeza, text of the lectures placed on website of Faculty of Metallurgy, Faculty of Metallurgy, Sisak, 2014.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/3-godina-preddiplomskog-studija/metalurgija-zeljeza/view

2.12. Optional literature (at the time of the submission of the study	S. Muhamedagić, Metalurgija gvožđa, Faculty for metallurgy and materials, Zenica, 2006. B. Koželj, Osnove proizvodnje gvožđa, Faculty for metallurgy and materials, Zenica, 1988.

programme proposal)	B. Božić, Metalurgija gvožđa, BIGZ, University of Beograd, Beograd, 1973. V. Grozdanić, A. Markotić, Metalurgija željeza i čelika, Collection of solved tasks, University of Zagreb, Sisak, 2006. V. Trujić, Suvremeni proračuni u metalurgiji gvožđa, Institute for copper, Bor, 2007.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey at the level of Faculty and University. Analyses provided in the system of quality assurance of the institution. Analyses provided in the system of quality assurance and an authorized office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain fundamental reactions inside the blast furnace.	1st colloquium, written exam
2	Make the balance of components in pig iron production.	1st and 2nd colloquium, written exam
3	Explain processes of direct reduction and smelting reduction processes.	2nd colloquium, written exam
4	Analyze ecological aspects of input and output components and processes of their remediation and treatment.	1st and 2nd colloquium, written exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Natalija Dolić, PhD	1.6. Year of study	2
1.2. Name of the course	**METALLURGY OF NON-FERROUS METALS**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	1. Acquiring knowledge about the properties of aluminium, copper and magnesium, raw materials for their obtaining and application areas. 2. Acquisition and understanding of the basic theoretical knowledge about the processes production of aluminium, copper and magnesium. 3. Introduce students with the modern technological processes for production of aluminium, copper and magnesium. 4. Acquiring knowledge about the most important alloys for aluminum, copper and magnesium and their phase diagrams, properties and application areas. 5. Training students through to the computational tasks establish the basic elements of technology estimates in the production of aluminium, copper and magnesium.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. Compare and choose individual technological process. Calculate material and thermal balance of metallurgical processes. Predict and solve problems in metals' production. Describe and explain the modern technologies in the metallurgical practice.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Explain the basic properties of aluminium, copper and magnesium and their alloys, raw materials for their obtaining and application areas. 2. Describe the most important methods for obtaining alumina, aluminium, copper and magnesium. 3. Summarize the basic technological parameters in processes of obtaining alumina, aluminium, copper and magnesium. 4. Calculate the rational composition copper's concentrate, material and thermal balance roasting charge and flames refining of copper. 5. Present a seminar paper.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction to the plan course and the time schedule for the colloquium. The basic classification and characteristics of non-ferrous metals. Obtaining non-ferrous metals throughout history and their uses (1).

	Metallurgy of aluminium and their alloys History and current state in metallurgy of aluminium. Aluminium and its alloys: application, mineral raw materials, uses. Oxides and hydroxides of aluminum. Aluminate solutions (2). Bayer's process for alumina production. Other processes for alumina production (3). The theory of electrolytic reduction of alumina (Hall – Heroult's process). Characteristics of the electrolyte. Phenomena at the electrodes. Electrolytic cell (4). Other processes of aluminium extraction. Refining of aluminium. The processing of aluminium and its alloys. Processing of secondary aluminium (2). Aluminium alloys. Binary aluminium alloys (Al – Mg, Al – Si, Al – Cu). Multicomponent aluminium alloys (2). TEST I. *Metallurgy of cooper and their alloys* History and current state in metallurgy of cooper. Copper and its alloys: application, mineral raw materials, uses. Froth flotation (1). Pyrometallurgical processes for copper production, mechanical and metallurgical preparation of raw materials, roasting, smelting, converting, refining (4). Autogenous smelting processes (3). Hydrometallurgical extraction of copper (2). Copper alloys (Cu - Zn, Cu - Sn, Cu – Be, Cu - Ni, Cu - Pb, Cu - Al, Cu – Si) (2). *Metallurgy of magnesium and their alloys* History and current state in metallurgy of magnesium. Magnesium and its alloys: application, mineral raw materials, uses (1). Production magnesium: electrolysis of magnesium chloride, thermic reduction of magnesium oxide, carbothermic reduction, silicothermic reduction, aluminothermic reduction. Refining of magnesium. Processing of metallic magnesium (2). Magnesium alloys (Mg - Mn, Mg - Al – Zn) (1). TEST II. SEMINAR (15): How to properly write seminar paper and make the best possible presentation!? (1). Phase diagrams of basic alloys (4). Preparation and presentation of seminar papers (8). Test I, II (2) EXERCISES (15): Basic elements of technology budgets for the production of alumina (Bayer's process) (2). Calculation of amount and composition of the red mud in the Bayer's process (2). Calculation of the degree of saturation aluminate solution (2). Basic elements of technology budget for electrolysis aluminium (1). Calculations of the roasting, smelting, converting, refining, fire and the electrolytic refining of copper (7). Basic elements of technology budgets for the production of magnesium by electrolysis (2). (computational tasks)

2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☒ work with the mentor ☒ seminar paper	2.7. Comments:	
2.8. Student responsibilities	**Conditions for signature:** regular attendance (> 70 %), successful and timely written and exposed seminar paper (ppt).			

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
	Class attendance		Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		Seminar paper	1
	Tests		Oral exam	2	(Other—describe)	
	Written exam	2	Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam

Continuous monitoring and evaluation of student:
The exam could be passed through two TESTS (writing + oral). In case it is not passed one of the two tests, the student has the right to take not passed test one more time. Both positive evaluation tests release the student of laying the final exam. At each tests student can achieve a maximum of 10 points for the question, number of questions is 5. For satisfactory accomplishment in each tests student must collect more than 30 % of points for each question. If student fails the examination by tests, laying the final exam (written + oral).

Continuous monitoring and evaluation of student:
Tests (I + II), writing + oral: 4 ECTS
Seminar paper: 1 ECTS

2.11. Required literature (available at the library and via other media)

Title	Number of copies at the library	Availability via other media
N. Dolić, Metalurgija aluminija, Sveučilište u Zagrebu, Metalurški fakultet, Sisak, 2015.		http://www.simet.unizg.hr/nastava/predavanja/diplomski-sveucilisni-studij-metalurgija/2-godina-diplomskog-studija/metalurgija-aluminija/view)
Z. Lenhard, Metalurgija obojenih metala I, Sveučilište u Zagrebu Metalurški fakultet, Sisak, 2008.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/2-godina-preddiplomskog/metalurgija-obojenih-metala-i/view
Z. Lenhard, Metalurgija obojenih metala II, Sveučilište u Zagrebu Metalurški fakultet, Sisak, 2008.		https://www.simet.unizg.hr/nastava/predavanja/diplomski-sveucilisni-studij-metalurgija/1-godina-diplomskog-studija/metalurgija-obojenih-metala-ii/view

2.12. Optional literature (at the time of the submission of the study programme proposal)

A. Vignes, Extractive Metallurgy 1, Basic Thermodynamics and Kinetics, ISTE Ltd UK and John Wiley & Sons, Inc. SAD, 2011.
R. Ž. Vračar, Teorija i praksa dobivanja obojenih metala, Savez inženjera metalurgije Srbije, Belgrade, 2010.
N. Štrbac, Ž. Živković, I. Mihajlović, Zbirka zadataka iz metalurgije obojenih metala, University of Belgrade Technical Faculty in Bor, Bor, 2004.

	R. Ž. Vračar, Ž. D. Živković, Ekstraktivna metalurgija aluminija, Naučna knjiga, Beograd, 1993. Ž. Živković, Ekstraktivna metalurgija magnezija, University of Belgrade Technical Faculty in Bor, Bor, 1993. Handbook of Extractive Metallurgy, Volume II: Primary Metals, Secondary Metals, Light Metals, ur. F. Habashi, WILEY-VCH, Weinheim – Chichester - New York - Toronto - Brisbane - Singapore, Germany, 1997. C. B. Gill, Nonferrous Extractive Metallurgy, Robert E. Krieger Publishing Company, Malabar, Florida, 1988.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Examination of students who have finished study. Survey at the level of Faculty and University. Analyses provided in the system of quality assurance of the institution. Analyses provided in the system of quality assurance and an authorized office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain the basic properties of aluminium, copper and magnesium and their alloys, raw materials for their obtaining and application areas.	1st colloquium, 2nd colloquium, written and oral exam, seminar paper
2	Describe the most important methods for obtaining alumina, aluminium, copper and magnesium.	1st colloquium, 2nd colloquium, written and oral exam, seminar paper
3	Summarize the basic technological parameters in processes of obtaining alumina, aluminium, copper and magnesium.	1st colloquium, 2nd colloquium, written and oral exam
4	Calculate the rational composition copper's concentrate, material and thermal balance roasting charge and flames refining of copper.	1st colloquium, 2nd colloquium, written exam, audotiry exercises
5	Present a seminar paper.	Seminar paper

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Full Prof. Mirko Gojić, PhD Assoc.Prof. Stjepan Kožuh, PhD	1.6. Year of study	2
1.2. Name of the course	**FUNDAMENTALS OF HEAT TREATMENT AND WELDING**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	25
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%
2. COURSE DESCRIPTION			
2.1. Course objectives	Showing the basic procedures of heat treatment. Showing basic welding procedures for metallic materials with an emphasis on metallurgical approach. Planning of correspoding welding procedure depending on the particular case of use.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Compare and choose individual technological process. Identify material properties and technological process parameters and adjust them in order to achieve the desired product quality.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Identify the individual processes of heat treatment and welding. Enumerate the basic characteristics of the plant for heat treatment. Describe the individual welding process of materials. Articulate metallurgical phenomena during welding. Identify potential risks and means of protection and safety during welding and heat treatment of steel.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): 1. Introduction and classification of heat treatments processes (2 hours). 2. The fundamentals of heat treatment processes (processes of annealing, quenching and tempering, aging, etc.) (4 hours). 3. The fundamentals of chemical-heating methods (4 hours). 4. The fundamentals of special heat treatments processes (2 hours). 5. The fundamental principles of heat treatment of steel and cast iron (2 hours). 6. The fundamental principles of heat treatment of non-ferrous metals (2 hours). 7. Introduction to welding: definitions, types of joints, historical overview of the development of welding procedures (2 hours). 8. The main characteristics of the most important procedures of fusion welding (SMAW, TIG, MIG / MAG, gas welding) (4 hours). 9. Generally about welding metallurgy. Gases in the weld joint (4 hours). 10. Welding of steels, Repair welding (2 hours). 11. The basic of security and safety at work (2 hours). SEMINAR (15): The selection of topics and seminar work in writing form by a mentor system (10 hours). Preparation and		

	presentation of the seminar and discussions related to the topic of the present paper (5 hours). LABORATORY EXERCISES (15): Preparation of joints for welding (4 hours). Individual and group performance of specific welding processes (SMAW, TIG, MIG/MAG) (7 hours). Annealing, quenching and tempering (4 hours).					
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ independent study ☐ multimedia and the internet ☒ laboratory ☒ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities	Students must attend over 70% of lectures and exercises and are required to complete a seminar in writing form and orally present.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	0.5	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	1.5	(Other--describe)	
	Tests	3.0	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	- evaluation of students activities at the class, - evaluation of written examination (two colloquiums) through continuous monitoring or final examination (written and oral), - evaluation of seminar paper.					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	M. Novosel i dr., Posebni čelici, Strojarski fakultet Slavonski Brod, Slavonski Brod, 1998.	9	
	M. Gojić, Tehnike spajanja i razdvajanja materijala, Metalurški fakultet, Sisak, 2003.	10	
	J. Pirš, Toplinska obrada metala, Tehnički fakultet Rijeka, Rijeka, 1992.	3	
	ASM Handbook.pdf		Electronic form

2.12. Optional literature (at the time of the submission of the study programme proposal)	C.R. Brooks, Principles of the Heat Treatment of Plain Carbon and Low Alloy Steels, ASM International, Materials Park, 1996. Z. Lukačević, Zavarivanje, Strojarski fakultet Slavonski Brod, Slavonski Brod, 1998. Grupa autora, Inženjerski priručnik 4, prvi svezak: Materijali, Školska knjiga, Zagreb, 1998. B. Anzulović, Zavarivanje i srodni postupci, Fakultet elektrotehnike, strojarstva i brodogradnje, Split, 1990.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Questionnaire at Faculty and University. Survey at the level of Faculty and University. Analyses provided in the system of quality assurance of the institution. Analyses provided in the system of quality assurance and an authorized office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Identify the individual processes of heat treatment and welding.	1st colloquium, written and oral exam
2	Enumerate the basic characteristic of the plant for heat treatment.	1st colloquium, seminar paper, written and oral exam
3	Describe the individual welding process of materials.	2nd colloquium, written and oral exam
4	Articulate the metallurgical phenomena during welding.	2nd colloquium, written and oral exam
5	Identify the potential risks and means of protection and safety during welding and heat treatment of steel.	Laboratory exercises

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Anita Štrkalj, PhD	1.6. Year of study	2
1.2. Name of the course	**CHEMICAL ANALYSIS TECHNIQUES**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	45
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION			
2.1. Course objectives	Introducing students to the fundamentals of chemical analysis. Introducing students to a wide range of modern analytical methods. Acquiring skills for obtaining high-quality analytical data.		
2.2. Enrolment requirements and required entry competences for the course	Passed exam in General Chemistry. Passed exam in Inorganic Chemistry.		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Use the skills and knowledge of qualitative and quantitative analysis. Apply logical conclusion and precision in data processing.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Explain the basic concepts in chemical analysis of material composition. Prepare a sample for chemical analysis. To compare the methods of analysis. Select the appropriate analytical method for the analysis of materials. To interpret the obtained results.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Chemical analysis. Categorization of analytical methods. The analytical system. (2) The errors of the analytical system. (2) Sample. Sampling of solid materials. (2) Samplings of liquid materials. Sample of gases materials. (2) Preparation of analytical sample. Disolution. (2) Sedimentation. (2) Separation and isolation of analytes. (2) Gravimetry. Titrimetry. (2) Review of Physical-chemical methods of analysis (2) Optical methods. (2) Electrochemical metods. (2) Thermometrical methods. (2) Radioactive methods. Other methods. (2) Equipment and instruments for the analysis of the Faculty of Metallurgy. (2) Visit to a well equipped analytical laboratory. (2) EXCERCISES (30): Establishing cations. (2) Establishing anions. (2) Alloys analysis. (2) Quantitative chemical analysis: Gravimetrical (6), Neutralization titrations (6), Sedimentation titrations (6), Complexometric titrations (6).		
2.6. Type of instruction	☒ lectures	☐ independent study	2.7. Comments:

	☐ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ multimedia and the internet ☒ laboratory ☐ work with the mentor ☐ (other)			
2.8. Student responsibilities	Conditions for signature: attendance at lectures min. 70%, lab exercises completed 100 %, lab reports.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	1	Research		Practical training	
	Experimental work	1	Report			
	Essay		Seminar essay		(Other--describe)	
	Tests		Oral exam		(Other—describe)	
	Written exam	2	Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Through continuous monitoring-student must pass two colloquiums. Through a final exam: written exam for the students who have not passed the exam through continuous monitoring or are not satisfied with the success from the exam that are achieved through continuous monitoring, or have not decided on this method of examination.					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	A. Štrkalj, Tehnike kemijske analize, text of the lectures placed on website of Faculty of Metallurgy, Faculty of Metallurgy, Sisak, 2014.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/2-godina-preddiplomskog/copy_of_tehnike-kemijske-analize-predavanja/view
	A. Štrkalj, Tehnike kemijske analize - exercises, text of the exercises placed on website of Faculty of Metallurgy, Faculty of Metallurgy, Sisak, 2011.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/2-godina-preddiplomskog/vjezbe-iz-tehnika-kemijske-analize/view
	D. A. Skoog, D. M. West, F. J. Holler, Osnove analitičke kemije, Školska knjiga, Zagreb, 1999.	1	
	M. Kaštelan-Macan, Kemijska analiza u sustavu kvalitete, Školska knjiga, Zagreb, 2003.	1	

2.12. Optional literature (at the time of the submission of the study programme proposal)	Z. Šoljić, Računanje u analitičkoj kemiji, Fakultet kemijskog inženjerstva i tehnologije Zagreb, Zagreb, 1998.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey at the level of Faculty and University. Analyses provided in the system of quality assurance of the institution. Analyses provided in the system of quality assurance and an authorized office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain the basic concepts in chemical analysis of material composition.	Colloquium, written exam
2	Prepare a sample for chemical analysis.	Colloquium, laboratory exercises, written exam
3	To compare the methods of analysis.	Colloquium, written exam
4	Select the appropriate analytical method for the analysis of materials.	Colloquium, written exam
5	To interpret the obtained results.	Colloquium, laboratory exercises, written exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Full Prof. Stoja Rešković, PhD	1.6. Year of study	2
1.2. Name of the course	**FUNDAMENTALS OF THEORY OF METAL FORMING**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	Tin Brlić, mag.ing.met.	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	25
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	1. Introduce students to the physical-chemical theory of deformation 2. Introduce students to the mechanical-mathematical theory of deformation 3. Introduce students to the scientific principles of deformation 4. Acquired knowledge applied to metal forming processes
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Explain the physical-chemical fundaments of phenomena characteristic for the technical profession. 2. Explain and apply technology of metals production, treatment and forming. 3. Describe and explain the modern technologies in the metallurgical practice.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Explain the theoretical basis of the metal forming process. 2. Calculate the stresses and strains in the metal forming process. 3. Create dependence diagrams of stresses and strains on process parameters. 4. Analyze the influential parameters on metal forming process. 5. Predict the behaviour of different metals during deformation. 6. Investigate deformation resistance of metal materials. 7. Calculate and analyze process parameters at different deformation processes. 8. Valorise the deformation parameters at different deformation processes. 9. Apply theoretical knowledge to solve engineering problems in practice. 10. Set hypothesis on influence of individual factors of deformation process, design and conduct an experiment, analyze and present the results.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30) AND EXERCISES (30): - Introduction 2 - The properties of metals and alloys which are formed by deforming 4 - Plasticity and deformability 2 - Indicators of plasticity (analog, simple, complex and universal) 2 - Possibility of increasing the plasticity 1 - The impact of individual elements on the plastic properties 1 - Exercise 1: Testing the plasticity of different metals and alloys 6

	- I. Colloquium - Influential factors on the plastic flow of metal 2 - The influence of the chemical composition and structure 2 - The effect of temperature on the plastic flow 2 - Exercise 2: Determination of deformation resistance 6 - The influence of strain rate on the plasticity of steel 1 - Exercise 3: Determining the influence of strain rate on the deformation resistance 6 - The influence of the shape and dimensions of deformed body 1 - Basic laws of plastic flow of material 1 - Stresses and stress state 1 - Cold plastic deformation 2 - Exercise 4: Hardening of metal during cold deformation 6 - Hot plastic deformation 2 - II. Colloquium - Friction and theoretical foundations of friction in metal forming 2 - Methods for testing plasticity 2 - Exercise 5: The influence of friction on the deformation processes 6 - III. Colloquium

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:

2.8. Student responsibilities	Attendance at lectures min. 70%, individual work on all exercises and preparation and submission of reports from field of colloquium before writing the colloquium or the written exam.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
Class attendance		Research		Practical training		
Experimental work	0.5	Report				
Essay		Seminar essay		(Other--describe)		
Tests	2.0	Oral exam	0.8	(Other—describe)		
Written exam	0.3	Project	0.4	(Other—describe)		

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	During the classes the presence and activity of students on classes are evaluated. Score of independent work during performing exercises. Students score participation on projects. Score on written colloquium trough continuous monitoring (or final written exam) and oral exam. Score of seminar paper.

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	S.Rešković, Teorija oblikovanja deformiranjem, Sveučilište u Zagrebu, Metalurški fakultet, Sisak 2014., peer reviewed lessons		https://www.simet.unizg.hr/nastava/predavanja/diplomski-sveucilisni-studij-metalurgija/1-godina-diplomskog-

			studija/S%20Reskovic%20TEORIJA%20OBLIKOVANJA%20DEFORMIRANJEM.pdf/view
	I. Mamuzić, Teorija plastične deformacije metala, MF Sisak, 2000.	5	
	M. Čaušević, Teorija plastične prerade, Svjetlost, Sarajevo 1979.	3	
2.12. Optional literature (at the time of the submission of the study programme proposal)	B. Grizelj, Oblikovanje metala deformiranjem, Sveučilište J. J. Strossmayera u Osijeku, Strojarski fakultet u Slavonskom Brodu. Professional journals, articles from this area.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey on the level of faculty and University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized office of the University.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain the theoretical basis of the metal forming process.	1st colloquium, written and oral exam
2	Calculate the stresses and strains in the metal forming process.	1st colloquium, independent task, written and oral exam
3	Create dependence diagrams of stresses and strains on process parameters.	laboratory exercises, project task, oral exam
4	Analyse the influential parameters on metal forming process.	2nd colloquium, laboratory exercises, written and oral exam
5	Predict the behaviour of different metals during deformation.	2nd colloquium, laboratory exercises, oral exam
6	Investigate deformation resistance of metal materials.	laboratory exercises, independent task
7	Calculate and analyze process parameters at different deformation processes.	2nd colloquium, laboratory exercises, written and oral exam
8	Valorise the deformation parameters at different deformation processes.	3rd colloquium, written and oral exam
9	Apply theoretical knowledge to solve engineering problems in practice.	independent task
10	Set hypothesis on influence of individual factors of deformation process, design and conduct an experiment, analyze and present the results.	3rd colloquium, independent task, laboratory exercises, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assist.Prof. Martina Lovrenić-Jugović, PhD	1.6. Year of study	2
1.2. Name of the course	**MACHINERY ELEMENTS**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	45
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION			
2.1. Course objectives	1. Introduce students to the most commonly used machine parts. 2. To know their names, divisions, features, materials used for building and usage 3. To determine of the shape, size and material of each element.		
2.2. Enrolment requirements and required entry competences for the course	Attended Engineering Drawing and Computer Graphics course		
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Apply teamwork-oriented, ethical principles and encourage the development of communication and social skills. 2. Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. 3. Apply norms in the technical profession.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Describe and analyse the functionality of individual elements of machines. 2. Calculate the dimensions of machine elements. 3. Analyse and verify the state of stress in the parts of structure or machinery. 4. Select the appropriate material for the production of components or structures. 5. Adjust form of compounds or components in the design phase.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30) AND EXERCISES (15): 1. Welded joints: The procedures, Weld materials, Types of welds and joints, Strength of welded joints (6). 2. Screw and bolts: Thread type, Types of nuts and bolts, Insurance against joint separation, Forces and deformations due to overloading, Calculation of static and dynamic strength, Screw drives (6). 3. 1st preliminary exam: includes the units 1-2 4. Connections with pins and bolts, Connections with taper and parallel keys, Compound transverse pin (3). 5. Spring: Characteristics and use, Flexion springs, torsion springs, Compressiontensile ring springs, Rubber springs (3). 6. Axles and shafts: Design, Sizin (3). 7. Bearings: Sliding bearings, rolling bearings, Friction, Lubrication and lubricants (6). 8. 2nd preliminary exam: includes the units 4-7 9. Couplings: Inelastic couplings, Flexible couplings, Friction clutches, Special clutches (3). 10. Friction drive, Belt drive, Chain drive (6). 11. Gear drive: Law of gearing, Gear ratio and the ratio of the number of teeth, Involute gearing, Lubrication and cooling, Materials and Heat Treatment, Calculation of load of spur gear drive (6). 12. Elements for fluid flow: Pipes, Pipe fittings, Expansion joints, Pipe, security and control valves (3). 13. Program Task: program designed one of the component of the units of 9-12		
2.6. Type of instruction	☒ lectures	☐ independent study	2.7. Comments:

	☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	

2.8. Student responsibilities	Conditions for signature: - attendance on Lectures and Exercises > 70% - program task Conditions for taking: rated course Engineering Drawing and Computer Graphics

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
	Class attendance	0.3	Research		Practical training	
	Experimental work		Report		Program task	0.6
	Essay		Seminar essay		(Other--describe)	
	Tests	1.2	Oral exam	0.6	(Other—describe)	
	Written exam	0.3	Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Exercises – 20% Attendance – 10% Written exam – 40% Oral exam – 30%

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	L. Lazić, Elementi strojeva, Sveučilišni udžbenik, Sisak, 2001.	13	-
	K. H. Decker, Elementi strojeva, Tehnička knjiga, Zagreb, 1986.	3	-

2.12. Optional literature (at the time of the submission of the study programme proposal)	J. E. Shigley, C. R. Mischke, Mechanical Engineering Design, Mc Graw Hill Book Co., Singapore, 1980.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Internal: Student survey input. Numerical analysis of tests and exams according to scoring task by task at the level of course. External: Survey at the level of faculty and University. Analyses provided in the system of quality assurance of the institution. Analyses provided in the system of quality assurance and an authorized office of the University.

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	Describe and analyse the functionality of individual elements of machines.	Colloquiums, Oral exam
2	Calculate the dimensions of machine elements.	Colloquiums
3	Analyse and verify the state of stress in the parts of structure or machinery.	Colloquiums, Program task
4	Select the appropriate material for the production of components or structures.	Colloquiums, Program task
5	Adjust form of compounds or components in the design phase.	Program task

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assist.Prof. Martina Lovrenić-Jugović, PhD	1.6. Year of study	2
1.2. Name of the course	**COMPUTER AIDED DESIGN**	1.7. Credit value (ECTS)	3
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	15+0+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	45
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION			
2.1. Course objectives	1. Adopt knowledge of 3D computer-aided design. 2. Adopt knowledge that is absolutely necessary for further studies as well as in engineering practice. 3. Adopt knowledge necessary for professional work in the field of profession.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Apply norms in the technical profession. 2. Apply acquired IT knowledge in engineering practice.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Identify the design process and the role of design using a computer. 2. Explain the basic principles of geometric modeling, parametric modeling and modeling features. 3. Apple 3D computer techniques to create 3D model of the object. 4. Construct a simple geometric designs and assemblies. 5. Determine the geometric features of the cross-sectional model. 6. To determine the mass of the geometric features of the model.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (15) AND EXERCISES (30): 1. Introduction to CAD / CAE systems (3) 2. Types of 3D CAD models: wireframe, surface and solid model (6) 3. Geometric Modelling (6) 4. Modeling features (6) 5. Parametric modeling (6) 6. Describing the curve (3) 7. Describing area (3) 8. Data structures for geometric modeling (3) 9. Application Library (3) 10. Data exchange between CAD systems (3) 11. Basic terms of structural analysis (3)		
2.6. Type of instruction	☒ lectures	☒ independent study	2.7. Comments:

	☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	

2.8. Student responsibilities	Conditions for signature: - attendance on Lectures and Exercises > 70% - eviewing homework Conditions for taking: rated course Engineering Drawing and Computer Graphics

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
	Class attendance	0.3	Research		Practical training	
	Experimental work		Report		Program task	0.9
	Essay		Seminar essay		Homework	0.6
	Tests	1.2	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Homework – 20% Program task – 30% Attendance – 10% Written exam – 40%

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	M. Kljajin, M. Karakašić, Modeliranje primjenom računala, Strojarski fakultet u Slavonskom Brodu, 2012.	5	-
	Daniel Rohde i dr., Oblikovanje pomoću računala, Modeliranje-podloge za vježbe, Fakultet strojarstva i brodogradnje, Sveučilište u Zagrebu, 2005.	-	http://www.cadlab.fsb.hr/download/skripte/33.pdf

2.12. Optional literature (at the time of the submission of the study programme proposal)	S.D. Lockhart, C.M. Johnson, Engineering Design Communication, Prentice Hall, New Jersey, 2011.

2.13. Methods of monitoring quality that ensure acquisition of exit competences	Internal: Student survey input. Numerical analysis of tests and exams according to scoring task by task at the level of course. External: Survey at the level of faculty and University. Analyses provided in the system of quality assurance of the institution. Analyses provided in the system of quality assurance and an authorized office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Identify the design process and the role of design using a computer.	Colloquiums
2	Explain the basic principles of geometric modeling, parametric modeling and modeling features.	Colloquiums
3	Apple 3D computer techniques to create 3D model of the object.	Program task, homework
4	Construct a simple geometric designs and assemblies.	Colloquiums, program task
5	Determine the geometric features of the cross-sectional model.	Colloquiums, homework
6	To determine the mass of the geometric features of the model.	Colloquiums, homework

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Zoran Glavaš, PhD Full Prof. Mirko Gojić, PhD	1.6. Year of study	2
1.2. Name of the course	**PRODUCTION OF IRON AND STEEL**	1.7. Credit value (ECTS)	6
1.3. Associate teachers	Assoc.Prof. Natalija Dolić, PhD.	1.8. Type of instruction (number of hours L+S+E+e-learning)	45+15+15+0
1.4. Study programme (undergraduate, graduate, integrated)	Undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	Compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Introduce students with the types and production processes of iron. Introduce students with the basic profile of blast furnace, charging of blast furnace, the processes inside the blast furnace and fundamental reactions. Introduce students with production technologies of iron without blast furnace. Introduce students with the basic calculations for assessment of metallurgical value of the ore, coke and fluxes, material and thermal balance of blast furnace and electric furnace; calculation of the degree of direct and indirect reduction. Introduce students with the basics of production and the importance of steel as a material. Introduce students with the basic raw materials for steelmaking. Introduce students with the basics of modern technologies of steelmaking. Introduce students with the basics of secondary metallurgy and steel casting.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Compare and choose individual technological process. Calculate material and thermal balance of metallurgical processes. Explain and apply the technology of metals' production, treatment and forming.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Explain fundamental reactions inside the blast furnace and aggregates for the steelmaking. Make the balance of components in pig iron and steel production. Explain processes of direct reduction and melting reduction processes. Explain the processing of steel by secondary metallurgy processes. Evaluate and explain the processes of steel casting. Analyze ecological aspects of input and output components and processes of their remediation and treatment.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES: I. PART – PRODUCTION OF IRON: Iron ores: types, characteristics, enrichment processes – today. (2); Metallurgy of pig iron. Classification - types of pig iron and basic principles of production. (2); Blast furnace: profile - description of basic components and functions. (2); Physical-chemical changes in blast furnace - charge flow - reduction. (2); Processes in blast furnace - pig irons and slags. Blast furnace gas. (2); Reduction of iron, silicon, manganese and phosphorous. Carburization of pig iron. (2); Sulphur in pig iron. Distribution of sulphur. Desulphurization. (1); Preheating of air for blast furnace. Modern equipments for preheating of air. (1); Gas in blast furnace. Composition and properties. Purification of gas. (1); Blast furnace closing devices. Types and characteristics. Charging the blast furnace. (1); Oxygen in blast furnace. Hydrocarbons blowing. Combined operation. (1); Electroreduction furnaces for pig iron production. (1); Direct reduction of iron.

	Fundamentals and the most important processes. (1); Smelting reduction. Fundamentals and the most important processes. (1); Plasma and the use of plasma technology in iron melting. (1). LECTURES: II. PART - STEEL MAKING: Role and importance of steel as material (2); Kinetics of steel making process (1); Role and basic properties of slag (2); Reaction of oxidation of carbon (1); Oxidation of silicon, manganese and phosporous (2); Desulphurization (1); Solution of oxygen, hydrogen and nitrogen in steel (1); Deoxidation and alloying of steel (1); Scarp as raw for steelmaking (1); Technology of steelmaking in oxygen converter (2); Technology steelmaking of steel in electro-arc furnace (3); Basis of secondary metallurgy (2); Technology of steel casting (3); Effect of steelmaking on environmental (2). SEMINAR (15): Manufacturing of material and heat balance for particular steelmaking procedure (10 hours), Manufacturing of seminar work with mentor system as well as presentation of the work and discussion on the topic seminar work (5 hours). EXERCISES (15): All computational tasks. Rating (evaluation) of ore (1). Assessment of metallurgical value of the coke (2). Assessment of metallurgical value of limestone (1). Utilization of fuel in the blast furnace (1). Analysis of blast furnace gas (1). Calculation of the degree of direct and indirect reduction in a furnace (3). Material balance of blast furnaces (1). The thermal balance of the blast furnace (1). Determination of melting point and viscosity of slag, sulphur control according to Oelsen's nomogram (1). Production of pig iron in electric furnaces (3).					
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities	Conditions for signature: Students must attend lectures (> 70 %), seminars (> 70 %) and exercises (> 70 %), written seminar in the field of steelmaking.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	0.5	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	1.0	(Other--describe)	
	Tests	4.5	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Exam of the course: Through continuous monitoring - student needs to pass three colloquium and present a seminar paper. If the student has passed all colloquiums and presented a seminar paper, the final score is determined as the average score. Through the final exam: written and oral exam for students who have not passed the exam through continuous monitoring or are not satisfied with the success from the exam that are achieved through continuous monitoring, or have not decided on this method of examination. Conditions for access to the exam: -					
2.11. Required literature (available at the library and via other media)	**Title**		**Number of copies at the library**		**Availability via other media**	
	Z. Glavaš, N. Dolić, Metalurgija željeza, text of the lectures placed on website of Faculty of Metallurgy, Faculty of Metallurgy, Sisak, 2014.				https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/3-godina-preddiplomskog-studija/metalurgija-zeljeza/view	

	M. Gojić, Metalurgija čelika, University of Zagreb, Faculty of Metallurgy, the second unchanged edition, Sisak, 2006.	15	
2.12. Optional literature (at the time of the submission of the study programme proposal)	S. Muhamedagić, Metalurgija gvožđa, Faculty for metallurgy and materials, Zenica, 2006. V. Grozdanić, A. Markotić, Metalurgija željeza i čelika, Collection of solved tasks, University of Zagreb, Sisak, 2006. V. Trujić, Suvremeni proračuni u metalurgiji gvožđa, Institute for copper, Bor, 2007.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey on the level of faculty and university. Analysis predicted in the quality assurance system of institution. Analysis predicted in the quality assurance system and authorized office of the university.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain fundamental reactions inside the blast furnace and aggregates for the steelmaking.	1st colloquium, written exam, oral exam
2	Make the balance of components in pig iron and steel production.	1st colloquium, seminar paper, auditory exercises, written exam, oral exam
3	Explain processes of direct reduction and melting reduction processes.	1st colloquium, written exam
4	Explain the processing of steel by secondary metallurgy processes.	2nd colloquium, written exam, oral exam
5	Evaluate and explain the processes of steel casting.	2nd colloquium, written exam, oral exam
6	Analyze ecological aspects of input and output components and processes of their remediation and treatment.	2nd colloquium, written exam, oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assist. Prof. Tahir Sofilić, PhD Assoc. Prof. Ivan Brnardić, PhD	1.6. Year of study	2
1.2. Name of the course	**HAZARDOUS SUBSTANCES IN THE ENVIRONMENT**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5 %

2. COURSE DESCRIPTION	
2.1. Course objectives	Acquaintance students with influence effects of hazardous substances which are coming as a result of human activities in environmental on life and health of people. Instruct students for need of applied protections and way for environmental protection from their harmful influences.
2.2. Enrolment requirements and required entry competences for the course	Listened Inorganic Chemistry and Organic chemistry.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply the regulations relevant to environmental protection in the production processes. Predict methods and identify samples for determining the causes of pollution of environmental components. Apply logical conclusion and precision in data processing.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	To define hazardous substances in environment based on their characteristics. To describe effects of hazardous substances on human and environment. To describe intervention in some industrial process in the case of environmental contamination with hazardous substances. To propose content of safety-technical sheet for any hazardous substances. To illustrate appearance of hazardous substances in water from near past of RH and the World.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Definition of hazardous substance (2h) Effect of hazardous substances on human and environment (2h) Toxicity, degradation and bioaccumulation of hazardous substances (2h) Sorts and characteristics of hazardous substances according to category (class) (2h) Packaging, storage, labelling and handling of hazardous substances (2h) Transportation of hazardous substances (2h) Usage of hazardous substances in technological processes (2h) Hazardous substances in water (2h) Most possible cause of accidents with hazardous substances in peaceful and war situations (2h) Indicator of accidents with hazardous substances (2h) Interventions in case of contamination with hazardous substances (2h) Hazardous chemicals (2h) European list EINECS (European Inventory of Existing Commercial Chemical Substances) and CAS number (3h)

	Safety-technical sheet according to HRN ISO 11014-1:1997 (3h) SEMINAR (15): Based on choosing the subject, students will learn about different effects of hazardous substances on human and environment. EXCERCISES (15): Auditory - Analysis of label content on the packaging of hazardous substance (2h) Creating a Safety Data Sheet for hazardous chemical (3h) Simulation of transport labeling for the transport of hazardous substances by road (2h) Simulation of transport labeling for the transport of hazardous substances by rail (2h) Tour of production facilities for loading of hazardous substances - transportation of liquid oxygen and products of the oil industry (6h). SEMINAR (15h): Instructions for the preparation of the seminar (2h) Topics presentation and selection (1h) Creating individual seminar work, supervision and corrections (6) Making PPT of seminar work and preparing for presentation (1h) Presentation of seminar work (5h) TESTS: 1. Test: Hazardous substances in the environment and their sources; Nature as a source of hazardous substances; The occurrence of hazardous substances in the environment as a result of human activity; The status of risk; The classification of hazardous substances; Labeling of hazardous substances; Hazard Communication of label; Mandatory content of label and its setting; Hazard, Hazard warnings and safety. 2. Test: Transport of hazardous substances from the production place to the distribution point and/or use; ADR and placards; Transport of small quantities of hazardous substances and categories for small quantities of hazardous substances; REACH; Conditions for the use of hazardous substances / chemicals; Care and storage of hazardous materials / chemicals; Security - Data Sheet (MSDS). 3. Test: Incident, accident, disasters and catastrophes; Seveso II Directive; Taxpayers Seveso II Directive; The county with the highest Seveso II plant (state some of the plant); The mandatory content of the Safety Seveso II for obligator; Notice of small quantities of dangerous substances in the installation; NATECH disasters and catastrophes; The use of hazardous substances in metallurgical processes.
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work ☒ independent study ☐ multimedia and the internet ☐ laboratory ☒ work with the mentor ☐ (other)
2.7. Comments:	
2.8. Student responsibilities	Students must attend more than 70% of lectures and make seminar.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit						
Class attendance		Research		Practical training		
Experimental work	1	Report				
Essay		Seminar essay	1	(Other--describe)		
Tests	3	Oral exam		(Other—describe)		

value of the course)*:*	Written exam		Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Continuous monitoring through 3 mid tests or written and oral exam.		
2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	T. Sofilić, OPASNE TVARI U OKOLIŠU, skripta, Sveučilište u Zagrebu, Metalurški fakultet, 2013.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija
2.12. Optional literature (at the time of the submission of the study programme proposal)	F. Plavšić, A. Wolf-Čoporda, Z. Lovrić, D. Čepelak, D., Siguran rad s kemikalijama, Zagreb, Hrvatski Zavod za toksikologiju, 2006. V. Glavač, Uvod u globalnu ekologiju, Hrvatska sveučilišna naklada, Zagreb, 2001. Zakon o kemikalijama (NN 18/2013) Pravilnik o uvjetima za obavljanje djelatnosti proizvodnje, stavljanja na tržište i korištenja opasnih kemikalija (NN 99/13, 157/13, 122/14) Pravilnik o načinu vođenja očevidnika o kemikalijama te o načinu i rokovima dostave podataka iz očevidnika (NN 99/13, 157/13) Pravilnik o uvjetima i načinu stjecanja te provjere znanja o zaštiti od opasnih kemikalija (NN 99/13)		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Students survey at the end of the semester. Numerical analysis of tests and exams by scoring task by task at the course level. Survey on the faculty and University level. Analysis predicted by systems for insurance of institution quality.		

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	To define hazardous substances in environment based on their characteristics.	1st colloquium, auditory exercises, seminar, written and oral exam
2	To describe effects of hazardous substances on human and environment.	2nd colloquium, auditory exercises, seminar, written and oral exam
3	To describe intervention in some industrial process in the case of environmental contamination with hazardous substances.	2nd colloquium, auditory exercises, seminar, written and oral exam
4	To propose content of safety-technical sheet for any hazardous substances.	3rd colloquium, auditory exercises, seminar, written and oral exam
5	To illustrate appearance of hazardous substances in water from near past of RH and the World.	3rd colloquium, seminar, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Tamara Holjevac Grgurić, PhD	1.6. Year of study	2
1.2. Name of the course	**AIR POLLUTION AND PROTECTION**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+0+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5 %

2. COURSE DESCRIPTION	
2.1. Course objectives	Acquisition of knowledge about sources of air pollution. To define air characteristics and measurements for achieving aims for protection. To acquaint with legislative connected with organization and protection of environment and quality of air.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Describe the present situation and developmental trends of modern industrial ecology. Recognize the connection of health and ecological risks. Predict methods and identify samples for determining the causes of pollution of environmental components. Apply the regulations relevant to environmental protection in the production processes.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	To define sources of air pollution. To analyze industrial processes from point of possible air pollution sources. To analyze possibilities of toxicological impact of polluted air on human health. To evaluate harmful impact of pollution on environment and to illustrate impact study for defined technical solution. To choose appropriate method of purification of waste gases. To apply legislative about quality and protection of air.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): The structure of the atmosphere, the atmospheric motion and climate. The composition of the air. (2) Types and sources of air pollution. Classification of the sources of pollution. (2) Analysis of industrial processes from point of possible pollution sources. (3) Agriculture, transport and public services as possible sources of air pollution. (2) Emission, imission and transmission of pollution. (2) The influence of air pollution. Occurrence and influence of the smog. (2) Damage of the ozone layer. Test methods for air pollution. (2) Sampling of dust, smoke and smog. Measurement and characterization of air pollution. (2) Determination of aerosols, dust and aero sediments. (1) The procedures and methods of detection of the carcinogenic substances, radiation and ionizing radiation. (2) Technological procedures and processes for lowering emission of harmful substances in the environment. (2) Mechanical methods and physical-chemical methods for purification of waste gases. (2) Gravity separators. Centrifugal separators. Electrostatic separators. Filtration. (2)

	Adsorption. Absorption. Control of nitrogen and sulfur oxides. (2) Air quality monitoring. The legislation on air quality. Air protection. (2) SEMINAR (15)		
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☒ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities	Attendance to lectures min 70 %. Attendance to seminar min 70 %. Written seminar and oral presentation.		

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
Class attendance	1	Research		Practical training		
Experimental work		Report				
Essay		Seminar essay	1	(Other--describe)		
Tests		Oral exam	1	(Other—describe)		
Written exam	1	Project		(Other—describe)		

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Seminar, results of preliminary exams as well as written and oral exams. Written exam could be replaced with successful preliminary exams.		
2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Snježana M. Šerbula, Željko B. Grbavčić, Air Pollution and Protection, Technical faculty in Bor, 2011.	3	
	V. Glavač, Introduction to Global Economy, II. Edition, University Press, Ministry of Environment and Planning, Open University, Zagreb, 2001.	1	
2.12. Optional literature (at the time of the submission of the study programme proposal)	Noel de Nevers, Air Quality, Thad Godish, CRC Press LLC, 2004. K. B. Schnelle, C. A. Brown, Air Pollution Control Technology Handbook, CRC Press LLC, 2000.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Internal student survey. Analysis of attendance to lectures and exercises, results of preliminary exams as well as oral exams. Survey on the faculty and University level. Analysis predicted by systems for insurance of institution quality.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	To define sources of air pollution.	1st colloquium, written and oral exam
2	To analyze industrial processes from point of possible air pollution sources.	1st colloquium, written and oral exam
3	To analyze possibilities of toxicological impact of polluted air on human health.	2nd colloquium, written and oral exam
4	To evaluate harmful impact of pollution on environment and to illustrate impact study for defined technical solution.	2nd and 3rd colloquium, seminar essay, written and oral exam
5	Define suitable protection technique.	3rd colloquium, seminar essay, written and oral exam
6	To apply legislative about quality and protection of air.	3rd colloquium, seminar essay, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Full Prof. Mirko Gojić, PhD Assoc.Prof. Zoran Glavaš, PhD	1.6. Year of study	3
1.2. Name of the course	**METALLURGY OF STEEL**	1.7. Credit value (ECTS)	6
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	45+15+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Get acquainted of students with basic physiscal-chemical fundamentals during steelmaking process. Getting knowledge about reactions at steelmaking process. Get acquainted of students with techological procedures of steelmaking. Getting insight in parameters effect on useful properties finish steel products. Get acquainted of students with mechanism solidification during continuously casting of steel.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Explain the physical-chemical fundaments of phenomena characteristic for the technical profession. Apply thermodynamic laws on production processes. Compare and choose individual technological process. Calculate material and thermal balance of metallurgical processes.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Explain of chemical reactions steelmaking process. Describe of particular raws for steelmaking. Define typies of steel in relation to steelmaking process. Using of material and heat bilance steelmaking for particular procedure of steelmaking process. Explain rafine process steelmaking of steel. Separate of basis of secondary metallurgy and continuous casting of steel. Ilustrate of mechanisms solidifation of steel. Interpretate of errors continuously casted of steel.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (45): Week 1 and 2: Definition of steel (1 hour), Role of steel in national economy (3 hours). Steelmaking and consumation of steel in Republic of Croatia (2 hours) Week 3: Physical-chemical fundaments of steelmaking (kinetics of process, nucleation of new phases and surphace phenomens (3 hours). Week 4: Properties of slag and melted of iron (3 hours). Week 5: Basis of reactions at steelmaking of steel (reaction oxidation of carbon, silicon, manganese, phosphorous and chromium (2 hours). Desulphurization (1 hour). Week 6: Gases and non-metallic inclusions into steel (1 hour). Deoxidation and alloying of steel (2 hours).

	Week 7: Raws and materials for steelmaking (ferroalloys, melters, oxidans, cast powder, refractory materials) (3 hours). Week 8: The first colloquium (parts from 1st to 7th week) (1 hour). History procedures of steelmaking (2 hours). Week 9: Steelmaking in oxigen converter (3 hours). Week 10: Steelmaking in electro-arc furnace (3 hours). Week 11: Steelmaking by premelted procedures (under slag, induction furnace, procedures under beam electrons and plazma etc.) (3 hours). Week 12: Fundamentals of secondary metallurgy (vacuum treatment, ladle-furnace etc.) (3 hours). Week 13: Rafine of stainless steels (AOD and VOD procedures, etc.) (3 hours). Week 14: Steel casting (clasical and continously) (3 hours). Week 15: Mechanisms of steel solidifacition (1 hour). Errors of coltinuously casted products (1 hour). The second colloquium (parts from 8th to 15th week) (1 hour). SEMINAR (15): The selection topics and manufacturing of seminar work in writen form using mentor system (10 hours). Preparing and presentation of seminar work as well as discussion in relation with the topic seminar work (5 hours). EXERCISES (15): Evaluation and preparation of raws (crude melt iron, scarp, ferroalloys and melters) (3 hours). Calculation of mixes (4 hours). Material and heat bilance of oxigen converter and electro-arc furnace (6 hours). Sintetic slags and calculation cast tools for different casting procedures (2 hours)
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work ☐ independent study ☐ multimedia and the internet ☒ laboratory ☒ work with the mentor ☐ (other)
2.7. Comments:	
2.8. Student responsibilities	Students must attend over 70% of lectures and exercises and they are required manufacturing of seminar work in writen form as well as orally presentation of seminar work. Also they required manufacturing of programme work.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*

Class attendance	1	Research		Practical training	
Experimental work		Report			
Essay		Seminar essay	2	(Other--describe)	
Tests	3	Oral exam		(Other—describe)	
Written exam		Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam

- evaluation of students activities in course,
- evaluation of written colloquiums (I. and II. colloquium) during continuously monitoring or final exam (written and oral),
- evaluation of seminar paper,
- manufacturing of seminar and programme work.

2.11. Required literature (available at the library and via other media)

Title	Number of copies at the library	Availability via other media
M. Gojić, Metalurgija čelika, Faculty of Metallurgy University of Zagreb, II. unchanged edition, Sisak, 2006.	15	
V. Grozdanić, A. Markotić, Metalurgija željeza i čelika, book of solved tasks, Faculty of Metallurgy University of Zagreb, Sisak, 2006.	13	

2.12. Optional literature (at the time of the submission of the study programme proposal)	Z. Pašalić, Proizvodnja čelika, Faculty of metallurgy and materials, University of Zenica, Zenica, 2007.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Input and output of students ankets. Survey at the level of faculty and University. Analyses provided in the system of quality assurance of the institution. Analyses provided in the system of quality assurance and an authorized office of the University.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain of chemical reactions steelmaking process.	1st colloquium, written exam, oral exam
2	Describe of particular raws for steelmaking.	1st colloquium, written exam, oral exam
3	Define typies of steel in relation to steelmaking process.	1st colloquium, written exam, oral exam
4	Using of material and heat bilance steelmaking for particular procedure of steelmaking process.	1st colloquium, seminar paper, auditory exercises, written exam, oral exam
5	Explain rafine process steelmaking of steel.	2nd colloquium, written exam, oral exam
6	Separate of basis of secondary metallurgy and continuous casting of steel.	2nd colloquium, written exam, oral exam
7	Ilustrate of mechanisms solidifation of steel.	2nd colloquium, auditory exercises, written exam, oral exam
8	Interpretate of errors continuously casted of steel.	2nd colloquium, written exam, oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Full Prof. Ladislav Lazić, PhD	1.6. Year of study	3
1.2. Name of the course	**HEAT AND MASS TRANSFER**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	Assist.Prof. Martina Lovrenić-Jugović, PhD	1.8. Type of instruction (number of hours L+S+E+e-learning)	45+0+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	40
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5 %

2. COURSE DESCRIPTION	
2.1. Course objectives	1. Acquire knowledge from the basic laws of heat and mass transfer, which are necessarily required for further studies. 2. Acquire the ability to solve problems in engineering practice in which the processes of heat and mass transfer appear. 3. Develop in students a simple and logical way of thinking in the analysis of a technical problem.
2.2. Enrolment requirements and required entry competences for the course	Completed course Engineering Thermodynamics.
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Explain the physical-chemical fundaments of phenomena characteristic for the technical profession. 2. Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. 3. Compare and choose individual technological process. 4. Choose the most convenient form of energy from the perspective of sustainable development. 5. Predict and solve problems in metals' production.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Extracted and explain the thermodynamic quantities essential for heat and mass transfer in real terms. 2. Evaluate and compare the modes of heat transfer in real technological processes. 3. Analyze the phenomena of mass transfer in different modes of flow. 4. Formulate and calculate the diffusion parameters in stationary and non-stationary conditions.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (45): 1. Fluid mechanics: Physical properties of fluids, Laws of conservation of mass, energy and momentum, Fundamental equations (4). 2. Introduction to heat transfer mechanisms, Conduction heat transfer: Temperature field, Temperature gradient, Heat flux, Fourier's law, Thermal conductivity, Differential equations of heat conduction (6). 3. One-dimensional steady-state heat conduction through a plane wall, through a composite wall, through a cylinder wall, Boundary conditions of First Kind, Second Kind and Third Kind, Overall heat transfer coefficient (6). 4. Introduction to convective heat transfer, Free and forced convection (1). 5. Fluid flow, Boundary layers and Heat transfer: Laminar flow in a tube and over a flat plate, Turbulent flow in a tube and over a flat plate, Differential equations, Viscosity and Newton's law of viscosity (6). 6. Theorem of similarity: Terms similarity of physical processes, Simulation of convective heat transfer, Dimensional analysis (4). 1st colloquium 7. Heat transfer associated with phase changes: Condensation and boiling heat transfer (3).

	8. Thermal radiation: Physical mechanism, Radiation properties (Reflectivity, Absorptivity, Transmissivity), Kirchhoff's law, Blackbody radiation, Gray body, Gas radiation (3). 9. Radiation heat transfer: Infinite parallel planes, Radiation shields, Enclosed body, Radiation view factor, Methods of determining view factor, Radiative heat transfer coefficient (3). 10. Mass Transfer: Mass flux, Fick's law of diffusion, Steady-state diffusion in gases and liquids, Unsteady diffusion, Mass diffusivity, Mass transfer in laminar and turbulent flow (9). 2nd colloquium EXERCISES (30): The understanding of the material exposed in lectures is facilitated by solving the practical problems. The examples are selected so that they expand the presented theory and illustrate the application of theory to real problems.

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities	Attendance on Lectures and Exercises > 70 %		

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
Class attendance	0.5	Research		Practical training		
Experimental work		Report				
Essay		Seminar essay		(Other--describe)		
Tests	2.5	Oral exam	2.0	(Other—describe)		
Written exam		Project		(Other—describe)		

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Class attendance – 10% Written exam – 50% Oral exam – 40%

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	A. Galović, Nauka o toplini II, Sveučilište u Zagrebu, 1997.	7	

2.12. Optional literature (at the time of the submission of the study programme proposal)	A. Galović, M. Tadić, B. Halasz, Zbirka zadataka iz nauke o toplini II, Sveučilište u Zagrebu, 1990. M. N. Ozisik, Heat transfer, McGraw-Hill Int. Book Company, 1987.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey at the level of faculty and University. Analyses provided in the system of quality assurance of the institution. Analyses provided in the system of quality assurance and an authorized office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Extracted and explain the thermodynamic quantities essential for heat and mass transfer in real terms.	1st colloquium and oral exam
2	Evaluate and compare the modes of heat transfer in real technological processes.	1st colloquium and oral exam
3	Analyze the phenomena of mass transfer in different modes of flow.	2nd colloquium and oral exam
4	Formulate and calculate the diffusion parameters in stationary and non-stationary conditions.	2nd colloquium and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Zoran Glavaš, PhD	1.6. Year of study	3
1.2. Name of the course	**FUNDAMENTALS OF METAL CASTING**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	45+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	40
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION			
2.1. Course objectives	Introduce students with production processes of metal castings. Introduce students with production processes of expendable moulds and cores. Introduce students with types and properties of the most commonly used casting alloys.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Compare and choose individual technological process. Explain and apply the technology of metals' production, treatment and forming. Identify material properties and technological process parameters and adjust them in order to achieve the desired product quality.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Select patterns, core and mould mixtures for the casting of the metal castings. Analyze the appropriate process of core and mould making. Construct the gating and risering systems. Select the appropriate melting and casting process. Select the appropriate casting alloy. Assess the application properties of castings.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (45): Fundamental terms in the founding. (2); Short history of metal casting. (1); Ferrous casting alloys. (3); Nonferrous casting alloys. (2); The production process of castings and departments in the foundry. (1); Melt production. (3); Gating systems. (3); Feeding system. (3); Analysis and elaboration of the draft of the casting. (2); Overview of the casting production processes. (1); Expendable mould casting processes (patterns, core boxes, green sand moulding, no-bake sand moulding, shell moulding, slurry moulding, no-bond sand moulding, pouring of the melt in expendable moulds, casting cleaning, sand reclamation). (12); Coremaking. (3); Permanent mould casting processes (gravity casting, low-pressure die casting, high-pressure die casting, squeeze casting, semisolid casting). (6); Centrifugal casting. (3). EXCERCISES (15): Calculation of the charge for melting aggregates. (2); Gating design. (3); Riser design. (3); Elaboration of the technological process of making expendable mould. (2); Handmade of green sand mould. (2); Visits to foundries. (3).		
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor	2.7. Comments:

	☐ mixed e-learning ☐ field work		☐ (other)			
2.8. Student responsibilities	Conditions for signature: Students must attend the lectures and exercises (> 70 %).					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	0.5	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	4.5	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Exam of the course: Through continuous monitoring - student needs to pass 2 colloquiums. If the student has passed all colloquiums, the final score is determined as the average score of the colloquiums. Through the final exam: written exam for students who have not passed the exam through continuous monitoring or are not satisfied with the success that are achieved through continuous monitoring or have not decided on this method of examination. Conditions for access to the exam: -					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Z. Glavaš, Osnove lijevanja metala, text of the lectures placed on website of Faculty of Metallurgy, Faculty of Metallurgy, Sisak, 2014.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/3-godina-preddiplomskog-studija/osnove-lijevanja-metala-predavanja/view
	F. Unkić, Z. Glavaš, Osnove lijevanja metala - Zbirka riješenih zadataka, text of the exercises placed on website of Faculty of Metallurgy, Faculty of Metallurgy, Sisak, 2009.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/3-godina-preddiplomskog-studija/Osnove%20lijevanja%20metala_vjezbe.pdf/view

2.12. Optional literature (at the time of the submission of the study programme proposal)	Metals Handbook, Volume 15, Casting, ASM International, Ohio, 2008.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey on the level of faculty and university. Analysis predicted in the quality assurance system of institution. Analysis predicted in the quality assurance system and authorized office of the university.

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	Select patterns, core and mould mixtures for the casting of the metal castings.	2nd colloquium, written exam
2	Analyze the appropriate process of core and mould making.	2nd colloquium, laboratory exercises, written exam
3	Construct the gating and risering systems.	1st colloquium, auditory exercises, written exam
4	Select the appropriate melting and casting process.	2nd colloquium, written exam
5	Select the appropriate casting alloy.	1st colloquium, written exam
6	Assess the application properties of castings.	1st colloquium, written exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Full Prof. Stoja Rešković, PhD	1.6. Year of study	3
1.2. Name of the course	**MATERIALS TESTING**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	Assist.Prof. Ivan Jandrlić, PhD Tin Brlić, mag.ing.met.	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	40
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2.,10 %

2. COURSE DESCRIPTION	
2.1. Course objectives	1. Introduce students the organization of control in metallurgical practice. 2. Introduce students to the principles of methods for sampling and testing of metal materials. 3. Introduce students to the principles, techniques, equipment for mechanical and non-destructive testing. 4. The acquired knowledge will enable the ability to choose relevant methods to determine the quality of products.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Use the skills and knowledge of qualitative and quantitative analysis. 2. Apply norms in the technical profession. 3. Identify material properties and technological process parameters and adjust them in order to achieve the desired product quality.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Analyze and evaluate metallic materials before, during and after their use. 2. Choose the method of testing for the specific case. 3. Prepare the samples for testing. 4. Compare the results of static and dynamic tests. 5. Determine the area of the elastic and plastic deformation. 6. Select a specific standard for materials testing.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30) AND EXERCISES (30): 1. Introduction. 1 2. The standards in materials testing. Types of international and Croatian norms. 1 3. Organization of control in metallurgical practice. Sampling. 2 4. Review of testing methods. Physical and physic-chemical properties of materials on which the instrumental methods of analysis are based. 2. 5. Mechanical testing. Short-term tests. Static tensile testing. 4 Exercise 1: Static tensile testing. 6 Exercise 2: Determination of modulus of elasticity. 2 6. Long static tests. Creep testing. 2 **I Colloquium, chapters 1-6** 7. Dynamic testing. Material toughness. 2

	Exercise 3: Determination of impact energy at room temperature and low temperatures. 6 8. Material fatigue. 1. 9. Fracture mechanics. 1 10. The hardness of materials. Brinell hardness testing method. Vickers hardness testing method. Rockwell hardness testing method. Overview of other methods for hardness testing. 4 Exercise 4. Vickers hardness test. Comparison of the results with the results at Brinell and Rockwell. 4 11. Technological testing methods. 2 Exercise 5. Technological testings. 2 **II Colloquium, chapters 7-11** 12. Non-destructive testingS. Defects in metal materials. 2 13. Optical testings. Radiographic examinations. 2 Exercise 6. Non-destructive testing: optical (endoscopic). 2 14. Ultrasound testings. 2 Exercise 7. Ultrasound testings. 4 15. Magnetic testings. Dye penetration testing. 2 Exercise 8. Magnetic and penetration testings. 4 **III Colloquium, chapters 12 – 15**

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☒ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:

2.8. Student responsibilities	Attendance at lectures 70%, individual work on all exercises and preparation and submission of reports from field of colloquium before writing the colloquium or the written exam.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course):	Class attendance		Research		Practical training	
	Experimental work	1.0	Report	0.5		
	Essay		Seminar essay		(Other--describe)	
	Tests	2.5	Oral exam	1.0	(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	During the classes are evaluated the presence and activity of students on classes. Score of independent work during performing exercises Score on written colloquium trough continuous monitoring (or written exam) and oral exam. Score of seminar paper.					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	S. Rešković, Ispitivanje materijala, Sveučilište u Zagrebu, Metalurški fakultet, Sisak, 2009.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/2-godina-preddiplomskog/web1.pdf/view
	S. Rešković, Ispitivanje materijala, interna	5	

	skripta, Sveučilište u Zagrebu, Metalurški fakultet, Sisak 2010.		
2.12. Optional literature (at the time of the submission of the study programme proposal)	M. Franz, Mehanička svojstva materijala, FSB, Zagreb, 1998. I. Vitez, Ispitivanje mehaničkih svojstava metalnih materijala, Sveučilište J. J. Strossmayer u Osijeku, Strojarski fakultet u Slavonskom Brodu, Slavonski Brod, 2006.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey on the level of faculty and University. Analyses provided by quality assurance system of the institution. Analyses provided by quality assurance system and authorized office of the University		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Analyse and evaluate metallic materials before, during and after their use.	1st colloquium, written and oral exam
2	Choose the method of testing for the specific case.	2nd and 3rd colloquium, written and oral exam, independent task
3	Prepare the samples for testing.	laboratory exercises, oral exam
4	Compare the results of static and dynamic tests.	2nd colloquium, written and oral exam, independent task
5	Determine the area of the elastic and plastic deformation.	1st colloquium, laboratory exercises, written and oral exam
6	Select a specific standard for materials testing.	laboratory exercises, oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Full Prof. Ankica Rađenović, PhD	1.6. Year of study	3
1.2. Name of the course	**REFRACTORY AND CARBON MATERIALS**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION			
2.1. Course objectives	Introduce a types, properties and significance of refractory and carbon materials in metallurgy. Predict the behaviour of refractory materials under conditions of the use. Understand the status and trends of carbon materials development and the extension of traditional carbon materials applying.		
2.2. Enrolment requirements and required entry competences for the course			
2.3. Learning outcomes at the level of the study programme to which the course contributes	Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. Compare and choose individual technological process. Describe the material production, select their types and explain their properties for a specific area of application		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	To propose a key elements for the production of refractory materials and carbon starting from raw materials. Distinguish the relevant elements for the evaluation of the characteristic properties of refractory materials. Select methods of refractory and carbon materials characterization. Recommend appropriate refractory material with respect to quality and price, to apply in the concrete conditions. To compare the properties of traditional and contemporary carbon materials.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Definition and classification of refractory materials (r.m.); raw materials (2); Phases of r. m. production process (2); Acid r. m. (4); Basic r. m. (4); Neutral r. m. (2); Special and unshaped refractories (2); Theory of carbonization, calcination and graphitization (2); Mineral coal, activated coal, carbon black (2); Metallurgical, petroleum and pitch coke (2); Graphites (2); Carbon fibers (2); C-C composites (2); Aplication of carbon materials out of metallurgy area (2). EXERCISES (15): Real and apparent density and porosity (2); Structural characteristics of carbon and refractory materials (2); Refractoriness (1); Thermal properties of r. m. (2); Corrosion of r. m. (2); Determination of quinoline insoluble substance in coal tar pitch; Carbonization of pitch (2); Calcination and graphitization of coke (4). SEMINAR (15): Preparation and presentation of seminar paper on a given theme.		
2.6. Type of instruction	☒ lectures	☐ independent study	2.7. Comments:

	☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)			
2.8. Student responsibilities	Conditions for signature: exercises in Refractory and Carbon Materials.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course):	Class attendance		Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	1	(Other--describe)	
	Tests	1	Oral exam	1	(Other—describe)	
	Written exam	2	Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Continuous monitoring through three colloquiums or written and oral exam.					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	A. Rađenović, Vatrostalni materijali, Sveučilište u Zagrebu, Metalurški fakultet, Sisak, 2010. (ISBN 078-953 7082-10-9)	10	
	M. Legin-Kolar, A. Rađenović, Ugljični materijali, Sveučilište u Zagrebu, Metalurški fakultet, Sisak, 2002. (ISBN 953-97821-5-5)	9	
	A. Rađenović, Vježbe iz Proizvodnje ugljičnih materijala, Metalurški fakultet, Sisak, 2005.		20

2.12. Optional literature (at the time of the submission of the study programme proposal)	A. Kelly, Composite Materials, Pergamon Press, Cambridge, 1994. P. J. F. Harris, Carbon Nanotubes and Related Structures, Cambridge University Press, Cambridge, 2001. C. A. Schacht (Ed.), Refractories Handbook, Marcel Dekker, New York, 2004.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Analysis of the preliminary exams, exercises and exams at the level of the course. Surveys at the level of the faculty and University. Analyzes planned by a system of institutions quality assurance. Analyzes provided by certified offices of the University quality assurance system.

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	To proposea key elements for the production of refractory materials and carbon starting raw materials.	Written exam, oral exam, seminar paper
2	Distinguish the relevant elements for the evaluation of the characteristic properties of refractory materials.	1st colloquium, auditory exercises, oral exam
3	Select methods of refractory and carbon materials characterization.	2nd colloquium, auditory exercises, written exam
4	Recommend appropriate refractory material with respect to quality and price, to apply in the concrete conditions.	Oral exam, seminar paper
5	To compare the properties of traditional and contemporary carbon materials.	Oral exam, seminar paper

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Full Prof. Ankica Rađenović, PhD	1.6. Year of study	3
1.2. Name of the course	**FUELS AND COMBUSTION**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	40
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION			
2.1. Course objectives	Course objectives are to know the types and characteristics of fuels, especially in the field of metallurgy, then basics of fuel combustion processes including calculation of fuel combustion, and apply the acquired knowledge into the practice.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. Describe the material production, select their types and explain their properties for a specific area of application.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Define the basic concepts related to fuels and their combustion Select the proper fuel and optimum conditions of combustion that contribute to the economy control of technological processes. Connect the fuel with the risks of environmental pollution. Predict the greatest risk from fuel combustion for the environment and propose measures for its protection.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Definition and classification of fuels (2); deposits, reserves, consumption in the world and in our (2); Significance of fuel in an industrial processes (2); Significance of fuel in metallurgical processes (2); Transformation of coal to other energy types (2); Transformation of oil to other energy types (2); Gaseous plasmas (2); Complete and incomplete combustion of fuel, general principles (2); Combustion calculations of fuels (4); Kinetics of combustion processes: homogeneous system (3); Kinetics of combustion processes: heterogeneous system (3); Combustion process as contamination source of air, soil and water (2); Posibility to reduce of harmfull product emission of fuel combustion (2). EXERCISES (15): Composition of fuels (2); Complete fuel combustion (2); Incomplete fuel combustion (2); Fuel heating value, Mollier characteristic (2); Ignition limit and explosive limit; Wobbe number (2); Numerical examples from practice (5).		
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:

2.8. Student responsibilities	The condition for taking the exam: completed exercises					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course):	Class attendance		Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	1	Oral exam	1	(Other—describe)	
	Written exam	2	Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Continuous monitoring through three colloquiums or written and oral exam.					

	Title	Number of copies at the library	Availability via other media
2.11. Required literature (available at the library and via other media)	M. Kundak, A. Rađenović, Goriva i izgaranje, Sveučilište u Zagrebu, Metalurški fakultet, Sisak, 2003. (ISBN 953-97821-8-X)	11	
	B. Udovičić, Energetika, Školska knjiga, Zagreb, 1993.	3	
	D. Krpan-Lisica, Osnove energetike, Hinus, Zagreb, 2001.	1	
2.12. Optional literature (at the time of the submission of the study programme proposal)	S. R. Turns, An Introduction to Combustion, Mc Graw Hill, Boston, 2000. F. El- Mahallawy, S.E.-Din Habrik, Fundamentals and Technology of Combustion, Elsevier, Boston, 2002. S. McAllister, J. Y. Chen, C. Fernandez-Pello, Fundamentals of Combustion Processes, Springer, New York, 2011.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Analysis of the preliminary exams, exercises and exams at the level of the course. Surveys at the level of the faculty and University. Analyzes planned by a system of institutions quality assurance. Analyzes provided by certified offices of the University quality assurance system.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Define the basic concepts related to fuels and their combustion.	1st colloquium, auditory exercises, written exam, oral exam
2	Select the proper fuel and optimum conditions of combustion that contribute to the economy control of technological processes.	2nd colloquium, auditory exercises, oral exam
3	Connect the fuel with the risks of environmental pollution.	Written exam, oral exam
4	Predict the greatest risk from fuel combustion for the environment and its protection.	Written exam, oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Stjepan Kožuh, PhD Full Prof. Mirko Gojić, PhD	1.6. Year of study	3
1.2. Name of the course	**INTRODUCTION TO ENTREPRENEURSHIP**	1.7. Credit value (ECTS)	3
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+0+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	40
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	To introduce the basic concepts of entrepreneurship. The ability to simplify the analysis of business. Get to know elements of business and develop the ability to solve examples of typical problems within the company.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply teamwork-oriented, ethical principles and encourage the development of communication and social skills. Explain the present situation and define developmental trends of metallurgy as a profession and its impact on the entire economy.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Define the basic elements for the formation and organization of companies. Express the results of operations of enterprises Describe the basic elements of entrepreneurship in selected successful and developed countries Explain the basic legal forms of entrepreneurship
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Week 1: Definitions. Profile of entrepreneurs. Business-development phases (2) Week 2: The characteristics of successful entrepreneurs. Advantages and disadvantages of entering into entrepreneurship. The economic influence of the company. External influences on entrepreneurship. (2) Week 3 and 4: The entrepreneurial venture. The entrepreneurial process. The company, the company management. Start-up company. (4) Week 5: Fundamentals of corporate financing. The financial system (financial markets, financial instruments, financial institutions). (2) Week 6: The cost and calculations. The criteria of business efficiency. (2) Weeks 7 and 8: Business results of companies (income and expenses, profit and loss account, indicators of financial stability, the structure of product prices, profitability, reproducibility). (4) Week 9: Balance. Financial reports. (2) Week 10: Legal form of business organization (strengths and weaknesses). (2) Week 11: Small Business. Innovation and entrepreneurship. Family business. (2) Weeks 12 and 13: Entrepreneurs project (business plan) – term of business plan, the contents of the business plan, methodology and components (4) Week 14: Fundamentals of the tax system (2)

	Week 15: Introduction to entrepreneurship in the EU countries (2) SEMINAR (15): The selection of topics and seminar work in writing form by a mentor system (10 hours). Preparation and presentation of the seminar and discussions in relation to the topic of the present paper (5 hours).					
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ independent study ☐ multimedia and the internet ☐ laboratory ☒ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities	Students must attend over 70% of lectures and are required to complete a seminar in writing form and orally present.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course):	Class attendance	0.3	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	0.5	(Other--describe)	
	Tests	2.2	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	- evaluation of students activities on classes, - evaluation of written examination (two colloquiums) through continuous monitoring or final examination (written and oral), - evaluation of seminar paper and presentation.					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	S. Dvorski, F. Ruža, V. Kovšca, Poslovna ekonomija, TIVA, Varaždin, 2007.	4	
	I. Vajić, Management i poduzetništvo, Centar za poduzetništvo, Zagreb, 1994.	2	
	F. Ruža, V. Veselica, Ekonomika poduzeća, Varaždin, 2002.	3	

2.12. Optional literature (at the time of the submission of the study programme proposal)	P. Skavica, M. Novak, Poslovna organizacija, Informator, Zagreb, 1999. V. Žanić, Vodić za poduzetnike, Ministarstvo gospodarstva RH, Zagreb, 1999. V. Brkanić i sur., Računovodstvo poduzetnika, Zagreb, 2008.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Questionnaire at Faculty and University. Surveys at the level of the faculty and University. Analyzes planned by a system of institutions quality assurance. Analyzes provided by certified offices of the University quality assurance system.

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	Define the basic elements for the formation and organization of company.	1st colloquium, written and oral exam
2	Express the results of operations of enterprise.	1st colloquium, seminar paper, written and oral exam
3	Describe the basic elements of enterpreneurship in selected sucessful and developed countries.	2nd colloquium, written and oral exam
4	Explain the basic legal forms of entrepreneurship.	2nd colloquium, seminar paper, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assist.Prof. Tahir Sofilić, PhD Assoc.Prof. Ivan Brnardić, PhD	1.6. Year of study	3
1.2. Name of the course	**SUSTAINABLE WASTE MANAGEMENT**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%
2. COURSE DESCRIPTION			
2.1. Course objectives	Acquaintance students with national strategy of waste management for regulation of management different sorts of waste on territory of RH, from its occurrence, possibilities of recovery until the final disposal with the basic aim for creation and maintenance of whole waste management system.		
2.2. Enrolment requirements and required entry competences for the course	Listened Inorganic Chemistry, Organic chemistry and Hazardous Substances In The Environment.		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Predict solutions for efficient waste management. Recognize the connection of health and ecological risks. Apply the regulations relevant to environmental protection in the production processes.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	To define terms related to waste To classify types of waste by properties To classify types of waste by originate. To describe effects of waste on environment. To enumerate actions for avoiding and reducing of waste and reducing its dangerous properties. To enumerate ways for waste treatment. To explain difference between recycling and recovery.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction, history of waste, definitions of terms related to waste, waste management history, 2h; A waste today, waste database on a global level, the EU and national regulatory framework, 2h; The categories of waste, special waste categories and related regulations for the management of each separate waste category, 2h; Waste / by-product, status of waste - not waste, definition of by-products, waste catalog, classification and labeling of waste, 2h; Waste Management, Waste Management Strategy of the Republic Croatia, the priority ranking of waste management, 2h; Recycling of waste, recovery procedures, examples of recycling of waste generated in metallurgical processes, 2h; Management of special waste categories, definitions, keeping records and reporting, 1h; Waste disposal, biological treatment methods, mechanical-biological treatment methods, thermal treatment methods, conditioning disposal, 3h; Import-export, cross-border transport of waste, Regulation 1013/2006 / EC, the general requirements, notification procedure,		

	supporting documents, 2h; Waste management information system, the obligation to keep the registration data on waste management, forms ONTO, ONTO, PL-A, PL-SPO, ... EPR, GOPO Plan, Plan GOOO .. 2h; Fees in the field of waste management, 2h; Waste management centers, schedule and construction of WMC, waste characterization, sampling and analysis, the criteria for the disposal of waste, landfills, 2h; The management of industrial waste in the Republic Croatia, annual reports, 2h; Slag-waste or by-product from the steel production by electric arc process, 2h; Electric arc furnace dust-waste or by-product from the steel production by electric arc process, 2h. SEMINAR (15): Instructions for the preparation of the seminar (2h) Topics presentation and selection (1h) Creating individual seminar work, supervision and corrections (6) Making PPT of seminar work and preparing for presentation (1h) Presentation of seminar work (5h) EXCERSISES (15): Auditory Exercises - 10 h Field exercises - visit landfill industrial waste and industrial waste landfills (5h) TESTS: 1. Test: The definition of waste; The classification of waste; The definition of hazardous waste; The properties that make waste hazardous; Sorting of waste by the place of origin; Industrial waste; Special categories of waste; Packaging waste; Waste oils and lubricants; The difference between waste and by-products; When waste ceases to be waste; Waste Catalogue; The key number of waste; Determination of waste key number. 2. Test: Waste Management; The objectives of the RH Waste Management Strategy; The basic principles of waste management; Participants in waste management; Priority order (hierarchy) in waste management; Treatment of industrial waste at source; "Following list"; "Declaration on the physical and chemical properties of waste"; Waste recovery procedures; The register of the waste flow; ROO; Characterization of waste. 3. Test: The waste from the process of pig iron production; The importance and use of BF slag; Wastes / by-products from the steel production EAF process; The most important by-product of steel production EAF process and its main features; The use of electric furnace slag in other industries; Electric furnace slag as hazardous waste; Electric arc furnace dust; Disposal of electric arc furnace dust in the steel mill; Disposal of electric arc furnace dust in other industries; Production wastes from the casting industry.	
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning	☒ independent study ☐ multimedia and the internet ☐ laboratory ☒ work with the mentor ☐ (other)	2.7. Comments:

	☐ field work					
2.8. Student responsibilities	Students must attend more than 70% of lectures and make seminar.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)	Class attendance		Research		Practical training	
	Experimental work	1	Report			
	Essay		Seminar essay	1	(Other--describe)	
	Tests	2	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Continuous monitoring through 3 mid tests or written and oral exam.					

	Title	Number of copies at the library	Availability via other media
2.11. Required literature (available at the library and via other media)	T. Sofilić, ODRŽIVO GOSPODARENJE OTPADOM, skripta, Sveučilište u Zagrebu, Metalurški fakultet, 2015.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija
2.12. Optional literature (at the time of the submission of the study programme proposal)	T. Sofilić, Priručnik za polaznike „IZOBRAZBE O GOSPODARENJU OTPADOM“, Metroalfa d.o.o., Zagreb 2015. S. Ramachandra Rao, Resource recovery and recycling from metallurgical wastes, Elsevier, Oxford, UK, 2006. Zakon o održivom gospodarenju otpadom (NN br. 94/13) Strategija gospodarenja otpadom Republike Hrvatske (NN br. 130/05) Pravilnik o gospodarenju otpadom (NN br. 23/14, 51/14, 121/15, 132/15) Pravilnik o katalogu otpada (NN br. 90/15)		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Students survey at the end of the semester. Numerical analysis of tests and exams by scoring task by task at the course level. Survey on the faculty and University level. Analysis predicted by systems for insurance of institution quality.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	To define terms related to waste	1st colloquium, seminar, field exercises, written and oral exam
2	To classify types of waste by properties	1st colloquium, seminar, field exercises, written and oral exam
3	To classify types of waste by originate	1st colloquium, seminar, field exercises, written and oral exam
4	To describe effects of waste on environment	1st colloquium, seminar, field exercises, written and oral exam
5	To enumerate actions for avoiding and reducing of waste and reducing its dangerous properties	2nd colloquium, seminar, field exercises, written and oral exam
6	To enumerate ways for waste treatment	2nd colloquium, seminar, field exercises, written and oral exam
7	To explain difference between recycling and recovery	2nd colloquium, seminar, field exercises, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Tamara Holjevac Grgurić, PhD	1.6. Year of study	3
1.2. Name of the course	**INDUSTRIAL PROCESSES AND ENVIRONMENT**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+0+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Adoption of basic knowledge required for understanding of industrial processes and their impact on the environment. Defining influences of oil-petrochemical industry on the environment and the introduction to protection possibilities. Adoption of knowledge of the influence of mineral industry on the environment. Introduction to Best Available Techniques (BAT) for different industrial processes. Acquirement of knowledge about new technological solutions and processes in accordance with sustainable development.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Describe the present situation and developmental trends of modern industrial ecology. Compare and choose the best available techniques (BAT) in environmental protection of the metallurgical processes and other industries. Apply the regulations relevant to environmental protection in the production processes.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Identify technological processes as sources of environmental pollution. Choosing the best technology solutions from the standpoint of environmental protection in various industries. Correlate and apply adopted basic engineering knowledge of the reaction mechanism and kinetics of the oil-petrochemical industry and technological processes in the mineral industry. Define the sources of pollution and the impact of the oil-petrochemical industry, minerals and power plants on the environment. Choosing the best available techniques in the corresponding technological process. Apply an integrated approach to environmental protection in the oil refining industry, the organic chemical industry, mineral and energy industry.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Power plants, oil refining and petrochemical industry, pharmaceutical industry, plastic industry, cement industry, ceramic industry - sources of environmental pollution. (2) Legislation and reference documents. (2) Oil and petrochemical processes - technological, economic, environmental, social and geopolitical effects. (2) Global trends and incentives to reduce the environmental impacts. (2) Drilling, extraction and transportation of oil. The types and properties of basic products of oil refining. (2) The processes of separation, cracking, reforming, isomerization and alkylation. (6) 1.preliminary exam.

	Emissions to air, soil and water of individual treatment processes of crude oil. (4) Products of the petrochemical industry and environmental emissions. BAT techniques. (3) The impact of thermal and hydroelectric power plants on the environment. (4) The cement industry and the environment. BAT techniques. (3) 2.preliminary exam. SEMINAR (15): Seminar on the theme. Oral presentation of the seminar.

2.6. Type of instruction			2.7. Comments:
	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☒ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☒ laboratory ☐ work with the mentor ☐ (other)	

2.8. Student responsibilities	Attendance to lectures min 70 %. Attendance to seminar min 70 %. Written seminar and oral presentation.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)						
	Class attendance	1	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	1	(Other--describe)	
	Tests		Oral exam	1	(Other—describe)	
	Written exam	1	Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Seminar, results of preliminary exams as well as written and oral exams. Written exam could be replaced with successful preliminary exams.

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Z. Janović, Oil and Petrochemical processes and products, ZDMG, Zagreb, 2004.	6	
	Reference documents		http://eippcb.jrc.ec.europa.eu/reference/

2.12. Optional literature (at the time of the submission of the study programme proposal)	A. Chauvel, G. Lefebvre, PETROCHEMICAL PROCESSES – TECHNICAL AND ECONOMIC CHARACTERISTICS, Editions Technips, Paris, 1989.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Internal student survey. Analysis of attendance to lectures and exercises, results of preliminary exams as well as oral exams. Student survey of University of Zagreb. Analysis of course`s results according to Rules of quality assurance at Faculty of Metallurgy.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Identify technological processes as sources of environmental pollution.	1st colloquium, written and oral exam
2	Choosing the best technology solutions from the standpoint of environmental protection in various industries.	1st and 2nd colloquium, written and oral exam
3	Correlate and apply adopted basic engineering knowledge of the reaction mechanism and kinetics of the oil-petrochemical industry and technological processes in the mineral industry.	1st and 2nd colloquium, written and oral exam, seminar
4	Define the sources of pollution and the impact of the oil-petrochemical industry, minerals and power plants on the environment.	1st and 2nd colloquium, written and oral exam, seminar
5	Choosing the best available techniques in the corresponding technological process.	2nd colloquium, written and oral exam, seminar
6	Apply an integrated approach to environmental protection in the oil refining industry, the organic chemical industry, mineral and energy industry.	1st and 2nd colloquium, written and oral exam, seminar

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Full Prof. Stoja Rešković, PhD	1.6. Year of study	3
1.2. Name of the course	**METAL FORMING TECHNOLOGIES**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	Assist.Prof. Ivan Jandrlić, PhD	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+30+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	40
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	2., 10%

2. COURSE DESCRIPTION	
2.1. Course objectives	1. Introduce students with the basics procedures of shaping materials by forming processes. 2. Introduce students with the main applied technologies of shaping materials by deformation, and with their advantages and disadvantages. 3. The acquired knowledge will provide insight into the development and understanding of new procedures applied for metal forming.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Explain and apply the technology of metals' production, treatment and forming. 2. Predict and solve problems in metals' production. 3. Describe and explain the modern technologies in the metallurgical practice.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Define and evaluate the specific procedures of forming process. 2. Evaluate and compare the different stages of the process and their influence on quality of products. 3. Compare and evaluate the process of rolling profiles, sheets, strips and pipes. 4. Develop a project or task for improvement and optimization of the technological process and the solution of the problem in the process.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	1. Introduction. 2 2. Review of methods for shaping metals by deformation. 2 3. Preparation of metal for deformation process. Defects at casting and deforming. Finding and removing of defects. 2 4. Heating and errors during heating. 4 5. I Seminar 3 I Colloquium, chapters 1- 4 6. Forging and pressing. Free forging and pressing. Forging and pressing in dies. 4 7. Auditory exercises. Calculation of free forging. 6 8. Auditory exercises. Calculation of forging in dies. 6 9. II Seminar 6 10. Extrusion pressing. Pressing with flow forming. Drawing. 2 11. Auditory exercises. Calculation of wire drawing. 3 12. Deep drawing. Bending. 2 13. Auditory exercises. Calculation of manufacturing of container by deep-drawing. 3

	II Colloquium, chapters 6- 13 14. Rolling. Elements of the deformation zone. Rolling lines, rolling mills and fittings. 4 15. The basic features of sheet and strip rolling. Profile rolling. Rolling of tubes. 4 16. III Seminar 6 17. Auditory exercises. Calculation of rolling flat profile. 6 18. Auditory exercises. Calculation of cold rolling sheet. 4 19. Modern procedures of metal forming. 2 20. High-power methods of shaping. Flexible manufacturing systems and CIM (Computer Integrated Manufacturing) in plastic processing. 1 21. Technical and economic indicators of the process of shaping by deformation. 1 22. Exercise: A tour of industrial rolling factories. 2 III Colloquium, chapters 14-21

2.6. Type of instruction			2.7. Comments:
	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☒ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	

2.8. Student responsibilities	Attendance at lectures 70%, individual work on all exercises and preparation and submission of reports from field of colloquium before writing the colloquium or the written exam.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)						
	Class attendance		Research		Practical training	
	Experimental work		Report	0.5		
	Essay		Seminar essay	1.0	(Other--describe)	
	Tests	2.5	Oral exam	1.0	(Other—describe)	
	Written exam		Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	During the course it is evaluated the presence and activity of students in class. Score of written colloquium through continuous monitoring (or final written exam) and oral exam. Score of seminar paper.

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	S. Rešković, Tehnologije oblikovanja deformiranjem, nastavna građa, Sisak 2011.	10	
	I. Mamuzić, V. M. Drujan, Teorija, materijali, tehnologija čeličnih cijevi, Hrvatsko metalurško društvo, Zagreb, 1996.	34	
	S. Rešković, Teorija oblikovanja deformiranjem, Sveučilište u Zagrebu, Metalurški fakultet, Sisak, 2014, peer reviewed lessons		https://www.simet.unizg.hr/nastava/predavanja/diplomski-sveucilisni-studij-metalurgija/1-godina-diplomskog studija/S%20Reskovic%20TEORIJA%20OBLIKOVANJA%20DEFORMIRANJEM.pdf/view

2.12. Optional literature (at the time of	M. Čaušević, Obrada metala deformiranjem, Veselin Masleša, Sarajevo, 1983.

the submission of the study programme proposal)	M. Math, Uvod u tehnologiju oblikovanja deformiranjem, Sveučilište u Zagrebu, FSB, Zagreb, 1999.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Input and output of students ankets. Numerical analysis of tests and exams by scoring task by task at the course level. Survey at the level of faculty and University. Analyses provided in the system of quality assurance of the institution. Analyses provided in the system of quality assurance and an authorized office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Define and evaluate the specific procedures of forming process.	1st colloquium, auditory exercises, independent task, written and oral exam
2	Evaluate and compare the different stages of the process and their influence on quality of products.	2nd colloquium, project task, written and oral exam
3	Compare and evaluate the process of rolling profiles, sheets, strips and pipes.	3rd colloquium, auditory exercises, independent task, written and oral exam
4	Develop a project or task for improvement and optimization of the technological process and the solution of the problem in the process.	independent task, project task

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Zdenka Zovko Brodarac, PhD	1.6. Year of study	3
1.2. Name of the course	**FUNDAMENTALS OF METAL SOLIDIFICATION**	1.7. Credit value (ECTS)	5
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Introduction to fundamentals of metals and alloys solidification. Introduction to the fundamentals of the melt metallurgical treatment. Introduction to the influence of the solidification conditions and applied metallurgical treatment on the properties development.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Explain the physical-chemical fundaments of phenomena characteristic for the technical profession. Describe the material production, select their types and explain their properties for a specific area of application. Identify material properties and technological process parameters and adjust them in order to achieve the desired product quality.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Explain the physical-chemical phenomena occurring during metals and alloys solidification process. Explain the structural zones occurred during solidification of metals. Compare and explain the metallurgical treatment of the melt. Compare and explain the influence of solidification conditions on development of castings microstructure and properties. Connect the conditions of solidification and melt metallurgical treatment with technological processes.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction to the subject curriculum and scheduling maintenance Colloquium. (1) Definition of liquid and solid states. Transitions between aggregate states and the corresponding thermodynamic interpretation. (4) The development of the structural zone occurred during solidification of metals. (4) Influence of the alloying elements of the microstructure development of iron and aluminum alloys. Connection with phase diagram. (5) Influence of cooling and solidification of the microstructure development. (3) Nucleation. (4) Metallurgical treatment of melt by inoculation and modification. (6) Connection of solidification parameters with applied technological processes. (3) SEMINAR (15): The study of relevant scientific and technical literature (10). The state of the art from scientific and professional articles presentation (5)

	EXERCISES (15): Field work: Visit to the relevant economic operators in the field of casting.					
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☒ field work		☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities	Attending the classes >70%. Seminar essay and presentation.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	1	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	2	(Other--describe)	
	Tests	2	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Seminar and presentation. Two tests through continuous monitoring or final examination (written and oral).					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Metals Handbook, Volume 15, CASTING, ASM International, Metals Park, Ohio, 1988.	1	
	W. Kurz, D. J. Fisher, Fundamentals of solidification, Trans Tech Publications LTD, Aedermannsdorf, 1986.	1	
	K. E. Easterling, Phase transformations in metals and alloys, Chapman & Hall, London, 1992.	1	

2.12. Optional literature (at the time of the submission of the study programme proposal)	D. M. Stefanescu, Science and engineering of casting solidification, Kluwer Academic /Plenum Publishers, New York, 2002. T. Nishizawa, Thermodynamics of microstructures, ASM International, Materials Park, Ohio, 2008. J. Campbell, Castings, Butterworth Heinemann, Oxford, 1991.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey at the Faculty and University level. Analysis provided the quality assurance system of the institution. Analysis provided the quality assurance system and authorized Office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain the physical-chemical phenomena occurring during metals and alloys solidification process.	1st colloquium, auditory exercises, written and oral exam
2	Explain the structural zones occurred during solidification of metals.	1st colloquium, auditory exercises, written and oral exam
3	Compare and explain the metallurgical treatment of the melt.	1st colloquium, auditory exercises, written and oral exam
4	Compare and explain the influence of solidification conditions on development of castings microstructure and properties.	2nd colloquium, seminar paper, written and oral exam
5	Connect the conditions of solidification and melt metallurgical treatment with technological processes.	2nd colloquium, seminar paper, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Tamara Holjevac Grgurić, PhD	1.6. Year of study	3
1.2. Name of the course	**THERMODYNAMICS OF MATERIALS**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%
2. COURSE DESCRIPTION			
2.1. Course objectives	Implement the basic thermodynamic laws and thermodynamic parameters essentials for understanding of physical and chemical processes in materials, as well as the technology of material preparation. Adopt basics of chemical and phase equilibrium in materials. Adopt models for thermodynamic prediction. Introducing with methods for thermodynamic modelling and experimental techniques for phase transition determination.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply thermodynamic laws on production processes. Identify processes and connect obtained results with theoretical models. Predict and solve problems in metals' production. Create simple computer applications and use them within existing in metallurgical processes.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Implement the basic thermodynamic laws and thermodynamic parameters essentials for understanding of physical and chemical processes in materials, as well as the technology of material preparation. Understand principles of chemical and physical equilibrium. Introduce to thermodynamic predictions by symmetric and asymmetric models. Use CALPHAD method and Thermo-Calc software for prediction of stable phases in multicomponent alloys. Choose adequate experimental technique for determination of thermodynamic parameters and temperatures of phase transitions.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction to thermodynamics of materials. Thermodynamic systems, extensive and intensive properties, phase parameters. Thermodynamic laws. (2) Specific heat capacity. Enthalpy of phase transformations. Reaction heat as a function of temperature. Entropy of reversible processes. Entropy of melting, evaporation and polymorphism in materials (2) The thermodynamic potentials. Maxwell`s relations. Gibbs-Helmholtz equation. (2) Thermodynamics of closed systems as a function of composition. Equilibrium conditions. Phase equilibrium in a one-component system. (2) Thermodynamics of mixtures. Ideal solutions. Real solutions. Thermodynamic activity. Fugacity. Gibbs-Duhem equation for binary and ternary systems. Alpha function. (2) Partial molar functions. Regular solutions. Standard state in ideal solution. Richards-Ellingham diagrams. Chemical equilibrium.		

	(2) 1.preliminary exam. Predicting of thermodynamic properties for binary, ternary and multicomponent metal systems. Symmetric and asymmetric models (Toop, Muggian, Kohler, Chou, etc.). (2) Thermodynamics and phase diagrams. Equilibrium in heterogeneous systems (Gibbs free energy, chemical potential, activity). Thermodynamics of binary systems. Phase diagrams - application of thermodynamic parameters. (2) Gibbs free energy as a function of composition. Ternary systems. Isomorph systems. Equilibrium in ternary systems. Solidification of ternary alloys. Phase diagram prediction. (2) CALPHAD method. Software packages Thermo-Calc and PANDAT. (2) GSM, sublattice models, ionic models, order-disorder models. (2) Magnetic transformations. Thermodynamics of electrochemical reactions. Pourbaix diagrams. Enthalpy and entropy change. (2) 2.preliminary exam. Reaction kinetics. Energy of activation and rate of homogeneous and heterogeneous reactions. Thermodynamics of diffusion processes. Thermodynamics of interfaces. (2) Experimental techniques for determination of thermodynamic parameters. Determination of p-V-T properties of materials (GNOMIX). Determination of temperatures and enthalpies of phase transitions in alloys. Calorimetry. Micro-calorimetry. (2) Oelsen calorimetry. Differential thermal analysis. Simple thermal analysis. Measurements in gas phase. Examples of EMF measurements. Knudsen cell. (2) 3.preliminary exam EXERCISES (15): Auditory exercises (8). Lab practice. (7)
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☒ mixed e-learning ☐ field work ☐ independent study ☐ multimedia and the internet ☒ laboratory ☐ work with the mentor ☐ (other) 2.7. Comments:
2.8. Student responsibilities	Attendance to lectures min. 70 %. Attendance to lab practice 100 % (compensation of 2 exercises). Lab reports. Attendance to auditory exercises min. 70 %.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)						
Class attendance	1	Research		Practical training		
Experimental work	1	Report				
Essay		Seminar essay		(Other--describe)		
Tests		Oral exam	1	(Other—describe)		
Written exam	1	Project		(Other—describe)		

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Lab reports, results of preliminary exams as well as written and oral exams. Written exam could be replaced with successful preliminary exams.

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	T. Holjevac Grgurić, Experimental Techniques in Thermodynamics, Faculty of Metallurgy, Sisak.		https://www.simet.unizg.hr/nastava/predavanja/diplomski-sveucilisni-studij-metalurgija/1-godina-diplomskog-

			studija/eksperimentalne-tehnike-u-termodinamici-materijala/view
	V. Gontarev, Thermodynamics of materials, NTF, University of Ljubljana, Ljubljana, 2005.	1	
	D. V. Ragone, Thermodynamics of Materials, John Wiley&Sons Inc., 1995.	1	
2.12. Optional literature (at the time of the submission of the study programme proposal)	T. Nishizawa, Thermodynamics of Microstructures, ASM International, 2008.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Internal student survey. Analysis of attendance to lectures and exercises, results of preliminary exams as well as oral exams. Survey at the Faculty and University level. Analysis provided the quality assurance system of the institution.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Implement the basic thermodynamic laws and thermodynamic parameters essentials for understanding of physical and chemical processes in materials, as well as the technology of material preparation.	1st, 2nd and 3rd colloquium, written and oral exam
2	Understand principles of chemical and physical equilibrium.	1st colloquium, written and oral exam, exercises
3	Introduce to thermodynamic predictions by symmetric and asymmetric models.	2nd colloquium, written and oral exam, exercises
4	Use CALPHAD method and Thermo-Calc software for prediction of stable phases in multicomponent alloys.	2nd colloquium, written and oral exam, exercises
5	Choose adequate experimental technique for determination of thermodynamic parameters and temperatures of phase transitions.	2nd and 3rd colloquium, written and oral exam, exercises

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Anita Štrkalj, PhD	1.6. Year of study	3
1.2. Name of the course	**WATER POLLUTION AND PROTECTION**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+0+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION			
2.1. Course objectives	Introducing students to the importance of protecting natural water resources and pollution. The study of different methods of treatment of polluted water.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. 2. Describe the present situation and developmental trends of modern industrial ecology. 3. Use the skills and knowledge of qualitative and quantitative analysis.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Explain the basic concepts related to water protection. 2. Define the impact of water pollution on human health. 3. Connect the sources of water pollution with consequences on the environment and human health. 4. Consider the method for treatment of drinking, industrial and agricultural water		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction (1). Water as an essential source of life (1). Introducing the legislation related to water as a component of ecosystems (3). Different types of water (3). Water protection measures (3). The study of various methods drinking water treatment such as disinfection, elimination of heavy metals ... (4) Preparation of water for industry (2). Wastewater (4) Methods of wastewater treatment: mechanical-biological, biological, physical-chemical, chemical (4). Introduction to the Water law, the EU Water Framework Directive and the Industrial Emissions Directive (4). Health standards related to water (1). SEMINAR (15): Preparation of seminar tasks (10). Oral presentation of seminar papers (5).		
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:
2.8. Student responsibilities	Conditions for signature: attendance at lectures min. 70%, attendance at seminar min. 70 %, submitted seminar paper in written form and orally presented.		

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)	Class attendance	0.5	Research	0.5	Practical training	
	Experimental work		Report			
	Essay		Seminar essay	0.5	(Other--describe)	
	Tests	0.5	Oral exam	2.0	(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Through continuous monitoring-student must pass two colloquiums. Through a final exam: written exam for the students who have not passed the exam through continuous monitoring or are not satisfied with the success from the exam that are achieved through continuous monitoring, or have not decided on this method of examination.					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	A. Štrkalj, Onečišćenje i zaštita voda, text of the lectures placed on website of Faculty of Metallurgy, Faculty of Metallurgy, Sisak, 2014.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija/3-godina-preddiplomskog-studija/oneciscenje-i-zastita-voda/view
	B. Tušar, Pročišćavanje otpadnih voda, Kigen d.o.o., Zagreb, 2009.	1	
	N. P. Chermisnoff, Handbook of Water and Wastewater Treatment Technologies, Butterwoth-Heinemann, Boston, 2002.		Electronic form

2.12. Optional literature (at the time of the submission of the study programme proposal)	T. J.Casey, Unit Treatment Processes in Water and Wastewater Engineering, John Wiley & Sons, New York, 1997. F. Valić, Zdravstvena ekologija, Medicinska naklada, Zagreb, 2001.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey at the Faculty and University level. Analysis provided the quality assurance system of the institution. Analysis provided the quality assurance system and authorized Office of the University.

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	Explain the basic concepts related to water protection.	Colloquium, written exam
2	Define the impact of water pollution on human health.	Colloquium, written exam
3	Connect the sources of water pollution with consequences on the environment and human health.	Colloquium, written exam
4	Consider the method for treatment of drinking, industrial and agricultural water.	Colloquium, seminar paper, written exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assist.Prof. Tahir Sofilić, PhD Assoc.Prof. Ivan Brnardić, PhD	1.6. Year of study	3
1.2. Name of the course	**POLLUTION AND PROTECTION OF SOIL**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+0+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Acquisition of knowledge about sources of soil pollution, relationship of air, soil and water pollution and protective measures. To define soil characteristics, methods of sustainable soil using and measurements for achieving aims for protection. To acquaint with legislative related to quality, planning and soil protection.
2.2. Enrolment requirements and required entry competences for the course	Listened Ecotoxicology, Inorganic Chemistry, Organic chemistry and Hazardous Substances In The Environment.
2.3. Learning outcomes at the level of the study programme to which the course contributes	Predict solutions for efficient waste management. Apply the regulations relevant to environmental protection in the production processes. Predict methods and identify samples for determining the causes of pollution of environmental components.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	To define sources of air and soil pollution. To analyze industrial processes from point of possible air and soil pollution sources. To define air and soil characteristics, soil composition and transport mechanism for soil pollution. To analyze possibilities of toxicological impact of polluted air and dangerous matter from soil on human health. To evaluate harmful impact of pollution on environment and to illustrate impact study for defined technical solution. To apply legislative about quality and protection of soil.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction, 1h Soil science, Earth structure, lithosphere and pedosphere, 2h The soil genesis and soil, 3h Pedogenic factors and processes, 2h Physical, chemical and biological properties of the soil, 2h Contamination of soil and soil types pollution, 3h Metals in the soil, 2h Radionuclides and polycyclic aromatic hydrocarbons in the soil, 2h Soil remediation, 4h Soil pollution from metallurgical processes, 5h Soil and soil protection strategy, 2h Measures to achieve the objectives of soil protection and ensuring sustainable use of soil, 2h

	SEMINAR (15): Instructions for the preparation of the seminar, 2h Topics presentation and selection, 1h Creating individual seminar work, supervision and corrections, 6h Making PPT of seminar work and preparing for presentation, 1h Presentation of seminar work, 5h **TESTS:** 1. Test Basic factors and processes for soil formation, general soil characteristics, physical characteristics of soils, mechanical composition of the soil / soil texture, soil structure, soil relative density, porosity of the soil, soil temperature, chemical soil characteristics, biological characteristics of the soil, Production-economic role of soil, Primary production of organic matter, Eco-regulatory role of soil, soil damage, classification of soil damage. 2. Test: Pollution as a form of soil damage, soil contaminants, most common pollutants in the soil, heavy metals in the soil, Polycyclic aromatic hydrocarbons in the soil, Persistent organic pollutants in the soil, radionuclides in the soil, limit values for pollutants in the soil, Condition of contaminated soil in Europe, Condition of contaminated soil in Croatia. Soil pollution from the manufacture processes, Soil pollution from the process of sintering iron ore, Soil pollution from the manufacturing BF process of iron, Soil pollution from the EAF steel production process, contamination of soil from temporary storage of scrap steel, Soil pollution from disposal of production waste, Soil pollution from casting industry. 3. Test: Bioremediation of soil, bioventilation, Phytoremediation, phytoextraction / Phytoaccumulation, Phytostabilization, Phytovoltization, chemical remediation, Electrochemical remediation, overflowing soil, soil washing, solidification / stabilization, natural cleaning, Physical remediation, Covering / encapsulation of soil, soil excavation, soil mixing, Thermal remediation, Incineration of soil, Vitrification / glazing of soil, solar photochemical degradation of the soil. Soil protection and the monitoring in the Republic of Croatia, protection of agricultural land in the Republic of Croatia, measures to protect agricultural soil from damage, soil protection legislation in the Republic of Croatia.
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work ☒ independent study ☐ multimedia and the internet ☐ laboratory ☒ work with the mentor ☐ (other) 2.7. Comments:
2.8. Student responsibilities	Students must attend more than 70% of lectures and make seminar.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)						
	Class attendance		Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	1	(Other--describe)	
	Tests	3	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction	Continuous monitoring through 3 mid tests or written and oral exam.					

and at a final exam			
2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	T. Sofilić, ONEČIŠĆENJE I ZAŠTITA TLA, skripta, Sveučilište u Zagrebu, Metalurški fakultet, 2014.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija
2.12. Optional literature (at the time of the submission of the study programme proposal)	F. Bašić, Oštećenje i zaštita tla - skripta, 2. izdanje, Agronomski fakultet sveučilišta u Zagrebu, 2009. I. Kisić, Sanacija onečišćenog tla, Agronomski fakultet Sveučilišta u Zagrebu, 2011. V. Čuljak, Rendgenska slika Hrvatske, Okoliš, br. 109, str. 6-7, 2001. M. Vihovanec, Tlo je medij života, Okoliš, br. 109, str. 3-4, 2001. M. Vihovanec, Dezertifikacija najviše pogađa siromašne, Okoliš, br. 109, str. 12-13, 2001.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Input and output of students ankets. Numerical analysis of tests and exams by scoring task by task at the course level. Survey on the faculty and University level. Analysis predicted by systems for insurance of institution quality.		

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	To define sources of air and soil pollution	1st colloquium, seminar, written and oral exam
2	To analyze industrial processes from point of possible air and soil pollution sources.	1st colloquium, seminar, written and oral exam
3	To define air and soil characteristics, soil composition and transport mechanism for soil pollution.	2nd colloquium, seminar, written and oral exam
4	To analyze possibilities of toxicological impact of polluted air and dangerous matter from soil on human health.	2nd colloquium, seminar, written and oral exam
5	To evaluate harmful impact of pollution on environment and to illustrate impact study for defined technical solution.	3rd colloquium, seminar, written and oral exam
6	To apply legislative about quality and protection of soil.	3rd colloquium, seminar, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Zdenka Zovko Brodarac, PhD Assoc.Prof. Ljerka Slokar, PhD Assoc.Prof. Stjepan Kožuh, PhD	1.6. Year of study	3
1.2. Name of the course	**MATERIALS RECYCLING**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+0+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	20
1.5. Status of the course	compulsory	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%
2. COURSE DESCRIPTION			
2.1. Course objectives	Introducing students to the basic concepts of materials recycling, methods of characterization and preparation of various materials. Explanation of basic steps of recycling various materials. Approaching the role of recycling to protect the environment and natural resources.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. Compare and choose the best available techniques (BAT) in environmental protection of the metallurgical process and other industries. Apply the regulations relevant to environmental protection in the production processes.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Define the terms and divide the different types of waste. Predict the economic feasibility of particular types of materials recycling. Predict and evaluate the recycling role in environment and natural resources protection. Design a materials recycle plan. Choose the optimal method of waste preparation and processing. Evaluate the success of waste recycling.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction to the course content and the method of acquiring knowledge. Introduction, Definitions, Legislation (2). The basics of recycling, recycling objectives and priorities (2). Analysis and criteria of recyclability, characterization and waste streams, organizational and technological aspects of recycling (4). The collection, identification, testing, separation and processing of materials for recycling (2). Recycling industrial products during and after the exploration. Technology, equipment and processes to recycle materials (2). Technological aspects of recycling aluminum and copper alloy (4). Technology of recycling cans. Recycling of automotive waste (4). Recycling of steel and cast iron (2). Recycling of polymers, wood, glass, textiles, rubber, etc. (4) The basics and specifics of recycling electronic waste, (2) effects of recycling (2)		

	SEMINAR (15): The selection of topics and seminar work in writing by the supervisor system (5). Preparation and presentation of the seminar and discussions related to the topic of the present paper (5). Visiting industrial entities engaged in recycling of various materials (5).

2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☒ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:

2.8. Student responsibilities	Attending the classes >70%. Seminar essay and presentation.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)						
	Class attendance	1	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	1	(Other--describe)	
	Tests	2	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Seminar essay. Three tests through continuous monitoring or final examination (written and oral).

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	H. F. Lund, The McGraw-Hill Recycling Handbook, McGraw-Hill, New York, 2001.	1	
	M. Allaby, Basics of Environmental Science, 2nd Edition, Routledge, London, 2000.	1	
	Aluminium Handbook 2, Forming, casting, surface treatment, recycling and ecology, Aluminium Verlag, Dusseldorf, 1998.	1	
	D. G. Altenpohl, Aluminium: Technology, application and environment, Pennsylvania, 1998.	1	
	L. D. Williams, Environmental Science Demystified, McGraw-Hill, New York, 2005.	1	

2.12. Optional literature (at the time of the submission of the study programme proposal)	-
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey at the Faculty and University level. Analysis provided the quality assurance system of the institution. Analysis provided the quality assurance system and authorized Office of the University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain the physical-chemical phenomena occurring during metals and alloys solidification process.	1st colloquium, written and oral exam
2	Explain the structural zones occurred during solidification of metals.	1st colloquium, written and oral exam
3	Compare and explain the metallurgical treatment of the melt.	2nd colloquium, written and oral exam
4	Compare and explain the influence of solidification conditions on development of castings microstructure and properties.	2nd colloquium, written and oral exam
5	Connect the conditions of solidification and melt metallurgical treatment with technological processes.	3rd colloquium, written and oral exam
6	Explain the physical-chemical phenomena occurring during metals and alloys solidification process.	3rd colloquium, seminar paper, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assist.Prof. Ivan Ivec, PhD	1.6. Year of study	3
1.2. Name of the course	**COMPUTER PROGRAMMING**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	10
1.5. Status of the course	elective	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	1) Create simple computer programs in the selected programming language. 2) Use ready-made software packages in engineering application. 3) Acquire competence to analyze engineering problem, design data and algorithms and implementation of a computer program that performs a calculation.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply acquired IT knowledge in engineering practice. Create simple computer applications and use them within existing in metallurgical processes.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1) Describe the engineering process of making a computer program at all stages: problem solving, solution design, implementation in a programming language, verification of accuracy and reliability. 2) Explain the importance of the design of solution of engineering problem. 3) Describe the concepts of functions, classes and objects and use them correctly in programming. 4) Identify and use appropriate algorithms/data structures in the developing a program that solves a new non-trivial engineering problem.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	1) Structure of the program, variables and data types. 2) Constants and operators. 3) Input-output commands, if-else control structure. 4) Loops: for, while, do-while; functions. 5) Functions: passing arguments by value and by reference, recursive functions. 6) Arrays and multidimensional arrays, strings. 7) 1st test, pointers. 8) Dynamic memory usage, structures, linked lists. 9) Classes, constructors and destructors. 10) Overloading operators, friendship and inheritance. 11) Polymorphisms, templates, namespaces. 12) Exceptions, type casting. 13) Preprocessor directives, C++ standard library. 14) Solving linear equations by Gaussian elimination method. 15) Repetition, 2nd test.

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)		2.7. Comments:		
2.8. Student responsibilities	Conditions for signature: attendance to lectures and exercisesmin 70%.						
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	1	Research		Practical training		
	Experimental work		Report				
	Essay		Seminar essay		(Other--describe)		
	Tests	1	Oral exam		(Other—describe)		
	Written exam	2	Project		(Other—describe)		
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Written exam: 80% Class attendance: 20%						

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Juan Soulié: C++ language tutorial.		http://www.cplusplus.com/files/tutorial.pdf

2.12. Optional literature (at the time of the submission of the study programme proposal)	Šribar, Motik, Demistificirani C++, II. izdanje, Element, Zagreb, 2001. S. Sarić, C#, PRO-MIL d.o.o., Varaždin, 2007.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey at the Faculty and University level. Analysis provided the quality assurance system of the institution. Analysis provided the quality assurance system and authorized Office of the University

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	Describe the engineering process of making a computer program at all stages: problem solving, solution design, implementation in a programming language, verification of accuracy and reliability.	1st colloquium, written exam
2	Explain the importance of the design of solution of engineering problem.	1st olloquium, written exam
3	Describe the concepts of functions, classes and objects and use them correctly in programming.	2nd colloquium, written exam
4	Identify and use appropriate algorithms/data structures in the developing a program that solves a new non-trivial engineering problem.	2nd colloquium, written exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assist.Prof. Tahir Sofilić, PhD Assoc.Prof. Tamara Holjevac Grgurić, PhD	1.6. Year of study	3
1.2. Name of the course	**HEALTH AND ENVIRONMENT**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+15+0+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	10
1.5. Status of the course	elective	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Health and environment - risk factors - better understanding of correlation between environmental and health risks. Reliable and accurate identification, evaluation and reduction / avoidance of risks to health and the environment. The procedures, methods, tools, techniques, objectives and principles of identification and prevention of environmental and health risks - Human and environmental biomonitoring.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Recognize the connection of health and ecological risks. Recognize the eco-toxicological effects on the environment. Predict methods and identify samples for determining the causes of pollution of environmental components.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Explain the sources and levels of pollution, and correlation of environmental and health risks. To assess the environmental and health risks. Apply and develop new technologies and procedures to better control of environmental and health risks (environmental and biological biomonitoring). Adjust the level of information, awareness and responsibility of individuals and companies to contribute to reducing the environmental and health risks. To respond to the challenges of health and environmental safety at the local, regional and global levels.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): The health effects of environmental factors, health and environmental standards, particulate matter and their effects on human health. (2) Ozone, nitrogen oxides, sulfur oxides, volatile organic compounds, the heavy metals in the air and their effects on human health. (2) Water pollution, sources, pollutants in water and their effects on human health. (2) Monitoring of soil pollution - monitoring the impact of pollutants in the soil to human health, the impact of heavy metals from soil to human health. (2) The influence of poly-aromatic hydrocarbons from soil to human health, the impact of organic compounds from soil to human health, the impact of pesticides from soil to human health. (2) Waste management and the impact of inefficient waste management on human health. (2) Environmental and noise pollution. (2) The noise in the big cities and its impact on human health. (2)

	The effects of noise on human health. (2) Light pollution, light pollution as a result of scattered light in the cities. (2) The impact of light pollution on human health. (2) Environmental pollution by electromagnetic radiation and its impact on human health. (2) Health risks and their assessment, management of health risks in the environment. (2) Using biomonitoring in risk assessment. (2) SEMINAR (15): Instructions for the preparation of the seminar. (2) Presentation of seminar topics and the selection. (1) Individual students work under supervision. (6) Written seminar and preparation of ppt presentation. (1) Oral presentations. (5) **PRELIMINARY EXAMS:** 1.preliminary exam. The health effects of environmental factors, health and environmental standards, particulate matter and their effects on human health, Ozone, nitrogen oxides, sulfur oxides, volatile organic compounds, the heavy metals in the air and their effects on human health, Water pollution, sources, pollutants in water and their effects on human health. 2.preliminary exam. Monitoring of soil pollution - monitoring the impact of pollutants in the soil to human health, the impact of heavy metals from soil to human health, The influence of poly-aromatic hydrocarbons from soil to human health, the impact of organic compounds from soil to human health, the impact of pesticides from soil to human health, Waste management and the impact of inefficient waste management on human health. 3.preliminary exam. Environmental and noise pollution, The noise in the big cities and its impact on human health, The effects of noise on human health, Light pollution, light pollution as a result of scattered light in the cities, The impact of light pollution on human health, Environmental pollution by electromagnetic radiation and its impact on human health, Health risks and their assessment, management of health risks in the environment, Using biomonitoring in risk assessment.
2.6. Type of instruction	☒ lectures ☒ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work ☒ independent study ☐ multimedia and the internet ☐ laboratory ☒ work with the mentor ☐ (other) 2.7. Comments : Seminar, continuous monitoring through three preliminary exams or written and oral exam.
2.8. Student responsibilities	Attendance to lectures min 70 %. Seminar.

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)						
	Class attendance		Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	1	(Other--describe)	
	Tests	3	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	

work over the course of instruction and at a final exam			
2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	T. Sofilić, Health and Envinroment, script, University of Zagreb Faculty of Metallurgy, 2015.		https://www.simet.unizg.hr/nastava/predavanja/preddiplomski-sveucilisni-studij-metalurgija
2.12. Optional literature (at the time of the submission of the study programme proposal)	D. Puntarić, M. Miškulin, J. Bošnir etc., Environmental health, Medicinska naklada, Zagreb, 2012. F. Valić etc., Environmental health, Medicinska naklada, Zagreb, 2001. F. Plavšić, Z. Lovrić, A. Wolf Čoporda, I. Z. Ježić Vidović, D. Čepelak Dodig, D. Gretić, S. Đurović, Safe working with chemicals, Hrvatski zavod za toksikologiju i antidoping i O-tisak d.o.o., Zagreb, 2014.		
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Input and output of students ankets. Numerical analysis of tests and exams by scoring task by task at the course level. Survey on the faculty and University level. Analysis predicted by systems for insurance of institution quality.		

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	Explain the sources and levels of pollution, and correlation of environmental and health risks.	1st colloquium, seminar, written and oral exam
2	To assess the environmental and health risks.	1st colloquium, seminar, written and oral exam
3	Apply and develop new technologies and procedures to better control of environmental and health risks (environmental and biological biomonitoring).	2nd colloquium, seminar, written and oral exam
4	Adjust the level of information, awareness and responsibility of individuals and companies to contribute to reducing the environmental and health risks.	3rd colloquium, seminar, written and oral exam
5	To respond to the challenges of health and environmental safety at the local, regional and global levels.	3rd colloquium, seminar, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Stjepan Kožuh, PhD	1.6. Year of study	3
1.2. Name of the course	**LABELING OF PRODUCTS AND PACKAGING**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	10
1.5. Status of the course	elective	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Introduce students to the ecological labeling of products and packaging. Explain the types of eco labels. Explain the methods and procedures for awarding marks.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. Apply the regulations relevant to environmental protection in the production processes.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Explain the types of eco labeling. Describe the different programs of labeling. Define procedure of labeling. Express methods of evaluation and verification programs for ECO labeling of products. Identify eco-labels on the packaging. Describe a practical example of ECO labeling.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	Week 1: Introduction, eco-labeling terms, definitions, standardization and types of eco labeling (2 hours) Week 2: General aspects of labeling in the environmental protection; Classification (2 hours). Week 3: Eco labeling Type I and national programs for the Type I labeling (2 hours). Week 4: Eco labeling program in the Republic of Croatia (2 hours). Week 5: The regional / international programs, Nordic Swan program, program of the European Union EU-ECU label (2 hours). Week 6: Global Network of ECO labeling (2 hours). Week 7: : Labelling in environmental Type II and review commonly used label Type II (2 hours). Week 8: Labelling in envirnonmental Type III (2 hours). Week 9: The method of evaluation and verification of programs for labelling in environmental (2 hours). Week 10: Effects of environmental labelling. Economic aspects of environmental labelling (2 hours). Week 11: Producer / consumer and labels (2 hours). Week 12: The classification of labels (2 hours). Weeks 13 and 14: Labeling of packaging materials (steel, aluminum, polymeric materials, paper and cardboard, tree, textiles, glass, composite materials, biodegradable materials) (4 hours).

	Week 15: The aspects of the future development for labeling of products and packaging to environment protection (2 hours). EXERCISES (15): Team and individual resolution of practical problems (tasks) in the field of eco-labelling.					
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities	Students must attend over 70% of lectures and are obliged to do the exercises.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)	Class attendance	1	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	3	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Evaluation of students activities in course, Evaluation of written examination (two colloquiums) through continuous monitoring or final examination (written and oral).

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	G. Burke, B. Singh, L. Theodore, Handbook of Environmental Management and Technology, John Wiley&Sons, New Yersey, 2005.	3	
	I. Budak, B. Kosec, J. Hodolić, B. Karpe, M. Stević, D. Vukelić, Environmental labelling of products, Fakultet tehničkih nauka, Novi Sad, 2009.	2	Electronic form
	C. Childs, S. Whiting, ECO-Labelling Green Design, University of Bradford, Bradford, 1998.	3	

2.12. Optional literature (at the time of the submission of the study programme proposal)	I. Budak, M. Ilić, B. Crnobrnja, B. Kosec, J. Hodolić, Analiza oznaka i deklaracija o zaštiti životne sredine tipa III prema ISO 14025:2000, Fakultet tehničkih nauka, Novi Sad, 2008. Scientific and professional papers in refereed journals and conference proceedings.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Input and output of students ankets. Questionnaire at Faculty and University. The analyzes provided a system of quality assurance institutions. The analyzes provided a system of quality and authorized office of University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain the types of eco-labelling	1st colloquium, oral exam
2	Describe the different programs of labelling	1st colloquium, written exam
3	Define procedure of labelling.	1st colloquium, auditory exercises, oral exam
4	Express methods of evaluation and verification programs of ECO labelling of products.	2nd colloquium, written exam
5	Identify eco-labels on the packaging.	2nd colloquium, written exam
6	Describe a practical example of ECO labelling.	2nd colloquium, auditory exercises, independent task

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Ivan Brnardić. PhD	1.6. Year of study	3
1.2. Name of the course	**RECYCLING OF ELECTRICAL AND ELECTRONIC WASTE**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	10
1.5. Status of the course	elective	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%
2. COURSE DESCRIPTION			
2.1. Course objectives	1. To introduce the principles of design and choice of materials due to the entire life cycle of electrical and electronic (EE) products. 2. To introduce the organization, procedures and effects of recycling of electrical and electronic (EE) waste. 3. To introduce methods, systems and equipment for recycling and ecological disposal at the end of the life cycle of electrical and electronic products.		
2.2. Enrolment requirements and required entry competences for the course	Knowledge on materials, work on computers and with computer applications		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. Predict solutions for efficient waste management. Describe waste characterization.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Acquire specific knowledge and skills of calculating recyclability for individual EE products. 2. Identify contemporary software tools for assessing the effects of EE products and processes on environment. 3. Define the types of EE products from which the WEEE is generated. 4. Explain procedures and describe the organization of recycling EE products. 5. Analyze recyclability of individual EE products. 6. Enumerate harmful substances in WEEE and describe their harmful effects.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Basics of recycling: Introduction. Technological, economic, organizational and social aspects of recycling. 1h Legislative and policy assessment. 2h Recycling in Croatia and other countries. Description of waste flow. Design for recycling. Basic concepts. The process of recycling. Preparation. Restoration (repair). 2h Instructions for products recycling. Marking of properties required for recycling. An example of a structure for recycling. The recycling of materials and products from household appliances. Evaluation based on recyclability. 3h Design for recycling. Eco-indicators. Life cycle of the product. What are eco-indicators? Human health. The quality of the ecosystem. Resources. Standard ecological indicators. The methodology for calculating the eco-indicators. Description of eco-indicators. The use of standard eco-indicators. The use of eco-indicators for complex products. 3 h Recycling analysis, classification and overview of WEEE recycling. Disassembly: manual and automated. The depth of disassembly. Mechanical procedures. Shredding procedures. 2h Examples of waste processing. The chemical procedures. Thermal processes. Development directions of waste processing.		

	The structure of materials of particular groups of EE waste. Example of household appliance for coffee. 2h Assessment and evaluation methods for disassembling. The method for dissembling estimation. Classical methods for dissembling analysis. Disassembling analysis. 2h Expert systems and artificial intelligence. Research of materials recycling. Quantitative evaluation methods for construction recycling. An example of an electric pencil sharpener. 2h Method for assessing of the recycle potential. Elementary indicators relevant for the recycling assessment. 2h Complex indicators. Short computing of products recycling. Modular and mobile systems for the WEEE recycling. 2h The organization and procedures of WEEE recycling. The place to storage, transport, drive and manipulation. 2h The recycling organization and procedures. Plant for the separation of oil and refrigerant gases from refrigeration equipment. Line: manual disassembly, the disassembly of a weight (not) exceeds 20 kg, for the dismantling of devices that have a cathode ray tube. 2h Disposal of components containing hazardous substances. Market Analysis of WEEE. Possible obstacles to conquer the market and their removal. 3h EXERCISES (15): through field work - visit the company for recycling of electrical and electronic equipment.

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☒ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:	
2.8. Student responsibilities	Regular attendance of lectures (70% of the lectures) and practical training through field work.			

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*						
Class attendance	0.5	Research		Practical training	1
Experimental work		Report			
Essay		Seminar essay		(Other--describe)	
Tests		Oral exam	1.25	(Other—describe)	
Written exam	1.25	Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Attendance on classes and practice, continuous monitoring – 2 preliminary exams or written and oral exam.

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	M. Kljajin, M. Opalić, A. Pintarić, Recikliranje električnih i elektroničkih proizvoda, Strojarski fakultet u Slavonskom Brodu, Slavonski Brod, 2006.	6	

2.12. Optional literature (at the time of the submission of the study programme proposal)	Lund, H. F. (Ed.), Ruckelshaus, W. D. Recycling Handbook, 2nd Edition, McGraww-Hill Professional, 2000. M. Šercer, D. Opsenica, G. Barić, Oporaba plastike i gume, Mtg topgraf d.o.o., Zagreb, 2000. B. Bilitewski, G. Härdtle, K. Marek, Abfall-Wirtschaft, Springer Verlag, Berlin, Heidelberg, 2000.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey on the faculty and University level. Analysis predicted by systems for insurance of institution quality. Analysis predicted by systems for insurance quality from authorized University office.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Acquire specific knowledge and skills of calculating recyclability for individual EE products.	1st colloquium, field work, written and oral exam
2	Identify contemporary software tools for assessing the effects of EE products and processes on environment.	1st colloquium, field work, written and oral exam
3	Define the types of EE products from which the WEEE is generated.	1st colloquium, field work, written and oral exam
4	Explain procedures and describe the organization of recycling EE products.	2nd colloquium, field work, written and oral exam
5	Analyze recyclability of individual EE products.	2nd colloquium, field work, written and oral exam
6	Enumerate harmful substances in WEEE and describe their harmful effects.	2nd colloquium, field work, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Zdenka Zovko Brodarac, PhD	1.6. Year of study	3
1.2. Name of the course	**SUSTAINABILITY OF FOUNDRY PROCESSES**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	10
1.5. Status of the course	elective	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%
2. COURSE DESCRIPTION			
2.1. Course objectives	Introduction to the basic stages of the process and plant in foundries. Introduction to methods of preparation and handling of raw materials. Introduction to basic methods of recycling metal.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Choose the most convenient form of energy from the perspective of sustainable development. Explain and apply the technology of metals' production, treatment and forming. Compare and choose the best available techniques (BAT) in environmental protection of the metallurgical process and other industries.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Explain the stages of the production process in foundries. Explain the methods of preparation, storage and handling of raw materials in foundries Explain the stages of metals recycling. Choosing the best available techniques for the production process of the corresponding metals.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction to the subject curriculum and scheduling maintenance Colloquium (1). Overview of foundry practice. Parameters of production of ferrous and non-ferrous alloys (5). The phases of the production process (flow charts) in the foundries focusing on alloys and the corresponding technologies (9). Raw materials and resources in foundries (5). Best available techniques related to procedures (7): • raw material handling • smelting and metallurgical treatment of the melt • making of molds and cores • casting • emissions from a process • water treatment • energy efficiency • regeneration of sand • treatment of dust and solid remains.		

	Comparison of parameters for certain types of castings and appropriate technology (3). EXERCISES (15): Field work: Visit to the relevant economic operators in the field of casting.					
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☒ field work		☒ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities	Attending the classes >70%. Seminar essay and presentation.					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)	Class attendance	1	Research		Practical training	
	Experimental work		Report	1		
	Essay		Seminar essay		(Other--describe)	
	Tests	2	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Independent task-Report: continuous work. Presentation after processed the relevant sections. Laying one colloquium through continuous monitoring or final examination (written and oral).

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Reference Document on Best Available Techniques in the Smitheries and Foundries Industry	1	

2.12. Optional literature (at the time of the submission of the study programme proposal)	-
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey at the Faculty and University level. Analysis provided the quality assurance system of the institution. Analysis provided the quality assurance system and authorized Office of the University

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	Define the terms and divide the different types of waste.	1st colloquium, auditory exercises, written and oral exam
2	Predict the economic feasibility of particular types of materials recycling.	1st colloquium, auditory exercises, written and oral exam
3	Predict and evaluate the recycling role in environment and natural resources protection.	2nd colloquium, auditory exercises, written and oral exam
4	Design a materials recycle plan.	2nd colloquium, auditory exercises, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Ljerka Slokar, PhD	1.6. Year of study	3
1.2. Name of the course	**WASTE CHARACTERIZATION**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	10
1.5. Status of the course	elective	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	Adopt theoretical and practical knowledge about the characterization of waste. Understand the issues related to the sampling and analysis of waste.
2.2. Enrolment requirements and required entry competences for the course	-
2.3. Learning outcomes at the level of the study programme to which the course contributes	Use the skills and knowledge of qualitative and quantitative analysis. Apply norms in the technical profession. Apply logical conclusion and precision in data processing. Recognize the eco-toxicological effects on the environment. Predict methods and identify samples for determining the causes of pollution of environmental components. Describe waste characterization.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Compare the physical and chemical characteristics to the microstructure of waste. Plan scientific research into environmental purposes. Carry out the proper sampling of waste analysis. Characterize samples of waste by appropriate methods and interpret the results.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction, definitions, classification and origin of solid waste (2). Luiqid and gasses waste, sludge from the industrial processes (4). Physical and chemical characteristics of waste (2). The strategy of scientific research in ecology. Defining a methodology for the study of waste. Theoretical basis of experimental analysis (2). Basics of methods for waste analysis (chromatographic, electrochemical, microscopic) (6). Planning the analytical experiments and sampling for ecological research (4). Basics of preparing the samples for analysis of waste (4). Waste characterization: determination of key number from the classification list of waste: type, appearance, waste description etc. (4). Examples of processing and interpretation of research results, and writing reports (2). LABORATORY EXERCISES (15): touring the labs and introducing to the equipment for the preparation and waste analysis (1). Preparation of metallic waste for analysis (3). Preparation of non-metallic waste for analysis (3). Analyis of prepared samples by selected methods (6). Processing and interpretation of the results and report writing of the performed investigation

	(2).					
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☐ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ independent study ☐ multimedia and the internet ☒ laboratory ☐ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities	Attending the classses (min. 70%).					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)	Class attendance	0.5	Research		Practical training	0.5
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	1.0	Oral exam	1.0	(Other—describe)	
	Written exam	1.0	Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	The final grade is determined by score of two colloquiums or assessments of written and oral exams respectively.					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	R. D. Spence, Chemistry and Microstructure of Solified Waste Forms, Lewis Publishers, SAD, 1993.		CD
	E. D. Ford, Scientific Method for Ecological Research, Cambridge University Press, Cambridge, 2004.		CD
	R. Conklin, Jr, R. Meinholtz, Field Sampling, Marcel Dekker, Inc, New York, 2004.		CD

2.12. Optional literature (at the time of the submission of the study programme proposal)	N. L. Nemerow, Industrial Waste Treatment, Elsevier Science & Technology Books, 2006. R. C. Gaur, Basic Environmental Engineering, New Age International Ltd Publishers, New Delhi, 2008. M. Radojevic, V. N. Bashkin, Practical Environmental Analysis, The Royal Society of Chemistry, Cambridge, 1999. Ch. Zhang, Fundamentals of Environmental Sampling and Analysis, John Wiley & Sons, New Jersey, 2007.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Anonymous survey on the level of the Faculty and University. Analysis provided by system of quality assurance institutions. Analyses provided by quality assurance system and authorized offices of the University.

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	Compare the physical and chemical characteristics to the microstructure of waste.	1st colloquium, laboratory exercises, written and oral exam
2	Plan scientific research into environmental purposes.	2nd colloquium, laboratory exercises, written and oral exam
3	Carry out the proper sampling of waste analysis.	2nd colloquium, laboratory exercises, written and oral exam
4	Characterize samples of waste by appropriate methods and interpret the results.	3rd colloquium, laboratory exercises, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Full Prof. Ladislav Lazić, PhD	1.6. Year of study	3
1.2. Name of the course	**RATIONAL USE OF ENERGY**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	10
1.5. Status of the course	elective	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION	
2.1. Course objectives	1. Acquire knowledge about the importance of energy security and the proper conduct of energy policy. 2. Acquire knowledge about the connection between energy and ecology. 3. Acquire knowledge about the various forms of energy and ways of their conversion. 4. Acquire knowledge about the methods and techniques of reducing energy consumption 5. Acquire knowledge for the implementation of the economic analysis of individual solutions for the rationalization of energy consumption.
2.2. Enrolment requirements and required entry competences for the course	The acquired knowledge from the course of undergraduate study: Technical Thermodynamics, Heat and Mass Transfer and Fuels and combustion.
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. 2. Compare and choose individual technological process. 3. Choose the most convenient form of energy from the perspective of sustainable development. 4. Calculate material and thermal balance of metallurgical processes.
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Identify devices, machines or aggregates where it is possible to implement the rationalization of energy consumption. 2. Analyze the causes of increased energy consumption. 3. Propose a method for increasing energy efficiency and reducing energy consumption. 4. Evaluate the effectiveness of applied method.
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): 1. Energy security and energy policy (2). 2. The meaning and forms of energy. Classification of energy forms (2). 3. Basic characteristics and reserves of non-renewable natural forms of energy (2). 4. Energy sources that can be renewed (2). 5. Conversion of energy forms (4). 6. Energy, ecology, environment (2). 1st colloquium 7. Energy management in the industry. The use of waste heat. Energy and materials. (6) 8. Heating systems, air conditioning and ventilation; Boiler rooms; Cooling stations. (6) 9. Economic analysis of elements and systems in the selection of equipment to reduce energy consumption (4). 2nd colloquium

	EXERCISES (15): Solution of practical problems facilitates the understanding of the subject material in lectures. The examples are selected so that they expand the presented theory and illustrate the application of theory to real problems.					
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work		☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)		2.7. Comments:	
2.8. Student responsibilities	Attendance on Lectures and Exercises > 70 %					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)	Class attendance	0.4	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	1.0	Oral exam	1.6	(Other—describe)	
	Written exam	1.0	Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Passed two tests through continuous monitoring or final exam (written and oral).					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	M. Matić, Gospodarenje energijom, Školska knjiga, Zagreb, 1995.	2	
	B. Udovičić, Energetika, Školska knjiga, Zagreb, 1993.	3	

2.12. Optional literature (at the time of the submission of the study programme proposal)	M. Matić, Energija i ekonomija, Školska knjiga, Zagreb, 1993.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey at the level of faculty and University. Analyses provided in the system of quality assurance of the institution. Analyses provided in the system of quality assurance and an authorized office of the University.

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	Identify devices, machines or aggregates where it is possible to implement the rationalization of energy consumption.	1st colloquium and oral exam
2	Analyze the causes of increased energy consumption.	1st colloquium and oral exam
3	Propose a method for increasing energy efficiency and reducing energy consumption.	2nd colloquium and oral exam
4	Evaluate the effectiveness of applied method..	2nd colloquium and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Ljerka Slokar, PhD	1.6. Year of study	2
1.2. Name of the course	**MODERN PROCEDURES OF MATERIALS PROCESSING**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	10
1.5. Status of the course	elective	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION			
2.1. Course objectives	Introduce the modern and the latest production procedures and design of metallic and non-metallic materials. Compare modern with conventional manufacturing processes regarding the technical and economic characteristics.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Get acquainted with new metallic materials and technologies and be able to apply them in practice. Describe and explain the modern technologies in the metallurgical practice. Compare and choose individual technological process. Describe the material production, select their types and explain their properties for a specific area of application. Apply the regulations relevant to environmental protection in the production processes.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Explain the basic types of modern procedures of materials processing. Define the application of modern procedures of materials processing. Select the technology of modern procedures of materials processing. Compare the microstructure and properties of materials produced by modern and conventional procedures.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction to modern technologies. Development chronology of development of materials processing procedures (2) Near net shape forming procedures of materials (2) Production and forming processes of materials: cold and hot isostatic pressing (4), laser sintering (2), injection molding of metals (2), forging (2), rolling (2) and extrusion of powder (2). Sintering (4) Comparison of conventional and modern processing and forming procedures of materials (2) Microstructure and properties of materials produced by modern procedures (4) Comparison of economic indicators of procedures (2) FIELD WORK (15): visits to the production subjects and laboratories.		
2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☒ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:

2.8. Student responsibilities	Attendance to classes (min (70%)					
2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)*:*	Class attendance	0.5	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay		(Other--describe)	
	Tests	1.5	Oral exam	1.0	(Other—describe)	
	Written exam	1.0	Project		(Other—describe)	
2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Grades of two colloquiums or written and oral exams respectively determine the final grade.					

2.11. Required literature (available at the library and via other media)	**Title**	**Number of copies at the library**	**Availability via other media**
	Lj. Slokar, Metalurgija praha i sinter materijali, Metalurški fakultet, Sisak, 2015.		https://www.simet.unizg.hr/nastava/predavanja/diplomski-sveucilisni-studij-metalurgija/2-godina-diplomskog-studija/METALURGIJA%20PRAHA%20I%20SINTER%20MATERIJALI.pdf/view
	T. Filetin, Pregled razvoja i primjene suvremenih materijala, HDMT, Zagreb, 2000.		http://hdmt.hr/wp-content/uploads/2016/03/1.pdf

2.12. Optional literature (at the time of the submission of the study programme proposal)	T. Filetin, Suvremeni materijali i postupci, HDMT, Zagreb, 2005. J. H. Gibbons, U. S. Congress, Office of Technology Assessment, Advanced Materials by Design, Washington, 1988.
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Anonymous survey on the level of the Faculty and University. Analysis provided by system of quality assurance institutions. Analyses provided by quality assurance system and authorized offices of the University.

Ordinal number	**Expected learning outcomes at the level of the course (4-10)**	**Methods for monitoring of the achievement of learning outcomes**
1	Explain the basic types of modern procedures of materials processing.	1st colloquium, written and oral exam
2	Define the application of modern procedures of materials processing.	1st colloquium, written and oral exam
3	Select the technology of modern procedures of materials processing.	2nd colloquium, written and oral exam
4	Compare the microstructure and properties of materials produced by modern and conventional procedures.	2nd colloquium, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Zdenka Zovko Brodarac, PhD	1.6. Year of study	3
1.2. Name of the course	**INTRODUCTION TO NUMERICAL SIMULATIONS**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergraduate	1.9. Expected enrolment in the course	10
1.5. Status of the course	elective	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%

2. COURSE DESCRIPTION			
2.1. Course objectives	Introduction to modern concepts of design and development of metal castings using of computer program packages. Getting acquainted with the procedures of castings, tools, models and prototypes construction by application of informatic technology. The use of computers in the planning of the production process by selecting materials and technologies.		
2.2. Enrolment requirements and required entry competences for the course	-		
2.3. Learning outcomes at the level of the study programme to which the course contributes	Apply acquired IT knowledge in engineering practice. Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. Describe the material production, select their types and explain their properties for a specific area of application.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	Explain the technological stages of the production process of castings. Compare and explain the modern concept of production of castings. Apply available information technology in the simulation process. Explain the results of numerical simulation of the process of casting and solidification.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	LECTURES (30): Introduction to the subject curriculum and scheduling maintenance Colloquium. (1) Introduction to the modern concept of production of castings. (5) Introduction to numerical simulation of casting and solidification. (5) Numerical simulation step by step. (15) Introduction to additive manufacturing procedures. (4) EXERCISES (15): Making stl models simple default casting. (4) The selection of materials and technology. (1) Numerical simulation of casting and solidification of a given model. (10).		
2.6. Type of instruction	☒ lectures	☒ independent study	2.7. Comments:

	☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	
2.8. Student responsibilities	Attending the classes >70%. Project work and presentation.		

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)	Class attendance	1	Research		Practical training	
	Experimental work		Report	1		
	Essay		Seminar essay		(Other--describe)	
	Tests	2	Oral exam		(Other—describe)	
	Written exam		Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	One test through continuous monitoring or final examination (written and oral). Independent task (report).

	Title	Number of copies at the library	Availability via other media
2.11. Required literature (available at the library and via other media)	Metals Handbook, Volume 15, CASTING, ASM International, Metals Park, Ohio, 1988. Dopunska literatura (1 do 5) 1 2	1	
	TMS, Modelling of casting, welding and advanced solidification processes, Illinois, 1998.	1	
	J. P. Womack, D. T. Jones, D. Roos, The machine that changed the world, New York, 1991.	1	
	M. Imaj, Kaizen, Ključ japanskog poslovnog uspjeha, Beograd, 2008.	1	

2.12. Optional literature (at the time of the submission of the study programme proposal)	-
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Survey at the Faculty and University level. Analysis provided the quality assurance system of the institution. Analysis provided the quality assurance system and authorized Office of the University

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Explain the technological stages of the production process of castings.	1st colloquium, laboratory exercises, written and oral exam
2	Compare and explain the modern concept of production of castings	1st colloquium, laboratory exercises, written and oral exam
3	Apply available information technology in the simulation process.	2nd colloquium, laboratory exercises, written and oral exam
4	Explain the results of numerical simulation of the process of casting and solidification.	2nd colloquium, laboratory exercises, written and oral exam

1. COURSE DECRIPTION – GENERAL INFORMATION			ISVU CODE:
1.1. Course teacher	Assoc.Prof. Vladimir Grozdanić, PhD	1.6. Year of study	3
1.2. Name of the course	**METALLURGY OF FERROALLOYS**	1.7. Credit value (ECTS)	4
1.3. Associate teachers	-	1.8. Type of instruction (number of hours L+S+E+e-learning)	30+0+15+0
1.4. Study programme (undergraduate, graduate, integrated)	undergaduate	1.9. Expected enrolment in the course	10
1.5. Status of the course	elective	1.10. Level of use of e-learning (1, 2, 3 level), percentage of instruction in the course on line (20% maximum)	1., 5%
2. COURSE DESCRIPTION			
2.1. Course objectives	1. Introduction students with basic and the most important ferroalloys. 2. Introduction students with the most important qualities and characteristics of ferroalloys. 3. Establish importance of basic (the most important) alloying elements in particular ferroalloys, and introduction students with the most important technologies of ferroalloys production. 4. Prepare students for independent calculation of composition mixture for production of Fe-Mn.		
2.2. Enrolment requirements and required entry competences for the course			
2.3. Learning outcomes at the level of the study programme to which the course contributes	1. Analyse the present situation, identify problems, formulate and recommend the optimal technological solution by using the knowledge acquired. 2.Compare and choose individual technological process. 3.Calculate material and thermal balance of metallurgical processes.		
2.4. Expected learning outcomes at the level of the course (4-10 learning outcomes)	1. Formulate the most important ferroalloys and technologies of their production. 2. Explaine choice of particular ferroalloys in selection adequate technology. 3. Choose ferroalloys for production of particular quality of steel. 4. Calculate balance fundamental components of technology production ferroalloys. 5. Select aggregate for production of ferroalloys.		
2.5. Course content broken down in detail by weekly class schedule (syllabus)	1. L: Ferroalloys. Fundamentals. Sort. Use. Importance. E: Ferroalloys. 2.L: The most important ferroalloys (on the basis of iron). Use (today). E: Ferroalloys production. Raw materials. 3. L: Basic raw materials and auxiliary materials for ferroalloys production. E: Production of ferroalloys. Aggregate. 4. L: Aggregates for ferroalloys production. E: Calculation of composition of mixture for production Fe-Mn (arithmetical problem). 5. L: Physical – chemical characteristics. Alloying elements. Balances. E: Calculation of composition for production Fe-Mn (arithmetical problem). 6. L: Basic processes of ferroalloys production. Carbothermical processes. E:Calculation of composition of mixture for production Fe-Mn (arithmetical problem). 7. L: Basic processes of ferroalloys production. Silicathermical processes. E: Carbotermical processes. 8. L: Basic processes of ferroalloys production. Metalothermical processes. E: Siliccatermical processes. 9. L:Metal. Slag. Gases. Treatment and care. E: Calculation of composition of mixture for production Fe-Si (arithmetical problem). 10. L:Fe – Mn. Sorts. Use. Way of production. Characteristics. E: Calculation of composition of mixture for production Fe-Si		

	(arithmetical problem). 11. L: Fe-Si. Sorts. Use. Way of production. Characteristics. E: Calculation of composition of mixture for production Fe-Si (arithmetical problem). 12. L:Fe-Cr. Fe-Ni. Sorts. Use. Way of production. Characteristics. E: Principles of processes of obtain ferroalloys. 13. L: Fe-Ti. Fe-Mo. Fe-V. Use. Characteristics. Significance. E: Basic processes of ferroalloys production. 14. L: New ferroalloys. Possibility of production. Use. E: New ferroalloys. 15. L: New ferroalloys. Possibility of production. Use. E: New ferroalloys.

2.6. Type of instruction	☒ lectures ☐ seminars and workshops ☒ exercises ☐ online in entirety ☐ mixed e-learning ☐ field work	☐ independent study ☐ multimedia and the internet ☐ laboratory ☐ work with the mentor ☐ (other)	2.7. Comments:

2.8. Student responsibilities	Conditions for signature: attendance to lectures and exercises min. 70%. Conditions for taking: -

2.9. Screening of student's work (specify the proportion of ECTS credits for each activity so that the total number of CTS credits is equal to the credit value of the course)	Class attendance	0.4	Research		Practical training	
	Experimental work		Report			
	Essay		Seminar essay	0.4	(Other--describe)	
	Tests		Oral exam	3.2	(Other—describe)	
	Written exam		Project		(Other—describe)	

2.10. Grading and evaluation of student work over the course of instruction and at a final exam	Attendance: 10 % Seminar essay: 10 % Oral exam: 80 %

	Title	Number of copies at the library	Availability via other media
2.11. Required literature (available at the library and via other media)	A. Riss, Y. Khodorovsky, Production of Ferroalloys, Foreign Languages Publishing H ouse, Moscow, 1991.	3	
	R. Durrer, G. Volkert, Metallurgie der Ferrolegirungen, 2.Aufl., Springer. Berlin, Heidelberg, New York, 1982.	1	

2.12. Optional literature (at the time of the submission of the study programme proposal)	-
2.13. Methods of monitoring quality that ensure acquisition of exit competences	Inquiry of graduated students. Survey on the level of faculty and University. Analysis anticipated by system of ensure quality of institution. Analysis anticipated by system of ensure quality and entitled office of University.

Ordinal number	Expected learning outcomes at the level of the course (4-10)	Methods for monitoring of the achievement of learning outcomes
1	Formulate the most important type of ferroalloys and technologies of their production.	Oral exam
2	Explain choice of particular ferroalloy in selection of adequate technology.	Oral exam
3	Choose ferroalloys for production of particular quality of steel.	Oral exam
4	Calculate balance fundamental components of technology production ferroalloys.	Seminar paper
5	Select aggregate for production of ferroalloys.	Oral exam