Department: Materials and Metallurgy - Winter Semester

No.	Course	Descrition of course	Level of studies	Hours				ECTS	Lecturer	Completely in English	Consultations in English
				Lectures	Seminars	Practice	Project work				
1	THERMODYNAMIC OF MATERIALS 1	The main objectives of this course are to teach students the thermodynamic laws and properties that the engineer of metallurgy and materials necessary for the understanding of the physico-chemical processes in materials and manufacturing technologies of these. **Competencies:** Students acquire thermodynamic laws, basic thermodynamics of liquid and solid solutions, chemical and phase equilibria in materials, fundamentals of kinetics and electrochemistry. All explanations are combined with a lot of calculation, enabling a better understanding of the processes in materials.	B.Sc.	45		30		5	prof.dr. Jožef Medved	depends on number of students	in case of small number of students
2	THERMODYNAMIC PRACTICUM (Only together with Thermodznamics of Materials 1)	Objective: Thermodynamic practicum is an upgrade ITEM Thermodynamics of materials. Student wins experimental techniques and evaluation of the results of basic thermodynamic methods of investigation and process engineering of non-ferrous metals. Competencies: Students in the practicum win the most important laboratory and "in-situ" methods of investigation of thermodynamics and kinetics of materials and evaluating the results. Students learn the basics of process engineering, non-ferrous metals.	B.Sc.	15		60		5	izr.prof.dr. Maja Vončina	depends on number of students	in case of small number of students
3	ALUMINIUM TECHNOLOGY	Aluminium is beside iron the second technically most useful metal. The properties of aluminium and its alloys like: small specific density, high strength, an advantageous relationship between strength and specific density, electrical and thermical conductivity, excellent formability, corrosion resistance and a simple and cheap recycling – enable its application in the all technically important sectors like: transport, building, construction, machinery, electrical, packaging, and consumer durable objects. Because of the increasing use and the constant improvements of the properties and manufacturing processes there appears, like at iron, a need to a deeper treatment of the topics in the research of aluminium as an independent subject. In the frame of this subject the student will get the knowledge about properties of aluminium materials in details and about the processes from the production to finalization and its application. The post-graduate bachelors of this field will have the possibility to get the employment in the firms producing and working aluminium, in the foundries in the metal-working industry and scientific institution.	M.Sc.	45	10	30		6	prof.dr. Jožef Medved, prof.dr. Aleš Nagode	depends on number of students	in case of small number of students
4	THERMODYNAMIC OF MATERIALS 2	The basis of the course is to teach the student basics of the thermodynamics in liquid and solid solutions, chemistry and phase equilibrium in materials, thermodynamics and kinetics of processes in solutions, that enables better understanding of processes in the materials. The students will learn about the thermodynamic basics of the phase diagrams, kinetics and diffusion and also chemistry. The lectures are complemented with seminar work, simulations and project work of planning, manufacturing and thermodynamic characterization of the materials.	M.Sc.	45	15		15	6	prof.dr. Jožef Medved	depends on number of students	in case of small number of students
1	PHYSICAL METALLURGY OF STEEL	The course covers topics on physical and chemical properties of iron, crystal structure, allotropy, measurements of temperature in phase transitions, diffusion, alloy systems of Fe- C and other elements, phase transformation in Fe-C system, impact of alloying elements on the constitution of phase diagrams and the course of transformation, heat treatment, mechanical processing and surface hardening.	B.Sc. Materials Engineering – First cycle university level, year 3, semester 5	45		30		5	prof. dr. Aleš Nagode	yes	
2	ALUMINIUM TECHNOLOGIES	Aluminium is, after iron, the second most useful metal technically speaking. The properties of aluminium and its alloys like: small specific density, high strength, an advantageous relationship between strength and specific density, electrical and thermical conductivity, excellent formability, corrosion resistance and simple and cheap recycling – enable its application in all technically important sectors like: transport, building, construction, machinery, electrical, packaging and consumer durable objects. Because of the increasing use and the constant improvements to the properties and manufacturing processes, there appears, like with iron, the need for deeper treatment of the topics in the research of aluminium as an independent subject. In the framework of this course, students will obtain knowledge about properties of aluminium materials in detail and about the processes from production to finalisation and application. Post-graduate bachelors of this field will have the possibility to gain employment in firms producing and working aluminium, in foundries in the metal-working industry and in scientific institutions.	M.Sc. Metallurgy and Materials Engineering – Second cycle university level, year 2	45	10	30	5	6	prof. dr. Jožef Medved, prof. dr. Aleš Nagode		yes (part of Aleš Nagode)
3	HEAT TREATMENT	The main procedure in making and processing metal materials is heat treatment of steels and alloys of non-ferrous metals. A controlled process of heat treatment leads to the formation of microstructures that define mechanical and technological properties of semi-products and final products. The goal of the course is to acquire theoretical foundations of structural changes occurring in the structure and microstructure of metals and alloys and transferring the knowledge into practice. Students will be able to autonomously plan and conduct heat treatment processes for various metal materials.	B.Sc. Metallurgical technology, Girst cycle Higher professional programme, year 3, semester 5	45		30		5	prof. dr. Aleš Nagode	yes	

11	FAILURE ANALYSIS	Mechanisms of failures and damages formation. The most frequent mechanisms of damages formation: fracture, brittle fracture, wear, fatigue, thermal fatigue, corrosion fatigue, stress corrosion, ... Study of residual stresses. Identification of failures and damages. Analyses. Examination methods. Physical methods: mechanical testing, metallographic examination methods, chemical analyses, corrosion tests. Non-destructive testing methods: optical examination methods, replicas methods, examinations by penetrants, radiography, neutronography, magnetic examination, ultrasonic examination. Failures at manufacturing and exploitation - examples. Study of cases of damages and machines breaking. Modeling. Numerical simulations. Standards. Rules. Patents. Working and preparation of exspertises, reports and expert elaborates. Methodology, requirements and rules of work and preparation of expert elaborates for courts, insurance companies and other clients. Presentations. Project work. Individual preparation of expertise or expert work.	B.Sc. Metallurgy and Materials Engineering – Second cycle university level, year 2	40		20	60	4	Borut Kosec, prof. dr. Ale	Yes	
12	INDUSTRIAL ECOLOGY AND ENERGETICS	General definitions. Environment. Natural sources. Environmental protection (ground, water and air protection, and noise protection). Emissions / imissions. Emissions types and quantity. Emissions quantity measurements. Measures and possibilities for emissions reduction. Pollution control. Monitoring. Fundamental principles of the waste management. Waste control. Collection, stocking and removing. Waste handling. Methods of waste processing and methods of waste removing. Waste management. Documentation for waste management. Evidence of waste handling. Evidence of wrapping and waste wrapping. Expert waste evaluation. Waste management plan. Control measurements and monitoring. Enterprise licences. Determination of responsibility and authorization. Restoration of internal and external communication. Employees' qualification. Development and enterprises investitions. Industrial waste. Classification. Concept of waste handling. Separate waste collection. Cleaning devices for waste gases and water. Handling with solid waste. Energetic and material waste utilization. Recycling. Radioactive waste. Analyses of ecological critical points in production processes. Data collection, analyses and presentation. Modeling. Obligatory regulations on the protection of the environment. Systematic regulation in the field of waste in RS and EU. National environment protection program. Environment protection law. Environmental protection management system ISO 14001. ISO 14000 family standards. Management systems and certification. Presentation of standard ISO 14001. Scheme of production process achieved according to the standard ISO 14001. PDAC cycle. Case of material and ecological-energetic balance in technological department achieved according to standard ISO 14001. EMAS – scheme of environmental management and audit. Energy. Definitions. Energy units. Energetics balance of the Earth. Energy use in the World. Growing of primary energy consumption – analyses. Renewable / fossil fuel energy sources. Energy and environment. Emissions and imissions. Ozonic hole. Effect of heating of atmosphere. Greenhouse effect. Emissions CO2, SO2, NOx and solid particles emissions. Measures for emissions reduction. Trade with the quotes of emissions of greenhouse gases. European pollutant emission registers. Rational use of energy in metallurgical and process industry of materials. Power plant technology. Basic concepts. Using various forms of energy. Breakdown of machinery and equipment. Work, power, efficiency. Electric power generation in Republic Slovenia. Hydroelectric power plants. Thermoelectric power plants. Cogeneration of electric and thermal energy. Advantages. Nuclear power plants.	M.Sc. Metallurgy and Materials Engineering – Second cycle university level, year 1	45	15	15	15	6	prof.dr. Borut Kosec	Yes	
13	PHYSICAL METALLURGY II	Advanced descripiton and explanaion of processes in metals and alloys with regard to deformation, solidifaction of multi component alloys, solid state phenomenon etc. Crystallographic description of martensitic and other solid state transformations. Lectures are complemented with seminar work, simulations and characterization of materials.	M.Sc.	45	10	35		6	prof. dr. Markoli	Yes	
14	MATERIALS DESIGN	Basics of material design with focus on metallic and composite materials. Lectures are complemented with seminar work, simulations and characterization of materials and visitation to state of the art companies from the field of material dvelopment and design.	M.Sc.	45		45		6	prof. dr. Markoli	Yes	
15	CASTING TECHNIQUES	Casting production understanding by knowing various technologies such as permanent casting and sand casting technologies. Understanding of inner surface design and production. Emphasis on High pressure die casting technology with the knowledge of gating system design and casting technology preparation and emphasis on incestment casting technology with patern production by wax model production and 3D printed patern production.	M.Sc. Metallurgy and Materials Engineering – Second cycle university level, year 2	30	5	20	0	4	prof. dr. Primož Mrvar	Yes	in case of small number of students
16	FOUNDRY	Basics of foundry engineering with explanation of different casting technologies, used materials and casting alloys. Solidification of alloys and casting defects. Moulding technology by sand casting and preparation of sand casting technology by theoretical calculations. Experimentqal confirmation of tecnology.	B.Sc. Materials Engineering – First cycle university level, year 3, semester 5	45	0	30	0	5	prof. dr. Primož Mrvar	Yes	in case of small number of students
17	MANUFACTURING TECHNOLOGIES - CASTING	Basics of foundry engineering with explanation of different casting technologies, used materials and casting alloys. Solidification of alloys and casting defects. Moulding technology by sand casting and preparation of sand casting technology by theoretical calculations. Experimentqal confirmation of tecnology.	B.Sc. Metallurgical technology, Girst cycle Higher professional programme, year 3, semester 5	45	0	30	0	5	prof. dr. Primož Mrvar	Yes	in case of small number of students
18	COMPUTATIONAL MATERIALS SCIENCE	Learn key concepts and major topics in computer modelling through which materials scientists and metallurgists study and apply these methods on atomistic, microscopic and mesoscopic spatial scales to understand and predict phenomena and properties of materials. Students will get familiar with computational methods and will learn of their strengths and limitations. They will gain the ability to apply fundamental knowledge on materials modelling via computer simulations.Students will get familiar with computational methods and will learn of their strengths and limitations. They will gain the ability to apply fundamental knowledge on materials modelling via computer simulations.	M.Sc. Metallurgy and Materials Engineering – Second cycle university level, year 1	45	15	30	0	6	prof. dr. Goran Kugler	Yes	in case of small number of students

Department: Materials and Metallurgy - Summer Semester

	Course	Descrition of course	Level of studies	Hours				ECTS	Lecturer	Completely in English	Consultations in English
				Lectures	Seminars	Practice	Project work				
1	ENDURANCE OF MATERIALS	The aim of the course is to establish a common base for study of endurance of materials, i.e. wear resistance, thermal fatigue resistance, resistance on mechanical and thermomechanical fatigue resistance and plasticity of materials. The student is able to carry out laboratory assessment of material endurance as well as forecasting (assessment) of material service time using known mathematical models; moreover, the student acquires knowledge about the most important processes in materials during their service time, transfer of laboratory results in practice and selection material for specific applications. Furthermore, the student acquires the ability of integral consideration of influence of process parameters during material production on endurance characteristics of materials.	M.Sc.	30	15	15	60	6	prof. dr. Milan Terčelj	depends on number of students - shorter course	in case of small number of students
2	MANUFACTURING TECHNOLOGIES - FORMING	Goals: The student gets insight into numerous procedures of plastic forming and can evaluate them in terms of technological, economic and environmental factors. Students acquire basic knowledge about forming machines and tools. Using integral calculus, the student can define the loads acting on forming machines and tools for bulk and sheet forming. The topics of the course cover: understanding the interdependence between the machine/tool/ work-piece and the properties of the product; observation skills for the basic technological parameters such as: loads acting on the machine and tool, kinetics of the process and condition of the material, methods of quantitative determination and assessment of the influence of parameters on repeatability of the process, presses, forging machines, rolling stands, forming tools and technology of bulk forming, such as forging, rolling, extrusion, drawing and technology of sheet forming by bending, deep drawing and cutting.	B.Sc.	45	0	30	75	5	assist. prof. dr. David Bombač	depends on number of students - shorter course	in case of small number of students
3	NANOTECHNOLOGIES AND NANOMATERIALS	Objectives and competences: The course addresses the issues that underlie nanotechnology and nanomaterials. Prior knowledge of structures and chemical bonds together with knowledge of modern investigative methods used at the same time to produce nanomaterials and manipulate basic building blocks. Areas of application of nanomaterials and developments in future. Knowledge and understanding: Prior knowledge of chemistry, mathematics, physics and structure of materials is required to understand the content of the course. The purpose of the course is to familiarize students with the basics of nanomaterials and nanotechnologies. Theoretical bases are needed for further study and understanding of the processes and processes involved in the manufacture, processing and use of nanomaterials. Content (Syllabus outline): Spectroscopy, atomic force microscopy (AFM), tunneling electron microscopy (STM), magnetic force microscopy (MFM) and other methods. Fundamentals of spectroscopy, electrochemistry and electron microscopy. Nanotechnologies, nanoscale lithography, tip displacement nanolithography (DPN) electron lithography, nanosphere lithography (NSL), molecular and synthesis and synthesis at nanoscale, self-regulation, crystal growth at nanoscale, polymerization, nanoscale. Nanomaterials and their application. Smart materials, sensors, nanoscale biostructures, storage and capture, optics, magnets, energy, data, electronics, manufacturing techniques, modeling. Learning and teaching methods: The course is taught through lectures and tutorials. Grading system:Final course grade is comprised of: (a) written report, comprising 20 %, (b) written exam, comprising 40 % of final grade, (c) oral exam, comprising 40 % of final grade.	M.Sc.	35	10	30	90	6	prof. dr. Boštjan Markoli	depends on number of students - shorter course	in case of small number of students

4	MATERIALS DESIGN	General description: Students become acquainted with the systematic structure and parameters of materials, enabling understanding of the methodology of materials design. They learn to design a constitution, its origins and development and stability of macro-, micro-and nano-structures in relation to the properties and behaviour of materials. This knowledge is the basis for validation of existing innovative materials and design and development of metal and nonmetal materials. Obtain skills in establishing and directing modern development work in the selection of materials in relation to structure-property-purpose. Objectives and competences: Students become acquainted with the systematic, structure and parameters of materials, enabling understanding of the methodology of materials designing. They learn to design a constitution, its origins, development and stability of macro-, micro- and nano-structures in relation to the properties and behavior of materials. This knowledge is the basis for validation of existing innovative materials and design and development of metal and nonmetal materials. Get skills in establishing and directing a modern development work in the selection of materials in relation to structure-property-purpose. Knowledge and understanding: Declarative knowledge: Basics of the structure of materials and its types in micro-and nanolevel. The stability of structural components. Understanding the nature of disorders or defects in structure of materials and the impact thereof on the properties and interaction of chemical elements. Students prepare and independant seminar related to their involvement in the current projects. Content (Syllabus outline): Development and designing of materials: objectives, scope and reliability of the materials, the scheme and selection of materials, design methodology. Materials structure: origin, definition and analysis, basic types of two-phase and multiphase microstructures; dispersion, net structure, duplex and dual microstructure, the transition of one type to another microstructure and physical properties, nanostructures, glassy state. The stability of the microstructure: the causes and mechanisms of change, laminates and fibril formation, deformation and recrystallization textures, the method of strengthening and inhibition of micro- changes and nanostructural ingredients. Physico-chemical basics of designing: the interaction of elements, constitutional criteria of selection of components, application of phase diagrams, the definition of the matrix, additions and ingredients, principles	M.Sc.	45	0	45	0	6	prof. dr. Boštjan Markoli	depends on number of students - shorter course	in case of small number of students
5	MATERIALOGRAPHIC PRACTICUM	General description: The course covers and introduces non-destructive methods for material testing. The student acquires fundamental knowledge of the specific physical and chemical properties necessary for identifying and defining structural elements and components in metallic and non-metallic materials at the nano-, micro-, and macro-levels using non-destructive methods. They become acquainted with methods suitable for the practical analysis of structure and micro-chemical composition, and are trained for independent work and the appropriate selection of analytical methods based on specific tasks in material characterization. They master the skills of sample preparation and analysis using light microscopy, electron microanalysis, and microanalysis, and are actively introduced to methods for surface analysis. Objectives and competences: Objectives: To upgrade the knowledge of the structure and its impact on the properties of metals and alloys and other materials. Knowing the basic concepts of the constitution of alloys and criteria of occurrence of certain alloying systems for non- metallic materials and meeting the basic sample preparation procedures. Acquire knowledge and understanding of the typical methods from the field of characterization materials in general. Competencies: ability to read phase diagrams, which enables the understanding and interpretation of the observed microstructure and the constitution of the material in general. Expert knowledge of the physical background of the research methods. For computational and laboratory work to develop the skills of critical evaluation of addressed phenomena in metals and alloys, as well as other materials, and independently perform laboratory work. Students get the ability to select appropriate investigative methods. Knowledge and understanding: Declarative: knowledge and understanding of the rules of mixing of metals and alloy formation system in conjunction with the process of solidification of metallic materials. Knowledge of basic microstructural features typical representatives of technical alloys, which is transferrable on the characteristics of other non-metallic materials. Content (Syllabus outline): Light microscopy. Preparation of samples and detection of microstructure. Chemical and physical methods for detection of microstructure and contrasting researched area. Preparation processes interfering layers of samples and their use in materiallography. Ambulant metallography. Optical contrasting procedures. Apparatus	B.Sc.	20	0	40	60	4	prof. dr. Boštjan Markoli	depends on number of students - shorter course	in case of small number of students
6	MATERIALS ANALYSIS AND TESTING	Goals: acquiring knowledge about major mechanical and engineering testing methods used in laboratories or industrial scale. Students acquire theoretical foundations for each testing method and through practical work and exercises become autonomous for performing and evaluating tests.	B.Sc.	45	0	30	75	5	assist. prof. dr. Mitja Zorc	depends on number of students - shorter course	in case of small number of students
7	METALLURGY PRACTICALS	Goals: the course is given at an early stage for students to understand the major areas and issues of the Metallurgical Technology study programme. Through practicals, students become aware of the correlation between theoretical explanations and understanding of the phenomena observed in a laboratory and their applications as well as industrial processes of making melts – process technique, casting manufacturing – casting processes, bulk forming by rolling, formability, environmental monitoring of metallurgical gases and microstructure in the aforementioned processes.	B.Sc.	15	0	60	75	5	assist. prof. dr.Mitja Zorc at al.	depends on number of students - shorter course	in case of small number of students
8	THERMAL ENGINEERING CALCULATIONS	Goals: acquiring basic concepts about heat and temperature, fuels, combustion and mechanisms of heat transfer in nature and engineering. Students acquire skills for analysing heat engineering phenomena and heat transfer as well as skills for teamwork and use of professional literature and electronic information sources.	B.Sc.	30	15	30	75	5	prof. dr. Borut Kosec	depends on number of students - shorter course	in case of small number of students

9	MATERIALS RECYCLING	Goals: understanding the needs of waste material recycling from an economic and environmental point of view for already used and new materials. The recycling of steel and other metals is a cornerstone of the circular economy, transforming former waste into a vital resource. This process goes far beyond simply melting down scrap; it involves a sophisticated network of material recovery, including by-products such as slag and dust. In steelmaking, slag is no longer seen as a useless residue but as a valuable co-product. Once cooled and processed, this stony material replaces natural aggregates, and even serves as a high-quality fertiliser in agriculture. Similarly, the fine dust captured by filtration systems during production is recycled to reclaim valuable metals, while the residual material is safely rendered inert, closing the loop on hazardous waste. Energy recycling is the third pillar of this sustainable system. The high-temperature gases generated during metal processing are captured and used to power turbines, generating electricity. This energy recovery process significantly reduces reliance on fossil fuels. By meticulously reclaiming metal from scrap, repurposing slag and dust, and harnessing thermal energy, the metals industry is significantly lowering its carbon footprint, conserving natural resources, and demonstrating that industrial efficiency and environmental stewardship can coexist.	B.Sc.	45	0	30	75	5	assist. prof. dr. Matjaž Knap prof. dr. Jožef Medved	depends on number of students - shorter course	in case of small number of students
10	ACTICALS IN METALLURGICAL PROCESSES AND CASTI	The course is a follow up to the course on pyrometallurgy of iron and alloys and covers steel as well as non-ferrous metals. Students practise modelling of major pyrometallurgical and hydrometallurgical processes of metal extraction. During laboratory practicals, students acquire experimental methods and techniques for characterisation of refractory materials and different sand mixtures that are used in foundries and technology of gravity casting into disposable moulds. Through practical work and visualisation techniques, the course reinforces theoretical knowledge acquired through the course on Founding.	B.Sc.	15	0	60	75	5	prof. dr. Primož Mrvar assoc. prof. dr. Mitja Petrič assist. prof. dr. Tilen Balaško	depends on number of students - shorter course	in case of small number of students
11	PRODUCTION SYSTEMS IN SOLID STATE	Goals: acquiring methodology for planning forming technologies for manufacturing final metallurgical products with target properties, while considering forming properties of the material, operational characteristics of machines and equipment and conducting material through such processes. Students acquire knowledge about different possibilities of forming technologies in view of quality assurance and economicity of the process used as well as selection options of forming processes and acquire complex knowledge for planning the whole technological process, i.e. integration of individual elements of the process chain into a whole. Topics include: correlation between direction of the work piece movement and movement of the forming tool, deformation zone and thermo-mechanical control of material flow, thermo-mechanical impacts on forming properties in hot or cold processing, forming technology architecture, characteristics of production equipment and tools, kinetics of thermo-mechanically initiated metallurgical processes, control of target formed microstructure and shape, dimension and tolerance of the product. Information communication technologies for technology control.	B.Sc.	60	0	30	0	5	prof. dr. Goran Kugler	depends on number of students - shorter course	in case of small number of students